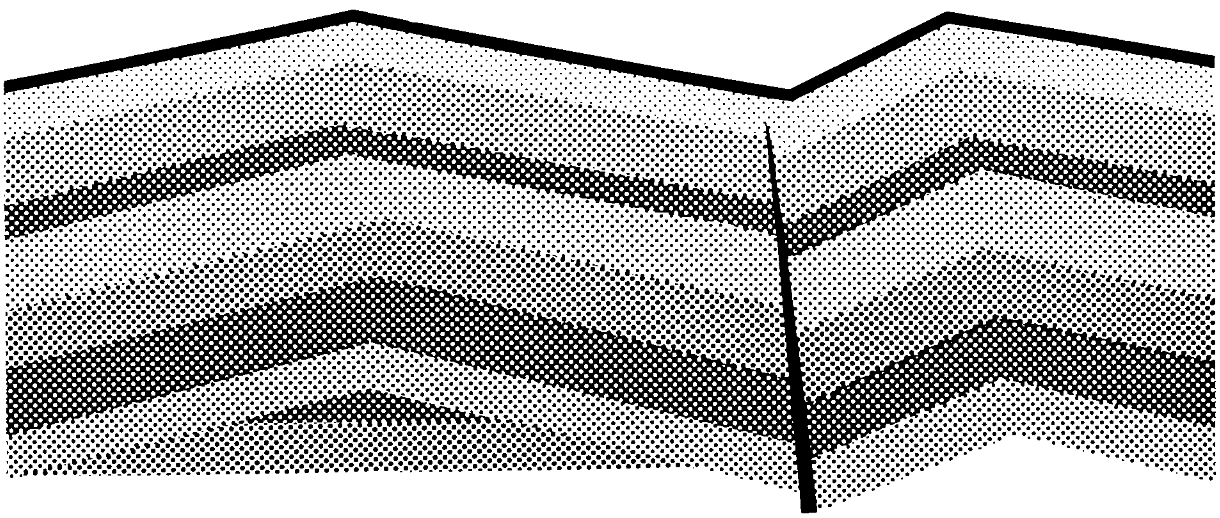
CANADIAN MINERALS YEARBOOK 1974



Mineral Report 24

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Foreword

This issue of the Canadian Minerals Yearbook is a report of developments in the industry for 1974. The 55 chapters dealing with specific commodities were issued in advance under the title Preprints, Canadian Minerals Yearbook 1974 to provide information as soon as possible to interested persons. The Statistical Summary prepared specifically for the Yearbook each year, deals with the overall position of the industry in its national and international perspective; it comprises 69 statistical tables not readily available from other sources. The Company Index provides full and accurate company names and a complete cross reference to corporate activities in the Canadian industry, supported again by pocket map 900A, Principal Mineral Areas of Canada.

The Yearbook is the permanent official record of the growth of the mineral industry in Canada and is preceded by similar reports under various titles dating back to 1886. Those wishing to refer to previous reports should consult departmental catalogues, available in most libraries.

The basic statistics on Canadian production, trade and consumption were collected by Statistics Canada, unless otherwise stated. Company data were obtained directly from company officials or corporate annual reports by the authors. Market quotations were mainly from standard marketing reports.

The Department of Energy, Mines and Resources is indebted to all who contributed the information necessary to compile this report.

October 1975

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Readers wishing more recent information than that contained in the present volume should obtain the 1975 series of preprints: a complete set costs $15.00; individual copies sell for 50¢ and may be obtained from Publishing Centre, Department of Supply and Services, Ottawa, Canada, K1A 0S9. For shipments outside Canada add 20 per cent to prices shown. Prices subject to change without notice.

Front End Leaf

In those cases where oil wells will not flow because of insufficient formation pressure in the reservoirs, the crude oil is extracted by pumping. The front end leaf depicts a pump jack operating in an oil field in northeast British Columbia. (Photo by John de Visser)

Frontispiece

A winter oil-drilling operation in northwest Alberta.

Contents

General Review

W.E. VAN STEENBURGH

The state of the Canadian economy 1974

The Canadian economy experienced slower growth in 1974 than in 1973, and the rate of inflation increased. Gross national product (GNP), at market prices, rose to $140.9 billion, which was 17.0 per cent higher than in 1973. After discounting the rise in overall prices, the growth in real GNP was 3.7 per cent. This real growth rate was below that experienced in any year since 1970. By comparison, real growth amounted to 6.8 per cent in 1973 and 5.8 per cent in 1972. Figure 1 shows the GNP and the GNP per capita from 1955 to 1974, in both current and constant dollars.

Corporation profits before taxes rose by 27.2 per cent in 1974, compared with 34.4 per cent in 1973 and 23.3 per cent in 1972. This pushed the profit share of GNP in 1974 to 13.0 per cent, which is high compared to historical values. On the other hand, labour income, which represents over one half of GNP, rose by 17.0 per cent in 1974, the largest rate of growth since 1951 and compared with an increase of 13.4 per cent in 1973.

During 1974, most industries had profit increases; especially strong growth was recorded in manufacturing, mining and trade. Within manufacturing, particularly large gains were recorded in paper and allied industries, primary metals, metal fabricating, machinery, electrical products, petroleum and coal products, and chemical and chemical products industries. All

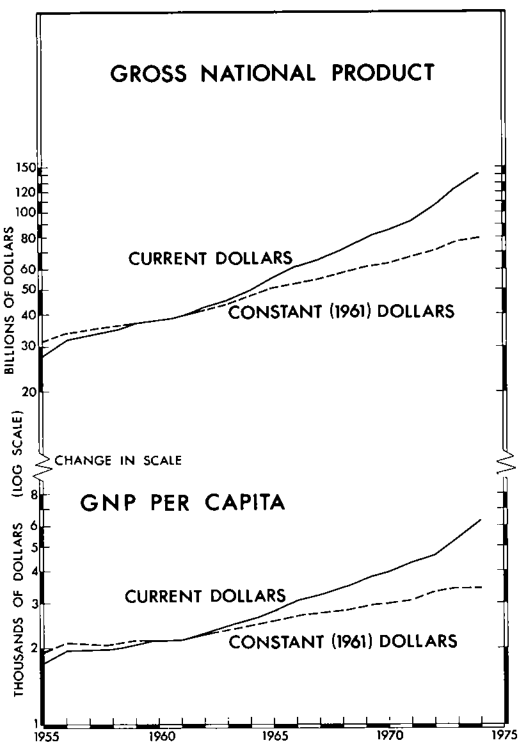


Figure 1

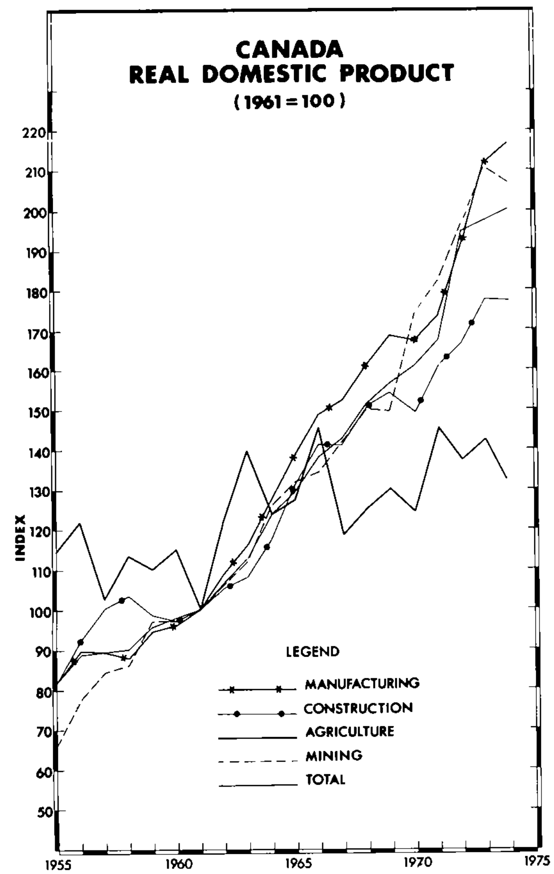


Figure 2

Statistical data were compiled by the Information Systems Division Staff from information provided by Statistics Canada.

mining groups — base metal mining, oil and gas mining and other mining — showed significant increases.

As in the previous year, a significant part of the rise in corporation profits and in non-farm unincorporated business income was due to inventory gains resulting from the turnover of goods at rising prices. This was indicated by the inventory valuation adjustment which is intended to remove from income those profits which do not reflect current production; this adjustment rose by 1.88 billion dollars in 1974.

Real domestic product (RDP). Figure 2 indicates the growth in RDP for selected Canadian industries since 1955. The RDP measures the country's output of goods and services and it differs from the GNP in that it is a measure of production rather than of the income of Canadians. The RDP index (1961 = 100) for all Canadian industries in December 1974 was 204.4 compared with 197.2 in 1973 — a rise of 3.7 per cent.

Mine, quarry, and oil-well (MQO) production decreased by 0.3 per cent in 1974 compared with 1973. In MQO, non-metal mine production increased by 11.3 per cent, metal mine production increased by 1.0 per cent and mineral fuel production decreased by 4.1 per cent. By comparison, manufacturing production increased by 3.0 per cent in 1974. In manufacturing, primary metal industries increased by 5.3 per cent in 1974, metal fabricating industries by 3.5 per cent, nonmetallic mineral products industries by 4.2 per cent and petroleum and coal products industries increased by 4.7 per cent.

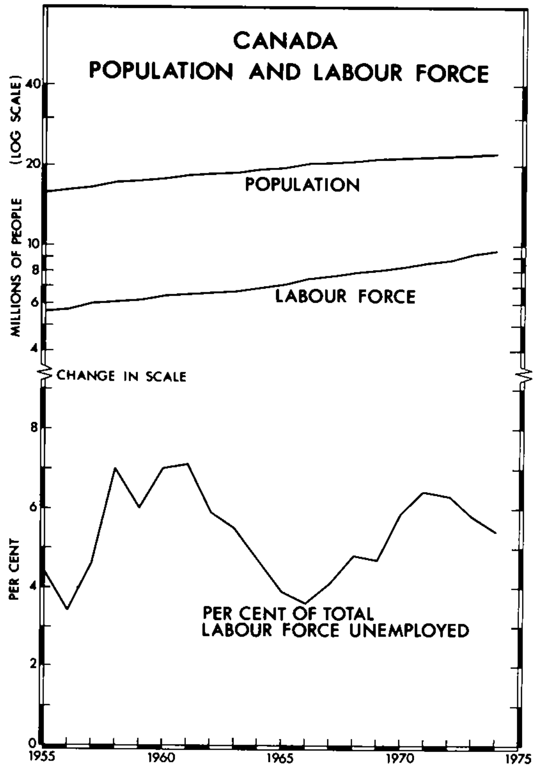


Figure 3

Labour force and unemployment. The year 1974 showed little improvement on the Canadian labour scene. The nation's total labour force increased by 4.1 per cent in 1974, from 9.28 to 9.66 million people, which was only slightly less than the 4.3 per cent growth in the labour force in 1973. However, the 1974 increase in employment was only 4.3 per cent compared with 5.2 per cent in 1973. As a result, unemployment increased by 5,000 people to a total of 525,000 people in 1974, compared to 42,000 people in 1973. The unemployment rate decreased marginally to 5.4 per cent in 1974 from 5.6 per cent in 1973. See Figure 3.

All regions shared in the growth of employment in 1974. The increase in British Columbia was 6.3 per cent (59,000 new jobs), Quebec 3.1 per cent (74,000 new jobs), Ontario 4.6 per cent (153,000 new jobs) and the Prairie Provinces 4.8 per cent (68,000 new jobs).

The service-producing sector provided the major contribution to the growth in employment in 1974, with an increase of 4.7 per cent or 261,000 people. By comparison, employment in the goods-producing sector grew at only 3.6 per cent or 117,000 people in 1974. Among industries in the goods-producing sector, mining employment showed an increase of 3.3 per cent or 4,000 people to a total of 127,000 people compared with a 0.8 per cent decrease in employment in 1973. Manufacturing employment had an increase of 2.9 per cent in 1974 (56,000 new jobs) compared with a 6.0 per cent increase in 1973. Employment growth in construction was 8.9 per cent in 1974 (49,000 new jobs) compared with 9.6 per cent in 1973. Labour disputes increased significantly in Canada in 1974.

Prices. Prices at both the retail and wholesale levels, continued to rise very sharply, in line with general inflation, a factor that was of concern during 1973 and 1974 in the industrialized countries. According to Statistics Canada, inflation* was 14.3 per cent in 1974. The price increases were originally due to world-wide demand pressures together with supply shortages, especially in the case of commodities such as raw materials (e.g., crude petroleum and metals) and food products. Later, cost increases contributed substantially to the inflation.

The Consumer Price Index (1961 = 100) which is designed to measure typical family living costs, went up to 175.8 in December 1974. This was a rise of 12.4

*Measured by the differences between overall GNP and real GNP.

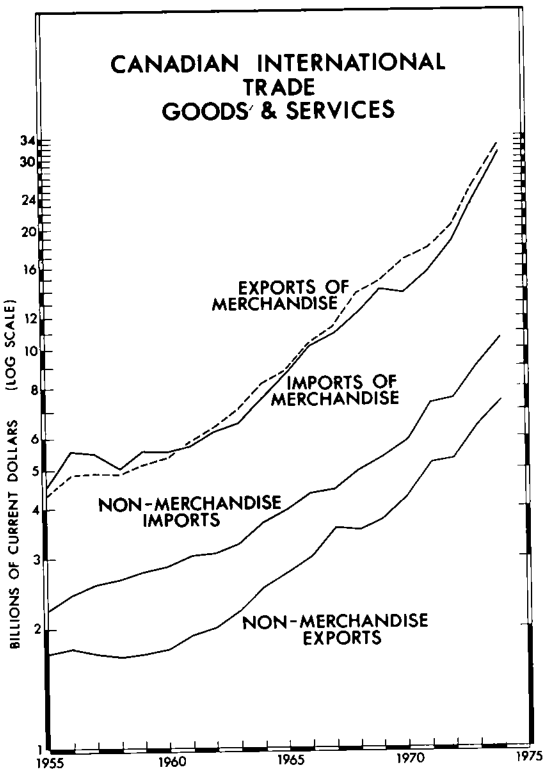


Figure 4

per cent over 1973. During 1974. food prices went up 17.1 per cent, housing 10.2 per cent, clothing 9.2 per cent, and health-personal care 10.9 per cent.

The purchasing power of the consumer dollar, in terms of 1961 prices, was 57 cents at the end of 1974.

Canada's seasonally adjusted wholesale price index (1935-39=100) was 482.0 in December 1974, a rise of 16.8 per cent over the previous 12 months. During this period the price of vegetable products went up 27.8 per cent, textile products 3.5 per cent, nonferrous metals 14.6 per cent, non-metallic minerals 27.7 per cent, and iron products 25.6 per cent.

Balance of international trade. Canada recorded a current account deficit of $1,643 million at the end of 1974, which represented a significant loss from the surplus of $18 million recorded in 1973. Both components of the current account showed a deteriorating balance; the surplus of merchandise trade decreased to $1,519 million in 1974 from $2,720 million in 1973 and the deficit for non-merchandise transactions increased to $3,162 million in 1974 from $2,702 million in 1973. Trends in the merchandise and non-merchandise trade

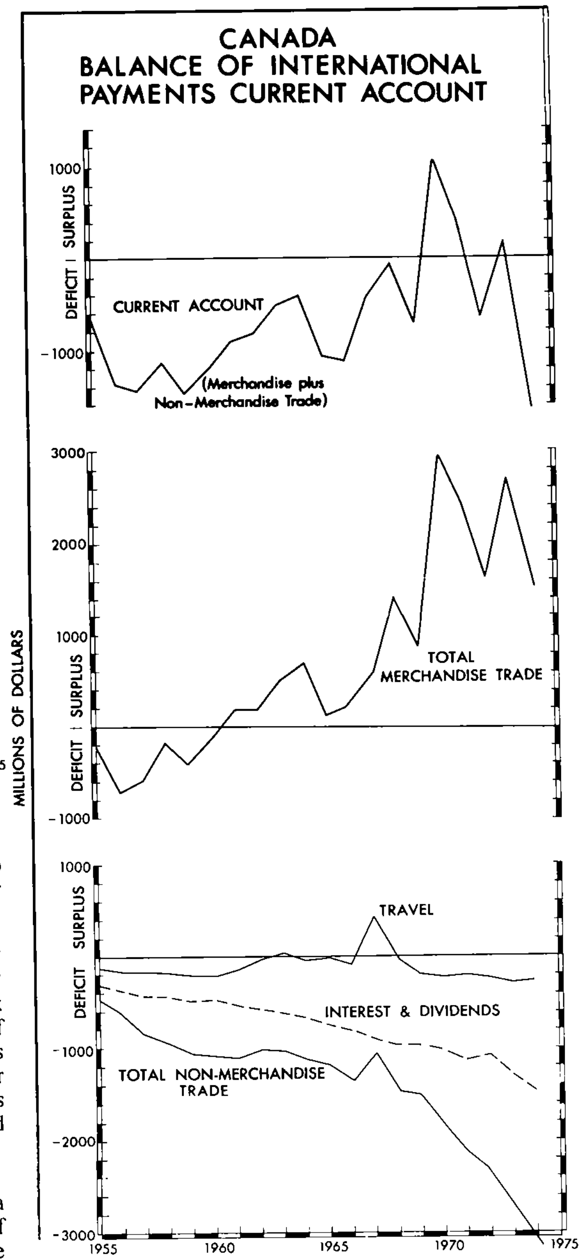


Figure 5

and current account from 1955 to 1974 are illustrated in Figures 4 and 5.

During 1974, the value of merchandise exports increased to $32,383 million, a gain of 27 per cent over 1973 — the largest growth in any year since 1951.

Major price increases for some of Canada's most important export commodities accounted for most of the total rise in the value of Canadian exports. There were substantial gains in the value of shipments to Canada's principal markets of the United States, the European Economic Community (EEC) and Japan. The United States market received about 66 per cent of total shipments in 1974. The largest increases in the value of exports were recorded for inedible crude and fabricated materials. On a commodity basis, increases were recorded for the value of shipments of wheat (67.9 per cent), crude petroleum (129.9 per cent), natural gas (40.7 per cent), coal and other crude bituminous substances (92.8 per cent), zinc in ores and concentrates (60.8 per cent), wood pulp (74.6 per cent), newsprint (34 per cent), fertilizer and fertilizer materials (49 per cent), iron and steel products (57.5 per cent), petroleum and coal products (96.2 per cent) and aluminum including alloys (37.2 per cent).

World-wide inflation, currency realignments, and the higher costs of petroleum in 1974, contributed to the rising prices of imports into Canada. The largest increases in imports were recorded from the United States, Japan, the EEC (including the United Kingdom), Venezuela, Iran, Australia, and Saudi Arabia. The major commodities accounting for the expansion in the value of imports included crude petroleum and coal, sugar, chemicals and plastics, fabricated steel materials, aircraft, automobiles, trucks, tractors and parts, and communication and related equipment.

The increased deficit for non-merchandise transactions in 1974 resulted from deteriorating deficits for most of the service transactions which more than offset the increased surpluses recorded for transfer payments. Within service transactions, the largest deficit was for interest and dividends which increased to $1,485 million in 1974 compared with $1,265 million in 1973. Freight and shipping and other service transactions also showed increased deficits. The only exception was travel, where the 1974 deficit was marginally less than in 1973. The various transfer payments such as inheritances and migrants' funds and withholding tax showed increased surpluses in 1974 over those of 1973.

During 1974 there were increases in the prices of both exports and imports. These increases were associated with Canadian and world-wide inflation as well as sharply rising international prices for some commodities caused by heavy demand and shortages of supply. Export prices rose faster than those for imports.

The rise in the export price index (1968 = 100) in 1974 was led by a 72.6 per cent increase in the index for crude materials, inedible; while the export price indexes for food, feed, beverages, and tobacco rose 50.7 per cent and fabricated materials 31.2 per cent. Export price indexes for commodities showing particularly strong increases were those of crude petroleum, up 192 per cent; wheat, up 101 per cent; rapeseed, up 72 per cent; and wood pulp, up 59 per cent. By comparison, the export price of natural gas and of coal both increased by 52 per cent in 1974, iron ores and concentrates by 17 per cent, copper ores and concentrates by 24 per cent and aluminum including alloys by 35 per cent.

On the import side, the largest increases were in the import price indexes (1968 = 100) for crude petroleum, up 217 per cent; sugar, up 180 per cent; petroleum and coal products, up 164 per cent; and coal, up 122 per cent.

Figure 6 illustrates the behaviour of the Net Capital Movement in the Canadian Balance of International Payments for 1955 to 1974. The net capital inflow in 1974 amounted to $1,667 million, a swing of over $2 billion from the net outflow of $485 million recorded in 1973. Net inflows of long-term capital in 1974 rose sharply by over $0.6 billion to $1,036 million. This mainly reflected increased sales of new Canadian issues abroad, fewer retirements of Canadian securities held by foreigners and less Canadian direct investment abroad which more than offset the drop in foreign direct investment in Canada. Short-term capital movements in 1974 led to a net capital inflow of $631 million, a rise of almost $1.5 billion from 1973. This inflow was mainly due to reduced holdings of foreign currencies by Canadian non-banking institutions.

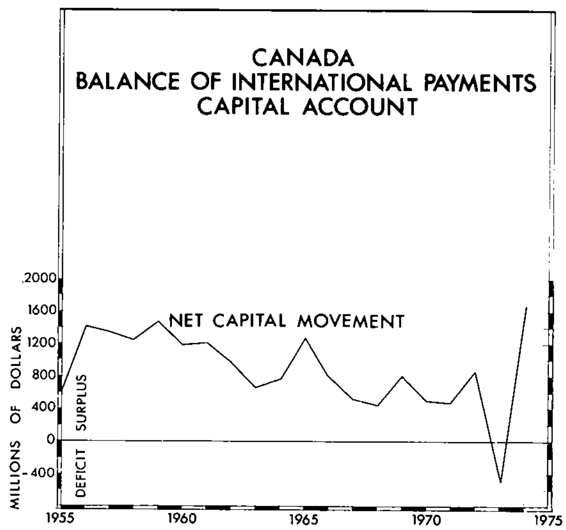


Figure 6

Capital and repair expenditures. Total investment, including both capital and repair expenditure on plant, machinery, equipment and construction in Canada during 1974, at current prices, was $41.1 billion. This was $6.9 billion or 20 per cent higher than in 1973.

Investments for 1974 were more substantial in the business sector than for the non-business sector. Sectors showing the largest percentage increases in 1974 compared with 1973 were manufacturing 27.2 per cent; forestry 26.5 per cent; agriculture and fishing 24.2 per cent; and finance, insurance and real estate 23.6 per cent. By comparison, mining quarrying and oil wells recorded a 17.7 per cent increase.

Investment trends in major Canadian industrial sectors from 1955 to 1974 and a forecast for 1975 are presented in Figure 7. Total investment is forecast at $46.6 billion for 1975, a rise of 13.3 per cent over 1974. Plans for the acquisition of new machinery and equipment are more buoyant than intended outlays on new construction. A particularly strong demand for capital expenditures is anticipated in the utilities sector for expanding programs of electric power, telephone, railway and urban transit systems. In manufacturing, large capital expenditures are expected for chemical products, primary metals, and paper mills.

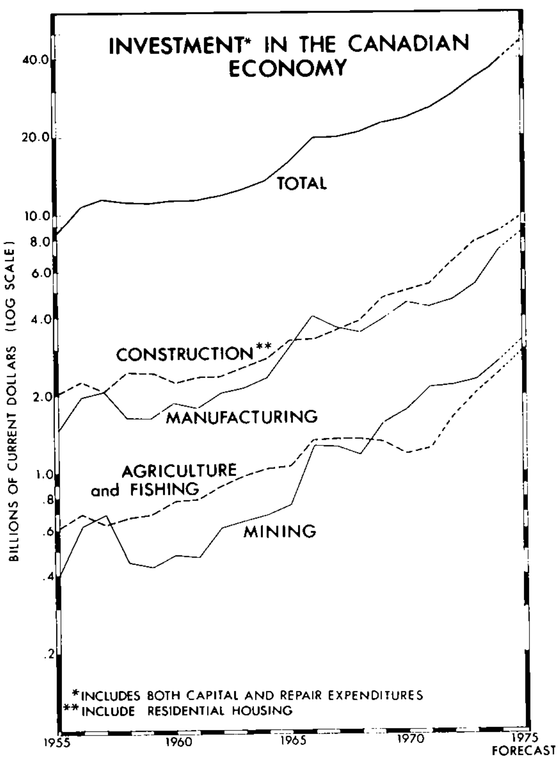


Figure 7

International background

Internationally, the year 1974 saw an accelerating rate of inflation and rising unemployment in most countries, a slowdown in economic growth, international monetary problems and a sharp escalation in energy costs, deeper imbalances in the balance of payments, fluctuations in international exchange rates, high interest rates, and increased labour unrest.

The oil crises, resulting from the concerted actions of the Organization of Petroleum Exporting Countries (OPEC) caused an almost fourfold increase in the posted price of crude oil between October 1973 and January 1974. The timing of the oil price rise was unfortunate for the industrialized economies. The world had just experienced more than a year-long period of commodity demand pressures, supply shortages, price increases, and rising expectations of further inflation. The oil price increase came at a time when there were signs that the commodity price boom was starting to decline. Firms passed on the energy-related cost increases in the selling price of their products. The commodity price boom was given a new lease on life. Wage demands increased due to the decline in the real purchasing power of employees and the anticipation of further inflation. The wage-price spiral continued. The rate of inflation increased.

The rate of inflation varied somewhat among countries. According to the Organization for Economic Cooperation and Development (OECD) statistics, consumer prices increased by 11 per cent in Canada and the United States in 1974, compared with 7.5 per cent and 6.2 per cent, respectively, in 1973; in Japan they increased by 23.2 per cent in 1974 compared with 11.7 per cent in 1973; Germany showed an increase of 7 per cent for both 1974 and 1973; and the United Kingdom had an increase in consumer prices of 16 per cent compared with 8.3 per cent in 1973.

The higher price of oil imports accentuated the balance of payment difficulties of a number of the oil-importing countries. The current account balance of the Federal Republic of Germany and the Netherlands remained positive in 1974, although to a lesser degree than in 1973; that of Canada and the United States went sharply negative in 1974 after a small surplus in 1973; and Japan, Italy and the United Kingdom had a larger current account deficit in 1974 than that existing in 1973. The balance of payments of some of the Less Developed Countries were even more adversely affected. In some cases, the commodities they exported were not among those subject to the commodity price boom. These countries were unable to substantially increase their exports either to the oil-producing countries or to the rest of the world. And their economies did not have sufficient potential and stability to attract adequate quantities of outside capital.

Most countries experienced a slowdown in economic growth in 1974, starting towards the latter half of the year. A number of factors contributed to the economic slowdown. Inflation was rampant, interest rates were generally high, business investment was down, consumer purchases were down for many types of goods, a number of governments had introduced restrictive fiscal and monetary policies to control inflation or correct the balance of payments problems, labour unrest was high, inventories were increasing, and there were delays or redistributions in the flow of money as the oil-producing countries started to spend their newly augmented wealth on goods and services or investment in the rest of the world. According to OECD statistics, Canada's economy* grew at 3.2 per cent in 1974 compared with 7.2 per cent in 1973; the United States grew at −1.7 per cent in 1974 compared with 5.5 per cent in 1973; Japan grew at −1.2 per cent in 1974 compared with 9.9 per cent in 1973; and the United Kingdom's economy grew at 0.5 per cent in 1974 compared with 5.4 per cent in 1973.

An International Energy Agency was established on November 15, 1974 under the auspices of the OECD. The Agency is to carry out a comprehensive program of cooperation both in the event of emergency and over the longer term, among sixteen oil-consumer countries (excluding France) belonging to OECD. The Agency is to work to promote cooperative relations with oil-producing nations and with other oil-consuming countries.

In June 1974, the International Monetary Fund (IMF) agreed to introduce several monetary reforms. These included, among other things, a new monetary system, effective July 1, to replace gold with a book-keeping-type entry known as Special Drawing Rights (SDRs) as the chief form of official credit exchange; new guidelines under which member countries will allow their currencies to fluctuate in value against one another; and an IMF facility to borrow money from oil-producing countries and lend to consumer countries facing balance of payments deficits due to higher oil prices.

Mineral industry

Mineral production. In 1974, the total output of the Canadian mineral industry, including metallics, non-metallics, structural materials and mineral fuels**, reached a record level of $11.6 billion, compared with $8.4 billion in 1973. This mainly reflected increases in price rather than in the actual quantities produced.

The highest production value was in the fuels sector, including coal, natural gas, natural gas byproducts and crude petroleum, which rose to $5.15 billion in 1974 from $3.23 billion in 1973. Alberta's output increased to $4.29 billion in 1974 from $2.68 billion in 1973.

Metal mining production had a value of $4.86 billion in 1974, up from $3.85 billion in 1973. Ontario was the leading province in metals output, with a production value of $2.07 billion, up from $1.48 billion in 1973.

In non-metals, production value was $887.3 million in 1974 compared with $614.4 million in 1973. Leading minerals in the group were: asbestos at $310.7 million in 1974, up from $234.3 million in 1973; and potash at $303.5 million, up from $176.9 million in 1973.

Total value of structural materials rose to $709.4 million in 1974, up from $673.1 in 1973. Leading materials were: cement at 244.7 million, up from $240.6 million; sand and gravel at $230.0 million, up from $213.4 million; and stone at $132.8 million, up from $127.6 million in 1973.

Figure 8 illustrates growth of the three major sectors of the Canadian mineral industry between 1955 and 1974. The value of mineral production has grown at about 10 per cent a year during the period, with metallics and mineral fuels growing at a higher rate

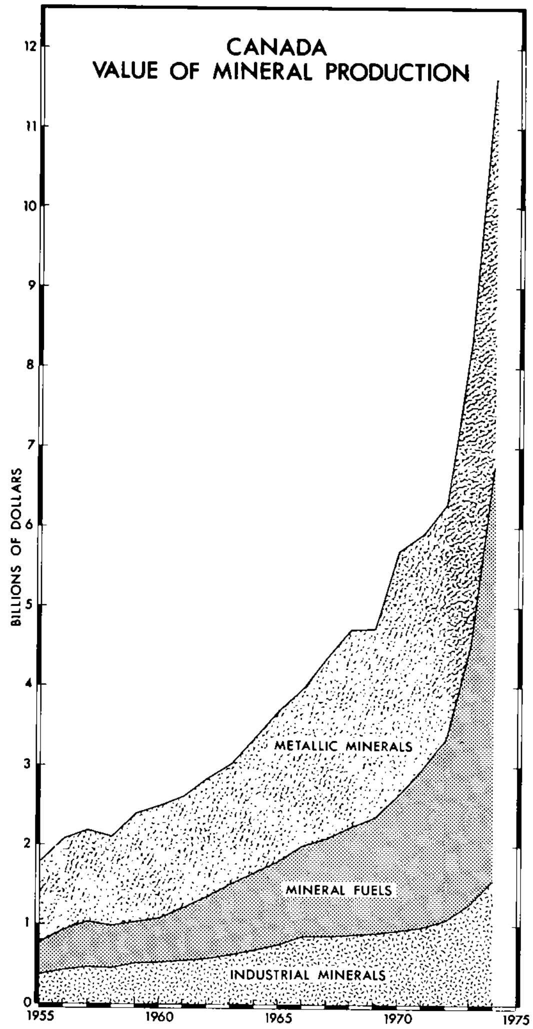


Figure 8

*Gross national product at constant prices (Gross domestic product for the UK)

**Fabricated mineral products are not included.

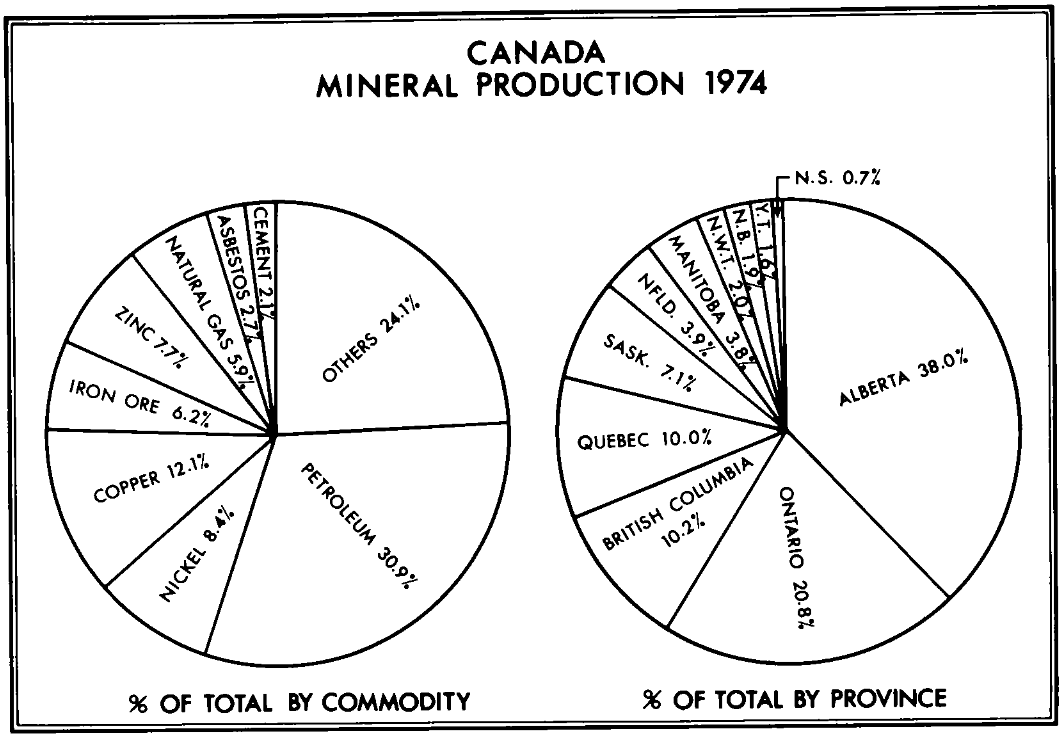


Figure 9

than the industrial minerals. During 1974, the *per capita* value of mineral production went up $138.8 million to $517.3, while mineral production, as a percentage of GNP, rose from 7.0 to 8.3.

Figure 9 shows mineral production by commodity and by province for 1974 in percentage terms. As in the past year, petroleum was the dominant mineral commodity in terms of value of output in 1974, with 30.9 per cent of the total. In terms of provincial mineral production, Alberta made the largest single contribution, 38.0 per cent of the total, followed by Ontario which contributed 20.8 per cent.

Mineral prices. The trends in general wholesale price indexes of mineral products since 1951 are shown in Figure 10. The iron product index reached 479.8 in December 1974 which was a 27.2 per cent increase over 1973, as compared with the nonferrous metals index which went up 14.6 per cent, the non-metallic minerals which rose 28.1 per cent and the general wholesale price index which rose 17.0 per cent.

The prices of most minerals went up in 1974. This was mainly due to inflation. At year-end, according to the *Northern Miner,* the Lake Erie price of iron ore was U.S. $18.50 a long ton in 1974 compared with $16.13 in 1973, the price of aluminum was 41¢ a pound in 1974 compared with 39¢ a pound in 1973, nickel (Port

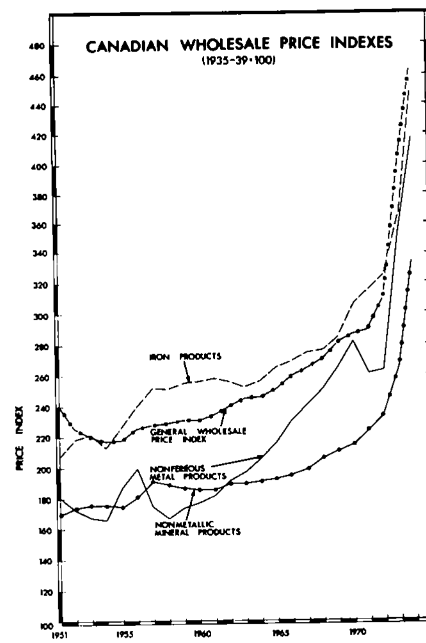


Figure 10

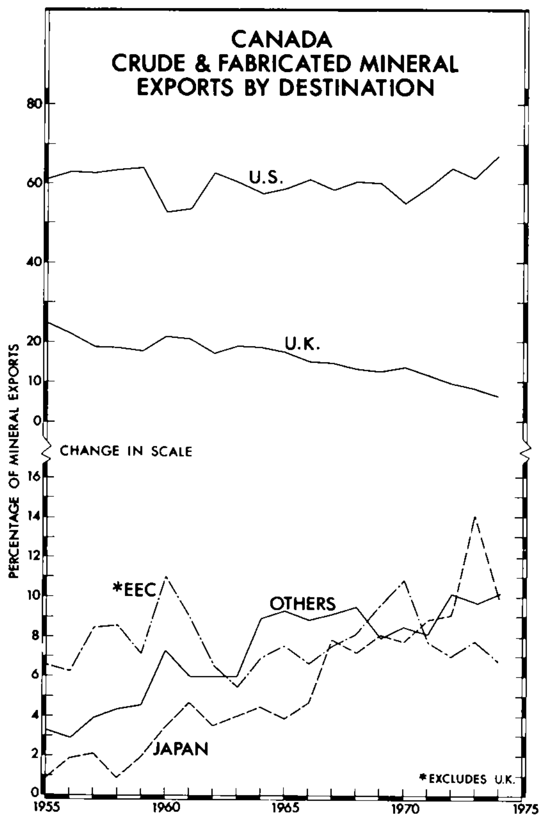


Figure 11

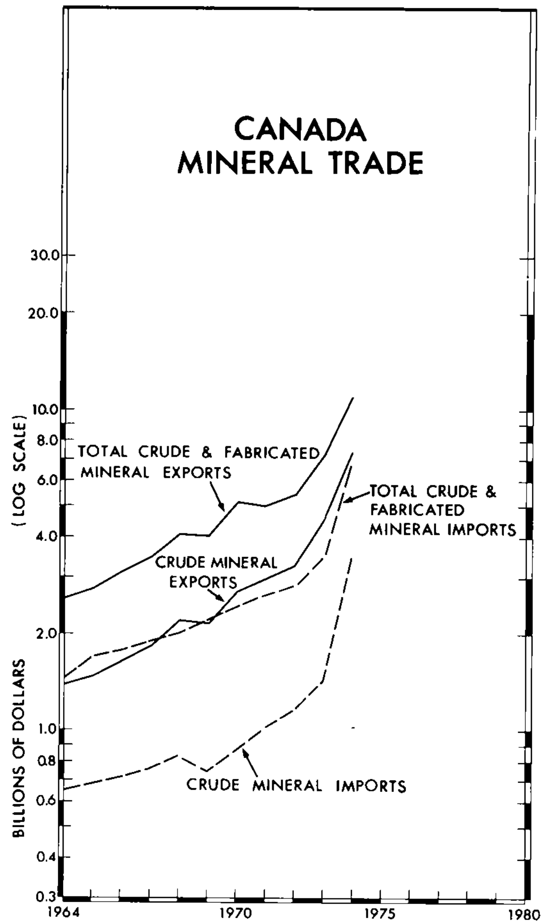


Figure 12

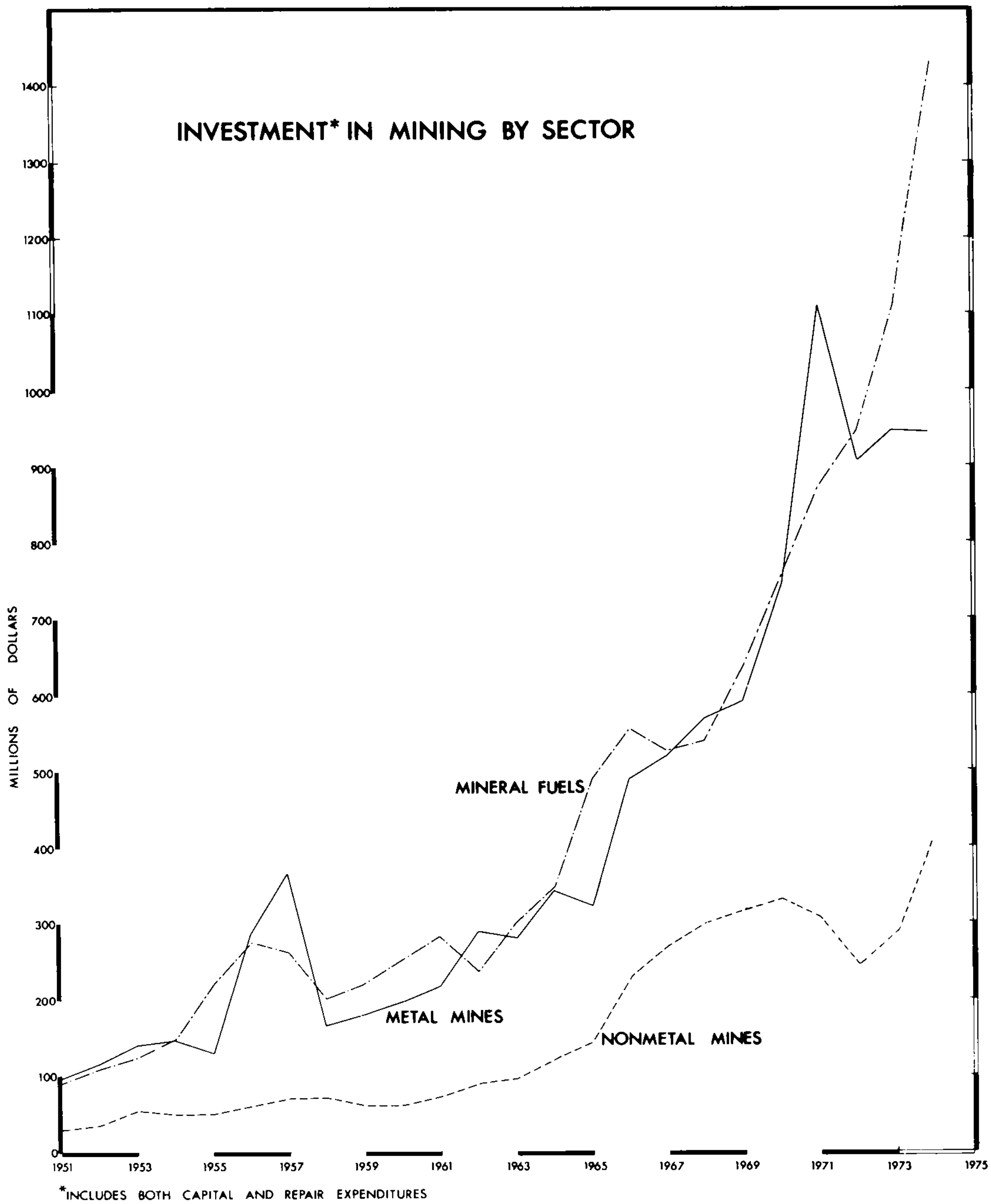
Colborne) was $2.20 a pound in 1974 compared with $1.89 in 1973, zinc 37¢ a pound up from 31 cents and copper was 73¢ a pound, down slightly from 74¢ a pound at the end of 1973.

Mineral trade. Canada exported $11.2 billion worth of crude and fabricated minerals during 1974, with the United States buying the bulk of mineral exports, 66.8 per cent, while Japan took 9.9 per cent, Britain 6.3 per cent, and the European Economic Community* 6.7 per cent. Figure 11 illustrates the declining share of mineral exports to Britain in the last decade and the fact that, in the case of Japan and other countries, they have increased in value. Canadian mineral exports to the United States were 5.0 per cent higher in 1974 than in 1973.

Trends in Canadian mineral trade since 1964 are given in Figure 12. At the end of 1974, the value of mineral exports, including both energy and non-energy minerals in crude and fabricated forms was $11,177 million, 47.7 per cent higher than a year ago. The share of mineral exports of crude and fabricated materials as a percentage of total Canadian export trade, which has been falling slowly between 1964 and 1972, improved somewhat during the last several years, from 28 per cent in 1972 to 30.5 per cent in 1973 to 35.6 per cent in 1974. During this period, mineral fabricated products, which were running at an average of about 12.8 per cent of total exports, recorded 12.1 per cent at the end of 1974, while crude minerals moved up from an average of about 17 per cent to 23.5 per cent.

Mineral investment. Trends in mineral investment in durable physical assets, including both capital and repair expenditures, for six major mineral sectors from 1951 to 1974 are illustrated in Figures 13 and 14. In mining, investment in mineral fuels in 1974 at $1.4 billion was 26.6 per cent higher than 1973, compared

*For this compilation, the EEC includes only the six original members, namely Belgium, France, Italy, Luxembourg, the Netherlands, and the Federal Republic of Germany.



INVESTMENT* IN MINING BY SECTOR
MILLIONS OF DOLLARS
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
MINERAL FUELS
METAL MINES
NONMETAL MINES
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
*INCLUDES BOTH CAPITAL AND REPAIR EXPENDITURES

Figure 13

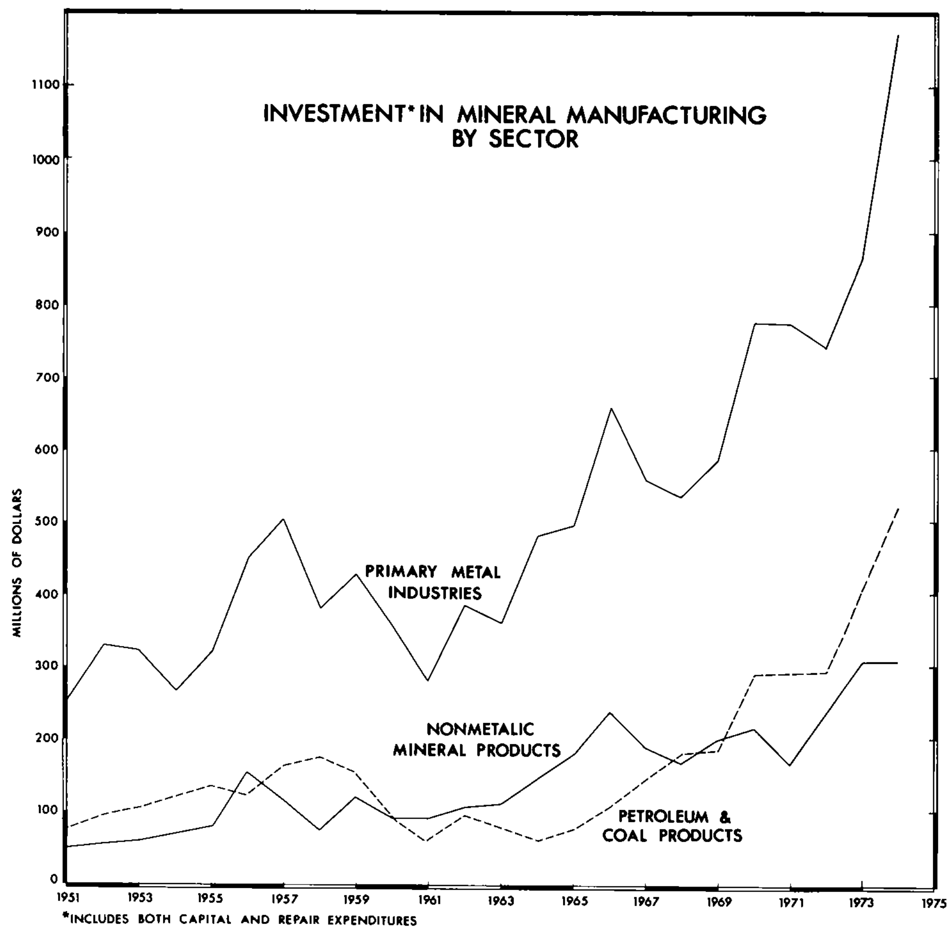


Figure 14

with nonmetal mines at $408.8 million that rose 41.5 per cent, and metal mines at $944.3 million that fell 0.2 per cent. Similarly, in mineral manufacturing, investment in nonmetallics at $308.5 million was 0.1 per cent higher than 1973, compared with petroleum and coal products at $520.1 million that rose 27.7 per cent and primary metals at $1,175 million that rose 36.1 per cent.

Return on invested capital. Figure 15 compares the average 1963-1974 rate of return on invested capital* given in per cent for various sectors of the Canadian mineral industries with the total of all Canadian industries. Among the various sectors presented, metal mines show the highest average rate of return at 12.7 per cent and mineral fuels the lowest at 7.7 per cent compared with the total of all Canadian industries at 11.0 per cent. The actual values in 1974 were higher than the average values. The rate of return in metal mines for 1974 was 18.8 per cent, in mineral fuels 17.7 per cent, and in all industries 16.1 per cent.

In the mining industries** the rate of return in 1974 was 18.2 per cent. This is much higher than the rate of return in the past ten years when the highest level was achieved at 13.5 per cent in 1973 and the lowest 7.2 per cent in 1972. In the mineral-based manufacturing industries*** the 1974 rate of return was 18.7 per cent. This rate is much higher than that experienced in the past ten years when it moved upward to 14.5 per cent

*Pre-tax profit/total assets minus total current liabilities.

**Includes metal mines, non-metal mining and mineral fuels.

***Includes primary metals, non-metallics and petroleum and coal products.

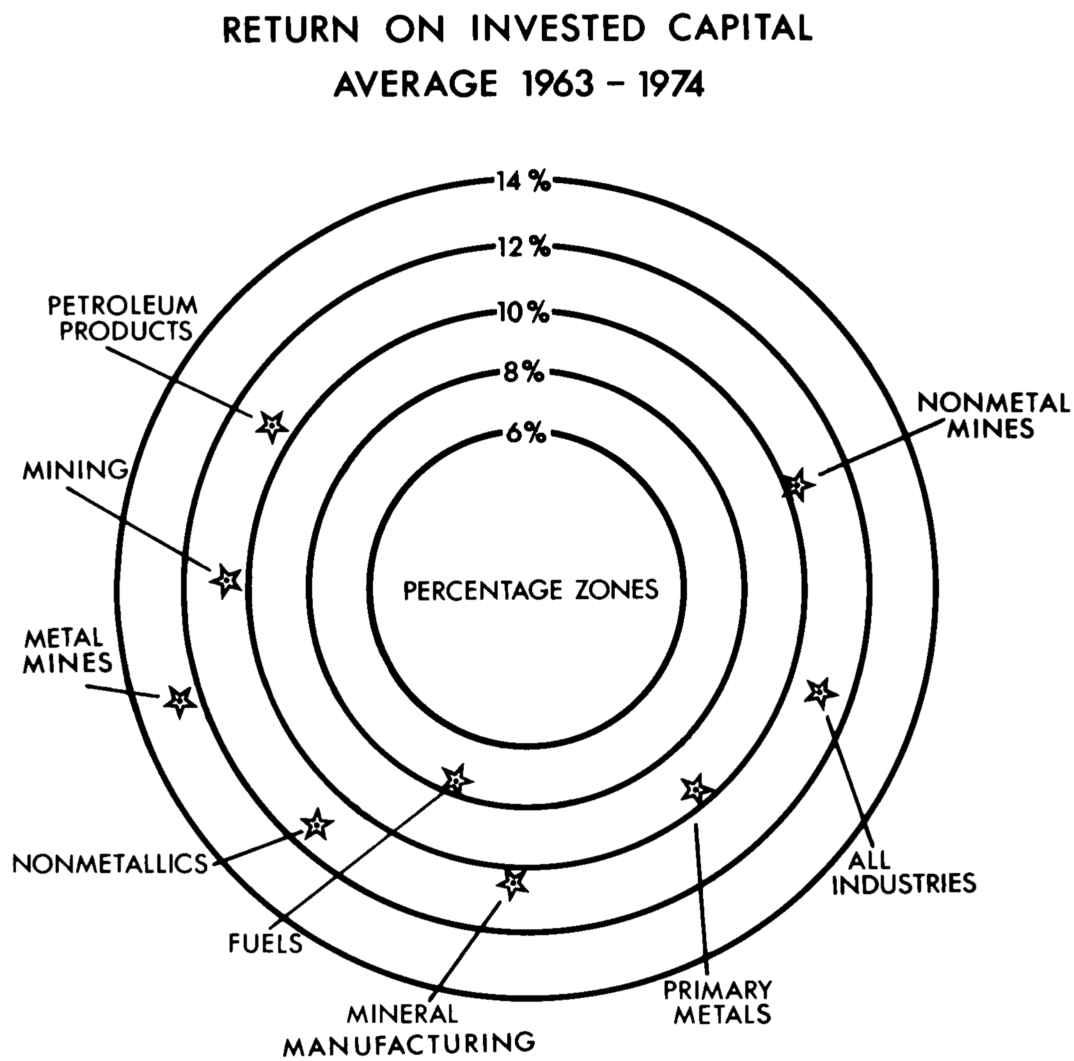


Figure 15

in 1973 and fluctuated in the period from 1966 to 1972 between 7.9 and 9.8 per cent.

Outlook.

The world economy. The recession accompanied by inflation (stagflation) which started in mid-1974, is well under way in most countries of the world. Most short-term forecasts indicate an economic recovery sometime in the year 1975. However, there are some doubts as to the length and strength of the forecasted recovery.

With the advent of the recession in 1974, there was a decrease in the demand for most commodities. Excess demand for raw materials and foodstuffs no longer existed. Supply constraints remained in only a few instances. The reduction in aggregate demand should tend to reduce the rate of inflation. However, inflation will probably continue to be a problem for several years to come. Much of the world population has come to expect further inflation. Many countries have rapidly expanded their money supply to stimulate the economy and reduce unemployment. And the wage-price spiral is likely to continue to feed inflation in the near future.

The success of the cartel on oil production and marketing by the OPEC, both in limiting the supply of oil and in escalating the price in late 1973 and early 1974, will continue to have an impact on future world demand-supply relationships. Resource-exporting countries, especially the Less Developed Countries whose main income is derived from such exports, will be encouraged to form cartels or to search for other regulated means of controlling supply and increasing the price of their non-renewable products. Industrial nations will continue to be concerned with the adequacy and security of supply of imports of raw materials. Investment abroad will tend to be directed towards developing alternate sources of supply of raw materials in geographically separate locations. Foreign investment will tend to be concentrated in the more politically stable countries. Stockpiling of critical raw materials may be increased by some of the major industrialized nations.

World trade can be expected to remain depressed in the near-term as the depression bottoms out and starts the recovery. With recovery, world trade may expand at a somewhat slower rate than that experienced over the last two decades. There is massive disequilibrium among countries of the world in international payments. The monetary reform introduced by the International Monetary Fund on July 1, 1974 may not be sufficient to reduce the international monetary crises. The Tokyo Round of GATT has, to date, made little progress on further reductions to tariffs and other barriers to trade. And environmental pollution in many countries may start to place limits on further unrestricted growth.

The Canadian economy. Being self-sufficient in oil (our exports of oil to the United States from western Canada approximately equal our imports in the east) the Canadian economy was not as severely affected by the oil crisis as many of the industrialized nations. The subsequent world-wide recession in the latter half of 1974 was mild in Canada compared with the experience of our major trading partners.

In the short term, the recession should continue to be milder in Canada and recovery should follow that of the rest of the world later in 1975. Real growth in GNP should be in the order of 1 to 2 per cent in 1975 and from 4 to 5 per cent for the next several years. Inflation should continue to be a problem due to the inflationary expectations of the population, the wage-price spiral, the higher price of imports and, as increases in the money supply continue to work their way through the economy. Unemployment is expected to decrease as the recovery gets under way, but should remain high by historical standards. Labour unrest will probably remain high.

The combination of factors which caused and sustained the commodity price boom since 1972 no longer exist, and commodity prices relative to those of other products are likely to drop. Many of the commodities affected by the price boom are exported by Canada. The relative value of Canadian exports could decrease in the near future. Faced with the prospect of future oil shortages, the Canadian government has announced its intention to gradually phase out exports of oil to the United States over a period of eight years. The dropping commodity prices and reduced oil exports combined with prospects for reduced world trade could cause Canada's merchandise trade balance to continue to show a deficit for the next several years.

The deficit in the balance of trade will put downward pressure on the Canadian dollar in international markets. If depreciation of the Canadian dollar is to be avoided, offsetting investments will be required from foreign sources. Large amounts of capital will also be required to finance oil and gas exploration in the frontier areas, and for the Athabasca tar sands development, oil and gas pipelines, the James Bay hydroelectric project and other major programs envisioned for Canada. To attract the necessary foreign capital, interest rates in Canada will have to be maintained at a sizeable margin above U.S. levels.

The large investment programs to be undertaken within Canada in the next few years should act as a stimulus to the economy. The November 18, 1974 budget also seeks to reactivate the economy through tax reductions for individuals and industry. However, Canada is an open economy with high dependence on international trade. Full economic recovery may be tenuous, given the unsettled international economic picture. However, Canada should perform as well, if not better, than most of the industrialized nations.

The mineral industry. Taxation issues were of concern in the mining industry in 1974, both as to the appropriate level of overall taxation and the division of the revenue between the federal and provincial governments. The apparent high-profit atmosphere for Canadian mining over the last few years led various provinces to impose increased taxes or new or greater royalties. Other provinces began reviewing their mining taxation systems. As both the increased taxes and the new or greater royalties were deductible from the federal and provincial income taxes to at least the end of 1976, the government of Canada became concerned that its income tax base would be severely eroded. As a consequence, in 1974, the federal government moved to eliminate these levies as deductions for income tax purposes. Simultaneously, the federal income tax rate for the mining industry was reduced to 25 per cent, to compensate, in part, for the nondeductibility of mining taxes and royalties. As 1975 begins, the issues have not been fully resolved. However, given the importance of the mining industry in the Canadian economy, it is expected that any remaining difficulties will be cleared up early in the new year.

Canada may face increased world competition as a major mineral supplier owing to possible supply-demand imbalances and new discoveries in many parts of the new world. For example, Australia is becoming a major supplier of iron ore and, to some extent, nickel; large copper deposits have been discovered in Africa and the Pacific Rim countries; and large, high-grade iron ore deposits have been discovered and are under development in Brazil. However, Canada continued its efforts in 1974 to find new markets for Canadian products, especially with France and the EEC, and some of the negotiations could be beneficial.

Exports of crude and fabricated minerals* normally account for about one third of all Canadian exports. The growth in mineral exports depends largely upon the expansion in the economies of our main trading partners, especially the United States. Most economic forecasts expect economic recovery in the industrial world during 1975. However, there are some doubts as to the length and depth of the recovery. Taking all of the previous factors into account, the Canadian mineral industry may expect growth in the short- and medium-term future, both to provide increased exports and to feed a relatively healthy internal economy. However, the rate of growth of the mineral industry is likely to be somewhat less than that experienced over the last two decades.

*Mineral fuels are included

Regional Review

THOMAS W. VERITY

The value of mineral production increased in all Canadian provinces and territories in 1974 with the exception of Prince Edward Island. That province had a 14-per-cent decline in the value of sand and gravel, its only mineral commodity. Canada and all the provinces and territories, except Nova Scotia and P.E.I., established all-time highs for mineral production value in 1974. Most of the increases were due to the general inflationary trend that occurred in Canada and other parts of the world during 1973-74. All principal minerals increased in unit price during 1974. Fuels had particularly large increases, and Statistics Canada average Canadian prices increased for crude petroleum by 67 per cent, natural gas, 64; coal, 61 and natural gas byproducts by 92 per cent. Precious metals had increases of 83 per cent for silver, 59 per cent for gold and 33 per cent for platinum metals. Base metals had increases for zinc of 44 per cent, lead, 28; copper, 21; and nickel of 10 per cent. Iron ore increased by 10 per cent. Principal non-metallics showing increases were potash, 34 per cent; asbestos, 32; salt, 13 and gypsum 12 per cent. Structural materials had increases for lime of 26 per cent, stone, 23; cement, 11 and sand-gravel 10 per cent. Comparisons of minerals production values for 1973 and 1974 by provinces and territories have thus been distorted by the general inflationary increases in mineral prices.

Alberta, the principal producer of crude petroleum and natural gas, continued as Canada's leader in minerals production value, and increased its proportion of the national minerals output from 33.0 per cent in 1973 to 38.6 per cent in 1974. Ontario was the second-largest producer with 20.7 per cent, followed by Quebec, 10.2; British Columbia, 9.9; Saskatchewan, 6.7; Manitoba, 4.2; Northwest Territories, 1.9; New Brunswick, 1.8; Yukon Territory 1.5; Nova Scotia, 0.7 and Prince Edward Island, 0.01 per cent.

Table 1 shows the per cent contribution by provinces and territories to Canada's total value of mineral production for selected years between 1954 and 1974. It can be seen that only Alberta and Saskatchewan increased their share of the total minerals output value; all others declined. This was due to the large increase in fuels prices influencing Alberta and Saskatchewan, rather than any increase in the volume of production in these provinces.

Table 2 shows the per cent value of leading minerals in each province and territory during 1974 and the per cent change from 1973.

It shall be noted that Statistics Canada has revised its cement and lime production values for the year 1973 and this has resulted in changes to the total final value of minerals production for that year in all provinces except Prince Edward Island and in the Yukon Territory and Northwest Territories.

Review by Provinces

British Columbia. Mineral production value was 7.14 per cent of the Gross Provincial Product (GPP) in 1974, up from 7.08 per cent in 1973. The minerals were valued at $1,555.8 million, up from $978.0 million for an increase of 18.2 per cent. The increase was due almost entirely however, to higher mineral prices.

New mineral taxation policies overshadowed other developments in the province during 1974. The Mineral Royalties Act, providing a two-pronged system of royalties, was passed by the provincial legislature in June and proclaimed in effect from October 1. Royalties payable under the Act applied to the full year of 1974. Implementation of these royalties was heavily criticized by industry, which claimed that mineral exploration and new mine development would be slowed down, or halted entirely, in the province.

Mines ceasing production during 1974 included; the Britannia Beach copper mine of Anaconda Canada Limited, the nickel-copper mine of Giant Mascot Mines Limited near Hope, the Bull River copper mine of Placid Oil Company and the copper mine of Jordan River Mines Ltd. on Vancouver Island.

These closures were offset by the reopening of the mines of several former producers. The Boss Mountain molybdenum mine of Brynnor Mines Limited reopened early in 1974. The Utica silver-lead-zinc mine south of Keremeos reopened in March. The copper mine of Consolidated Churchill Copper Corporation Ltd., 80 miles west of Fort Nelson, resumed operations at 500 tons a day in January. The Mineral King mine near Invermere, a former zinc-lead-silver-copper producer, reopened in June to salvage mine pillars and sills remaining from prior operations.

Other developments during the year included postponement of the commencement of production of the J.A. copper-molybdenum zone of Bethlehem Copper Corporation near Ashcroft. Gibraltar Mines Ltd., at McLeese Lake, shifted production to its Granite Lake copper-molybdenum zone. Scurry-Rainbow Oil Limited brought a new coal mine into production at Elk River at an anticipated rate of 3 to 4 million tons a year.

Yukon Territory and Northwest Territories. The value of mineral production in the Yukon Territory increased to $171.5 million from $150.7 million, a 33.4 per cent increase. The increase was due almost entirely to higher prices for minerals, with only gold and

Table 1. Per cent contribution by provinces and territories to Canada's total value of mineral production, selected years, 1954-1974.

	1954	1964	1969	1973	1974
			(per cent)		
Alberta	18.7	21.1	25.5	33.0	38.6
Ontario	33.4	26.9	25.8	22.2	20.7
Quebec	18.7	20.3	15.1	11.2	10.2
British Columbia	10.7	8.0	9.2	11.7	9.9
Saskatchewan	4.6	8.7	7.3	6.1	6.7
Manitoba	2.4	5.2	5.2	4.9	4.2
Newfoundland	2.9	5.4	5.4	4.5	3.8
Northwest Territories	1.8	0.5	2.5	2.0	1.9
New Brunswick	0.8	1.4	2.0	1.9	1.8
Yukon	1.1	0.5	0.8	1.8	1.5
Nova Scotia	4.9	2.0	1.2	0.7	0.7
Prince Edward Island	—	0.02	0.01	0.02	0.01
Total — Canada, per cent	100.0	100.0	100.00	100.0	100.0
Millions of $	1,488.4	3,365.2	4,734.3	8,369.5[r]	11,711.0

Source: Statistics Canada.
[r] Revised.

natural gas showing increases in production volume. Cyprus Anvil Mining Corporation at Faro had a 10 per cent drop in production because of a 33-day walk-out during May and June, and United Keno Hill Mines Limited at Elsa milled a lower tonnage of ore due to a shortage of experienced miners.

Mineral exploration in the Yukon experienced an upturn during 1974 and an important lead-zinc discovery was made in the Vangorda Creek area by Kerr Addison Mines Limited. Exploration interest also continued in the Bonnet Plum-Goz Creek area.

In the Northwest Territories the value of minerals production increased to $223.0 million from $165.5 million, a 34.8 per cent advance. Most of this was due to higher mineral prices, with only zinc and tungsten showing gains in the volume of output. The Minister of Indian and Northern Affairs, The Honourable Jean Chrétien, announced in June that the federal government would invest $16.7 million towards the development of the lead-zinc mine of Mineral Resources International Limited (MRI) on Baffin Island. The property, 35 per cent owned by Texasgulf Inc., will be operated by a new company to be named Nanisivik Mines Limited.

Petroleum and natural gas continued to spur exploration activities in the North. The first official estimates of natural gas reserves in the Mackenzie River delta show an accumulation of more than three trillion cubic feet in the Taglu field on Richards Island. According to Imperial Oil Limited, evidence from the Taglu area would indicate possible future discoveries in comparable structures in unexplored tertiary sediments in the Beaufort Basin. At year-end, three offshore wells were being drilled from artificial islands off the coast of Richards Island in the coastal waters of the Beaufort Sea.

In the Arctic Islands the pace of exploration has declined from previous years, with no new oil or gas discoveries being made. Since 1969, when large-scale exploration started, Panarctic Oils Ltd. has discovered and partially outlined five substantial gas fields and made two non-commercial oil discoveries, one on Ellesmere Island and the other on Cameron Island.

Alberta. Mineral production is a very important part of the economy of this province, being 37.5 per cent of the GPP in 1974, up from 27.1 per cent in 1973. Value of mineral production increased from $2,760.2 million to $4,518.4 million, a 63.7 per cent increase. Alberta continued as the leading producer of crude petroleum, natural gas and its byproducts, coal (in terms of total tonnage) and elemental sulphur. All these minerals showed large increases in value, but only coal and elemental sulphur had gains in tonnage produced.

Recent Canadian taxation changes have had an effect in Alberta. It was estimated by six major petroleum producers that the new federal tax which disallows provincial royalties and tax credits will cost in excess of $1 billion in income. With the added cost, a decline in exploration and development activities is anticipated. In an attempt to soften the impact of the federal budget taxation measures, the Alberta government announced in December that it intended to revise its royalty and corporate tax systems. The Alberta corporate tax on royalties, collected by Ottawa, then rebated to the province, and amounting to approximately $130 million, will be passed on to the industry in full for 1975. Royalty rates for oil and gas were also to be revised.

Early in June, Syncrude Canada Ltd. commenced construction on the first segments of its $1.2 billion bituminous sands extraction plant near Fort McMurray. Syncrude was jointly owned by Atlantic Richfield Canada Ltd., Canada-Cities Service Ltd. and Imperial Oil Limited, each with 30 per cent interests; and by Gulf Oil Canada Limited with 10 per cent. Early in December, Atlantic Richfield announced that it was withdrawing from the project because of rising costs and other uncertainties. The Atlantic Richfield portion will be taken up by a partnership consisting of the federal government and the provinces of Alberta and Ontario.

The Alberta bituminous sands were estimated to contain 900 billion barrels of crude bitumen, but only

Table 2. Value of leading minerals by provinces and territories, 1974.

	% of Total	% Change from 1973
British Columbia		
Copper	42.5	+11.0
Coal	13.3	+66.3
Petroleum	9.0	+57.8
Natural Gas	5.3	+33.0
Molybdenum	5.3	+19.5
Zinc	5.2	−18.2
Sand and Gravel	3.5	−1.7
Cement	2.7	−0.8
Asbestos	2.4	+29.7
Silver	2.3	+30.5
Metallics	61.3	+7.3
Non-Metallics	3.2	+23.1
Fuels	28.6	+57.2
Structural Materials	6.9	+3.3
Total	100.0	+18.2
Yukon Territory		
Zinc	41.0	−0.5
Lead	27.7	+8.0
Silver	17.1	+74.6
Asbestos	15.3	+63.7
Copper	10.5	+5.2
Gold	2.8	+102.5
Metallics	86.6	+32.4
Non-Metallics	13.3	+40.5
Fuels	0.1	+25.8
Structural Materials	—	—
Total	100.0	+33.4
Northwest Territories		
Zinc	57.3	+51.3
Lead	15.6	+8.4
Gold	12.8	+18.5
Silver	7.9	+29.1
Natural Gas	2.5	+28.0
Metallics	96.1	+34.9
Non-Metallics	—	—
Fuels	3.9	+32.6
Structural Materials	—	—
Total	100.0	+34.8

	% of Total	% Change from 1973
Alberta		
Petroleum, crude	66.1	+57.6
Natural Gas	14.3	+66.0
Natural Gas, Byproducts	14.0	+86.5
Coal	2.5	+85.3
Elemental Sulphur	1.5	+192.2
Metallics	—	−11.5
Non-Metallics	1.6	+161.4
Fuels	96.9	+63.1
Structural Materials	1.5	+40.8
Total	100.0	+63.7
Saskatchewan		
Petroleum, crude	50.4	+51.0
Potash	39.1	+74.7
Copper	1.7	+4.5
Sodium Sulphate	1.6	+103.8
Sand and Gravel	1.2	+87.1
Natural Gas	1.1	−0.5
Coal	1.0	−12.3
Metallics	2.8	−6.7
Non-Metallics	41.5	+24.1
Fuels	53.3	+48.3
Structural Materials	2.4	+40.7
Total	100.0	+55.0
Manitoba		
Nickel	45.7	−2.8
Copper	25.0	+33.3
Zinc	9.9	+49.8
Petroleum, crude	5.6	+58.1
Sand and Gravel	4.6	+52.8
Cement	2.8	+22.0
Gold	1.7	+74.2
Silver	1.2	+115.0
Metallics	85.1	+13.7
Non-Metallics	0.7	+7.1
Fuels	5.6	+58.4
Structural Materials	8.6	+40.5
Total	100.0	+17.4

Table 2 (concl'd)

	% of Total	% Change from 1973
Ontario		
Nickel	30.8	+30.7
Copper	19.9	+32.6
Zinc	13.8	+52.2
Iron Ore	7.4	+18.2
Gold	5.1	+38.5
Cement	4.3	+19.5
Sand and Gravel	3.5	+11.5
Silver	3.4	+66.8
Platinum Group	2.5	+45.3
Salt	1.7	+21.3
Metallics	84.4	+34.7
Non-Metallics	2.6	+12.2
Fuels	0.3	+16.0
Structural Materials	12.7	+14.5
Total	100.0	+31.0
Quebec		
Copper	20.7	+22.6
Asbestos	19.7	+32.0
Iron Ore and Iron Remelt	19.3	+32.0
Zinc	8.1	+29.9
Cement	7.0	+13.1
Gold	5.7	+46.7
Titanium Dioxide	4.3	+11.2
Metallics	56.3	+30.3
Non-Metallics	25.8	+28.0
Fuels	—	−4.1
Structural Materials	17.9	+18.6
Total	100.0	+27.5
New Brunswick		
Zinc	54.1	+24.5
Lead	10.8	+53.7
Silver	9.7	+129.4
Copper	9.1	+47.6
Sand and Gravel	2.6	−47.3
Coal	2.5	+58.8
Metallics	86.2	+38.7
Non-Metallics	2.6	+32.9
Fuels	2.6	+58.5
Structural Materials	8.6	−22.8
Total	100.0	+30.1
Nova Scotia		
Coal	30.5	+57.5
Sand and Gravel	20.1	+29.0
Gypsum	19.3	+7.1
Salt	13.9	+34.3
Barite	5.8	−39.6
Metallics	0.3	+36.7
Non-Metallics	34.4	+14.8
Fuels	30.6	+56.6
Structural Materials	34.7	+32.7
Total	100.0	+32.0
Prince Edward Island		
Structural Materials	100.0	−13.5
Total	100.0	−13.5
Newfoundland		
Iron Ore	83.0	+18.3
Asbestos	3.6	−18.0
Zinc	3.3	+249.0
Copper	2.2	−12.4
Sand and Gravel	1.9	+4.2
Fluorspar	1.6	+54.2
Metallics	90.8	+21.3
Non-Metallics	5.8	+2.6
Fuels	—	—
Structural Materials	3.4	+14.2
Total	100.0	+19.8
Canada		
Metallics	41.2	+25.2
Non-Metallics	7.6	+45.7
Fuels	44.4	+61.2
Structural Materials	6.8	+17.0
Total	100.0	+39.9

Source: Statistics Canada.

about 250 billion barrels could be considered recoverable, and only 27 billion barrels by present open-cast mining methods. The Alberta reserves of conventional liquid petroleum were expected to last another 11 years at 1974 rates of production, while reserves of natural gas were sufficient to last another 19½ years.

Saskatchewan. The mineral production of this province was 14.2 per cent of the GPP in 1974, up from 11.3 per cent in 1973. Value increased from $509.8 million to $790.3 million, a 55 per cent increase. Crude petroleum contributed 50 per cent of the production value but the non-metallic mineral, potash, also was a major source of revenue with 39 per cent of the total. A 51 per cent rise in the value of crude petroleum was due to higher oil prices, but a 75 per cent increase in potash value was due not only to a price increase but also to a 28 per cent increase in the volume of production. Sodium sulphate and sand-gravel also showed large increases in both volume and value of production.

Saskatchewan introduced new taxation measures that affected the potash industry. A potash reserve tax will apply to potash reserves under Crown lease from July 1, 1974. The tax will be the product of the assessed value of each potash property and a mill rate. The government will also participate in all new potash mine developments and the expansion of existing facilities. The Saskatchewan Mining and Development Company, Limited, was also established in June. It will become involved in non-potash mining ventures.

The new lignite mine of Manitoba and Saskatchewan Coal Company (Limited) at Estevan commenced production at a rate of 1.7 million tons a year in January, with its output being sold to the nearby power plant of Saskatchewan Power Corporation. The Rabbit Lake uranium mine of Gulf Minerals Canada Limited expects to go into production at 2,000 tons a day early in 1975. Amok Ltd. continued exploration of its Cluff Lake uranium property. Eldorado Nuclear Limited plans to expand its uranium mine mill rate from 1,100 to 2,000 tons a day, commencing in mid-1975.

Manitoba. Mineral production in the province represented approximately 8 per cent of the GPP in both 1974 and 1973. Value increased from $414.0 million to $486.2 million, a 17.4 per cent advance. Some 85 per cent of the value came from metallics, with nickel and copper being the principal metals. The volume of production declined in nickel but increased in copper, gold, silver and zinc. All the industrial minerals, except clay, increased in both volume and value of production.

Tax changes, as in other provinces, represented significant developments in Manitoba's minerals industry during 1974. Commencing on April 1, 1974, the rate of taxation under the Mining Royalty and Tax Act was increased from 15 to 23 per cent on mining profits in excess of $50,000. Further changes are anticipated with the introduction of the Principal Minerals Royalty Act in 1975. The increased taxes have prompted Hudson Bay Mining and Smelting Co. Limited to defer a $20 million improvement program in mine operation at Flin Flon and also to cut its exploration budget by 50 per cent.

The Manitoba government was active in mineral explorations through its Crown corporation, Manitoba Mineral Resources Ltd. This corporation had a $525,000 budget for 1974 and invested in 11 mineral and four oil exploration projects. The government also owns a 25 per cent share in Tantalum Mining Corporation of Canada Limited, which operates North America's only tantalum mine at Bernic Lake.

Ontario. The mineral industry of Ontario represents only a relatively small portion of the GPP, being 3.72 per cent in 1973 and 4.02 per cent in 1974. The value of production rose from $1,854.7 million to $2,429.5 million, a 31.0 per cent increase. Metallic minerals represented some 85½ per cent of the total with the principal metals being nickel, copper and zinc.

The new Ministry of Natural Resources was established in 1972 with the old Department of Mines becoming the Division of Mines. Major changes were made in the boundaries of the mining divisions in 1974 to conform to the new regional administration boundaries established in 1973. Changes were made in the Mining Tax Act in April 1974 that established a sliding scale of taxation on mining profits of 15 per cent between $100,000 to $1 million and rising to 40 per cent for profits over $40 million. The three-year tax exemption for new mines under the Ontario Corporation Tax Act was also repealed effective January 1, 1974.

The International Nickel Company of Canada, Limited, reopened its Crean Hill nickel-copper mine in January. Sturgeon Lake Mines Limited, a new copper-zinc-lead-silver mine near Ignace, was opened officially in October at an initial production rate of 800 tons a day. Kanichee Mining Incorporated brought an open-pit copper-nickel mine into production in Strathy Township during the first quarter of the year at a rate of 500 tons a day. Rio Algom Mines Limited announced a major expansion program at its Elliot Lake uranium mine that would more than triple its production by the late 1970s. United Asbestos Inc. has commenced development of an asbestos property in Midlothian township with production at a rate of 3,500 tons a day to start in 1975. Union Miniere Exploration and Mining Corporation Limited (Umex) has decided to bring its copper-nickel "Thierry" deposit near Pickle Lake into production at 4,000 tons a day commencing in 1976. Sheridan Geophysics Limited has made a palladium-platinum discovery in the Lac des Iles area north of Thunder Bay. Great Lakes Nickel Limited has suspended development of its copper-nickel property near Thunder Bay because of high interest rates and uncertain metal prices.

The province had initiated a Mineral Exploration Assistance Program (MEAP) in 1971 that provided one-third of the cost of approved exploration programs in certain designated areas, up to a maximum of $33,333 for each project. The budget for the 1974-75 fiscal year was $500,000, to be used in the Cobalt-Gowganda, Geraldton-Beardmore, Kirkland Lake and Red Lake mining areas. The MEAP program is administered by the Geological Branch of the Division of Mines. The Ministry of Treasury, Economics and Intergovernmental Affairs (TEIGA) made an additional $100,000 available during the 1974-75 fiscal year to be used in the Atikokan area of Northwestern Ontario.

Quebec. The mineral industry of the province contributed only 3.22 per cent of the GPP in 1973, which increased to 3.51 per cent in 1974. The value of production rose from $935.5 million to $1,192.4 million, a 27.5 per cent increase. Principal minerals were copper, asbestos, iron ore (including remelt iron), zinc and cement. Increased value of the principal minerals was due primarily to higher mineral prices, with only copper and asbestos showing increases in production volume.

During 1974 the province introduced interim measures to increase the mining tax rates under the Mining Duties Act. New rates, effective from April 1974 to March 31, 1975, provided a 13.5 per cent tax on profits between $150,000 and $1.15 million and increasing to 30 per cent for profits over $10 million. A committee on mining taxation was established to advise the provincial government on future taxation policy.

The nickel-copper mine of Société Miniere d'Exploration Somex Ltée., at Lac Edouard ceased production in January. The gold mine of Marban Gold Mines Limited stopped operating in September. A fire in January forced the closure of the copper-nickel mine of Renzy Mines Limited and another fire in December destroyed the asbestos mill of Asbestos Corporation Limited at Thetford Mines. The proposed construction of a $300 million pelletizing plant at Port Cartier was deferred indefinitely and development of the Quebec Cartier Mining Company, Mount Wright, iron ore complex was set back by two years, mainly because of troublesome labour conditions.

Chibex Limited commenced production in September of the former gold-copper producing mine of Key Anacon Mines Limited in the Chibougamau area. Noranda Mines Limited announced that it will spend $37 million during the next two years to add to its milling and smelting operation at Noranda. Noranda also announced that it intends to bring the former zinc-lead-silver Barvue mine of Manitou-Barvue Mines Limited in Barraute township back into production as an open-pit mine.

New Brunswick. Mineral production has increased significantly in the province since 1971 and totalled 6.76 per cent of the GPP in 1973, rising to 7.40 per cent in 1974. The value of production advanced from $164.2 million to $213.5 million, an increase of 30.1 per cent. Metallic minerals contributed about 86 per cent of the total, with zinc, lead, silver and copper being the principal metals. New Brunswick was second only to Ontario in the production of zinc in 1974.

The Sullivan Mining Group's Nigadoo River Mines Limited copper-lead-zinc-silver mine near Robertville reopened in 1974. A major expansion program was instigated by Brunswick Mining and Smelting Corporation Limited at its No. 12 underground mine. When this program is completed in 1979 it is expected that Brunswick will be the world's largest producer of zinc. With growing zinc concentrates production, all of which is now exported for treatment, the feasibility of constructing an electrolytic zinc plant in the province is being studied. The only mining casualty in the province during 1974 was the closing of the Caribou copper mine of Anaconda Canada Limited and Cominco Ltd. Open-pit ore on the property was exhausted, and metallurgical research was being started to find a method of treating the large tonnage of primary sulphide base-metal mineralization that still remains below the open-pit workings.

Several mining exploration companies were actively engaged in assessing and developing base-metal deposits in the Bathurst-Newcastle district. Some 33 primary sulphide deposits have been identified in the area but a metallurgical breakthrough, such as hydrometallurgical extraction, will be required before most of these deposits can be considered to have commercial possibilities. During the year the New Brunswick government and the New Brunswick Electiric Power Commission completed a joint drilling program to update recoverable coal deposits in the Minto-Chipman area.

Nova Scotia. Mineral industry production in the province amounted only to 1.88 per cent of the GPP in 1973, rising to 2.12 per cent in 1974. The value of production increased from $60.8 million to $80.3 million, a 32 per cent rise. Principal minerals were coal, sand-gravel, gypsum and salt. The peak year for mineral production was reached in 1966, when $85.6 million was recorded and 1974 was the second-highest year. Coal has been the mainstay of mineral production in the province for many decades and made somewhat of a recovery during 1974 when the tonnage processed increased by 20.0 per cent and the value of output by 57.5 per cent.

Cape Breton Development Corporation (DEVCO) has permanently sealed the No. 12 mine at New Waterford that was closed due to an explosion and fire in 1973. A new belt-haulage system, replacing the former rope-haulage system, was completed at No. 26 mine at Glace Bay during 1974. Production at one longwall operation commenced in August 1974 at the company's new Lingan mine. Expanded production is planned for both the Lingan and No. 26 mines in 1975. Construction of a new DEVCO preparation plant was started at Grand Lake, midway between the two mines.

During 1974 Imperial Oil Limited was drilling and assessing the lead-zinc deposits at Gays River on ground held by Cuvier Mines Ltd. Ore reserves of some 21 million tons with a grade of 6.14 per cent combined lead-zinc have been estimated. Discovery of this deposit touched off a resurgence of mineral exploration in Nova Scotia and several large mineral exploration companies were active in the province during the year. Exploration for petroleum off the east coast of the province also continued and nine holes were drilled during the summer. In an effort to bolster the coal industry, the provincial and federal governments have agreed to undertake a program aimed at expanding inventories of coal in the province. The program, to cost $1.3 million and take three years to complete, is designed to seek coal deposits in areas not presently producing coal.

Prince Edward Island. The only mineral production in the province came from the recovery of sand and gravel and their value declined from $1.7 million in 1973 to $1.5 million in 1974, a decrease of 13.5 per cent.

Hudson's Bay Oil and Gas Company Limited has encountered natural gas while drilling a test well at East Point, on the eastern tip of the island. At the present time all electrical energy on the island is generated by oil-fired stations from imported fuel, and deposits of natural gas, if found, would have great significance to the economy of Prince Edward Island.

Newfoundland and Labrador. Mineral production has great significance to the economy of the province, being 22.0 per cent of the GPP in 1973 and rising to 22.7 per cent in 1974. Production value increased from $374.4 to $448.5 million, a 19.8 per cent advance. Iron ore was the principal mineral, with 83 per cent of the total value in 1974. Most of the increase in total mineral production value was due to higher mineral prices. There was a higher volume production of zinc and lead but this was due to the fact that a 29-week strike at the Buchans mine in 1973 limited production during that year.

Green Bay Mining Company Limited commenced production in June at 500 tons a day at its Little Deer Pond copper deposit adjacent to the formerly producing Whalesback mine of British Newfoundland Exploration Limited (Brinex). Preparations have begun to bring into production at 1,500 tons a day the zinc mine of Newfoundland Zinc Mines Limited near Daniel's Harbour at a capital cost of $18 million. Production is expected to commence late in 1975.

Two significant natural gas discoveries were made in October by Eastcan Exploration Ltd., a subsidiary of Compagnie Francaise des Petroles, on the Labrador Shelf offshore from the east coast of Labrador. Further drilling will be necessary to fully evaluate the commercial viability of these discoveries. The area is exposed annually to Arctic ice floes, and new technology will have to be developed to safely pipe any gas production to shore and to markets.

Taxation of the Canadian Mining Industry

W.J. BEARD

Several major changes in mineral taxation legislation occurred in 1974 affecting the Canadian mining industry. The changes increased federal income taxation of the industry to some degree but provincial levies in some areas of jurisdiction were substantially higher.

Federal taxation

The major changes in federal income taxation with respect to mining resulted from two Budget Speeches in 1974, one on May 6 and the other on November 18.

In essence, the May 6 Budget Speech was a reaction to the significant increases instituted by certain provinces with respect to mining taxes and royalties. Prior to May 6, mining taxes and royalties were deductible in calculating the federal income tax base to which a 38 per cent federal tax rate was applied. The May 6 Budget proposed that mining taxes and royalties would no longer be deductible and that the federal tax rate be reduced to 25 per cent. This non-deductibility provision was instituted to prevent serious erosion of the federal tax base.

At the same time, the automatic percentage depletion allowance terminated and was replaced by an earned depletion benefit, and it was proposed to allow the claiming of exploration and development expenditures at 30 per cent per year on the unclaimed balance. Exploration and development had previously been claimable to the extent of income. Many of the May 6 proposals were changes that had been proposed under the 1972 Tax Reform to come into effect in 1977.

The May 6 Budget was defeated shortly after its introduction in the House of Commons, resulting in the downfall of the government. In the ensuing election the Liberals were returned to office and on November 18 another Budget Speech reinstated virtually all of the May 6 proposals with respect to mining, all effective May 7. The rate of claiming of exploration expenses was restored to the extent of income but that for development remained at 30 per cent of the unclaimed balance. The non-deductibility feature for provincial mining taxes and royalties was extended to include all payments made to a province with respect to the acquisition, ownership or development of a resource property.

Provincial taxation

Prior to 1974 most of the provinces and the two territories had levied a mining tax, not exceeding 15 per cent in any case, on their respective mining industries. In addition, all provinces collected an income tax from mining. Before 1974 very few of the provinces levied unit-of-production royalties on major mining production. The situation changed significantly in 1974.

British Columbia introduced a Minerals Royalties Act, effective January 1, 1974, which imposed both a basic royalty on net smelter returns for designated minerals and an incremental royalty designed to capture a portion of any "excess" profits on minerals taken from Crown lands. A new Mineral Land Tax Act was designed to provide a tax from Crown-granted (freehold) lands which was of the same magnitude as would have been obtained if the Mineral Royalties Act had applied. Both taxes were in addition to the 15 per cent tax applied under the Mining Tax Act.

Saskatchewan passed legislation, effective July 1, 1974, which provided for a potash reserve tax on its potash mining industry. The new tax was the product of the assessed value of each potash property and a rate of mills on the dollar varying from zero mills at an average selling price of potash of $35.50 a ton or less, up to 8.73169 mills on the dollar at an average selling price of $90 a ton or more. The potash reserve tax was an addition to the normal potash royalty, the potash prorationing fees and other mineral land taxes.

Manitoba raised its rate of mining tax from 15 per cent to 23 per cent, effective April 1, 1974. This increase was an interim increase pending the development of new mineral royalty legislation.

Effective April 10, 1974 Ontario significantly raised its rates of tax under the Mining Tax Act. Prior to the revision, the rate had been 15 per cent. The new marginal rates varied from 15 per cent on the first $900,000 of taxable income up to 40 per cent on taxable income in excess of $40,000,000. Amendments were made with respect to capital cost allowances, exploration and development write-offs, and processing allowances.

Quebec introduced interim measures in December, 1974, retroactive to April 1, 1974, which significantly increased the mining tax rates under its Mining Duties Act.

Prior to the revision the rates had ranged from 9 per cent on the first $1,000,000 of taxable income up to 15 per cent on taxable income over $4,050,000. The new rates ranged from 13.5 per cent on the first $1,000,000 of taxable income up to 30 per cent on taxable income over $10,000,000.

The other provinces and the two territories did not change their respective mining tax acts or, where applicable, their royalty systems, in 1974. However, in Newfoundland a Royal Commission on Mineral Taxation spent most of the year examining the province's system of mining taxation. Nova Scotia also reviewed its system of obtaining revenues from the mineral industry in 1974. The mining taxation systems in both the Yukon and the Northwest Territories have been under review for several years by the Department of Indian and Northern Affairs, Ottawa.

Lightweight Aggregates

D. H. STONEHOUSE

Traditionally, aggregates for use in concrete and concrete products have been sand and gravel. As concrete technology advanced, the need for clean, sharp aggregate with a designed particle size distribution was emphasized and the use of crushed stone aggregate as well as crushed, screened and washed gravel became standard procedure. The methods of mixing, transporting, placing and curing of concrete are the subjects of on-going studies and research in conjunction with the use of various types of cement as the binding media. Until the mid-forties, comparatively little attention was paid to designing concrete products to meet a specific requirement other than a certain predetermined strength and setting time. At that time increased housing demand accentuated the need for prefabricated structures. Techniques of construction were developed using structural sections and panels of much lighter unit volume, with no sacrifice of strength, by utilizing lightweight aggregates which also incorporated the added advantage of insulation from heat, fire, sound and moisture. The use of lightweight concrete in commercial and institutional projects has facilitated the construction of taller buildings and the use of longer clear spans. Normal aggregates are becoming increasingly scarce in many consuming regions such that the possibility of lightweight aggregate utilization for reasons other than the derived physical benefits could develop in these particular areas.

Four categories generally used to classify the lightweight aggregates combine elements of source, processing methods and end-use. Natural lightweight aggregates include materials such as pumice, scoria, volcanic cinders and tuff. Manufactured lightweights are bloated or expanded products obtained by heating certain clays, shales, and slates. Ultra-lightweights are made from natural mineral ores, such as perlite and vermiculite, which are expanded or exfoliated by the application of heat and used mainly as plaster aggregate or as loose insulation. Fly ash, which is obtained from the combustion of coal and coke, and slag, which is obtained from metallurgical processes, are classed as byproduct aggregates.

All types are used in Canada, but only expanded clays, shale and slag are produced from materials of domestic origin. Vermiculite is imported mainly from Montana, U.S.A., although a small amount is brought in from the Union of South Africa. Perlite is imported mainly from New Mexico and Colorado, and pumice is imported from the State of Oregon and from Greece.

Canadian industry and developments

With total construction spending in Canada showing continued increases, and with the general trend towards taller buildings, larger precast shapes and greater clear spans, the application of lightweight aggregates in concrete should increase greatly. The advantages of location and cost enjoyed by the normal heavy aggregates are becoming less of a factor as land-use conflicts are more evident and transportation costs continue to increase.

Perlite. Perlite is a variety of obsidian or glassy volcanic rock that contains 2 to 6 per cent of chemically combined water. When the crushed rock is heated rapidly to a suitable temperature it expands to between 4 and 20 times its original volume. Expanded material can be manufactured to weigh as little as 2 to 4 pounds a cubic foot, with attention being given to preblending of feed to the kiln and retention time in the flame.

In Canada, imported perlite is expanded and used mainly by gypsum products manufacturers in plaster products such as wallboard and drywall, where its value as a lightweight material is augmented by its fire-resistant qualities. It is also used as a loose insulation and as an insulating medium in concrete products. Perlite, vermiculite and expanded shale and clay, are becoming more widely used in agriculture as a soil conditioner and fertilizer carrier.

Imports of crude perlite for consumption in Canada are from New Mexico and Colorado deposits worked by such companies as Johns-Manville Corporation, United States Gypsum Company, United Perlite Corp. and Grefco Inc. In 1974, eight companies at ten locations in Canada reported production of expanded perlite.

Perlite occurs in British Columbia, but no commercial deposits have as yet been located.

Pumice. Pumice is a cellular, glassy lava, the product of explosive volcanism, usually found near geologically recent or active volcanoes. It is normally found as a loosely compacted mass composed of pieces ranging in size from large lumps to small particles. It is not the lightest of the lightweight aggregates, but when utilized as a concrete aggregate, particularly for the manufacture of concrete blocks, it exhibits strength, density and insulating values that have made it a preferred material.

In Canada, a number of concrete products manufacturers use pumice imported from Greece or from northwestern United States mainly in the manufacture of concrete blocks. A major use for pumice, as yet unexplored in Canada, has been in highway construction where lightweight aggregate surfaces have been shown to have exceptional skid resistance.

Pumicite, distinguished from pumice by its finer size range (usually minus 100 mesh), is used in concretes mainly for its pozzolanic qualities. (A pozzolan is a siliceous material possessing no cementitious qualities until finely ground, in which form it will react with calcium hydroxide in the presence of moisture to form insoluble calcium silicates.)

Extensive beds of pumicite have been noted in Saskatchewan and in British Columbia.

Table 1. Canada, production of lightweight aggregates, 1973-74

	1973		1974	
	(cu yd)	$	(cu yd)	$
From domestic raw materials				
Expanded clay, shale and slag	742,964	4,491,769	804,985	5,272,821
From imported raw materials				
Expanded perlite and exfoliated vermiculite	661,448	6,598,429	913,404	7,418,160
Pumice	60,250	436,800	57,850	544,732
Total	1,464,662	11,526,998	1,776,239	13,235,713

Source: Company data.

Table 2. Canada, consumption of expanded perlite

	1972	1973	1974
		(per cent)	
Insulation	81.0	92.0	92.0
Agriculture, horticulture	12.0	5.0	5.0
Other uses			
fillers	7.0	3.0	3.0

Source: Company data.

Vermiculite. The term vermiculite refers to a group of micaceous minerals, hydrous magnesium-aluminum silicates, that exhibit a characteristic lamellar structure and that expand or exfoliate greatly upon being heated rapidly. Mining is normally by open-pit methods; and beneficiation techniques include the use of hammer mills, rod mills, classifiers, screens, dryers and cyclones. Exfoliating is done in oil- or gas-fired, vertical or inclined furnaces, usually close to the consuming facility to obviate the higher costs associated with shipping the much bulkier expanded product. The expansion process has advanced technologically to permit production of various grades of expanded vermiculite as required. The uses to which the product is put depend on its low thermal conductivity, its fire-resistance and, more recently, on its lightweight qualities.

Canadian consumption is mainly as loose insulating material, with smaller amounts being used as aggregate in insulating plaster and concrete. The energy situation will undoubtedly give rise to increased domestic fuel costs and a trend towards electric heating would not be surprising. In any case greater use of insulation in both new construction and in older buildings will continue to tax the production capability of manufacturers for some time.

The major producer of vermiculite is the United States. The principal company supplying Canada's imports is W.R. Grace and Company from operations at Libby, Montana. Canada also imports crude vermiculite from South Africa where Palabora Mining Co. Ltd. is the major producer. At both the Grace and Palabora operations milling limitations have necessitated new mill installations in an effort to keep up with demand.

Vermiculite occurrences have been reported in British Columbia and a deposit near Perth, Ontario has been investigated but, as yet, no commercial deposits have been developed in Canada.

Table 3. Canada, consumption of exfoliated vermiculite

	1972	1973	1974
	(per cent)		
Loose insulation	72.0	73.0	75.0
Insulating plaster	5.0	3.0	2.2
Insulating concrete	15.0	7.0	3.7
Agriculture, horticulture	4.0	9.0	8.0
Minor uses			
Fireproofing, underground pipe insulation, barbecue base	4.0	8.0	11.1

Source: Company data.

Clay and shale. Common clays and shale are used throughout Canada as raw material for the manufacture of lightweight aggregates. Although the Canadian industry began in the 1920s in Ontario, it did not evolve significantly until the 1950s when it grew in support of demands from the construction industry. The raw materials are usually quarried adjacent to the plant sites at which they are expanded. Clay receives little beneficiation other than drying before being introduced to the kiln. Shales are crushed and screened before burning. Eight plants in Canada using a rotary kiln process currently produce lightweight aggregates from clay and shale.

Table 4. Canada, consumption of expanded clay and shale

	1972	1973	1974
	(per cent)		
Concrete			
block	70.0	67.0	65.6
precast structural	3.0	6.0	4.2
cast-in-place structural	24.0	25.0	24.0
Minor uses			
sand blasting, horticulture refractories, insulation brick grog, flexible pavement	3.0	2.0	6.2

Source: Company data.

One company produces an aggregate material from slag as a byproduct of a blast furnace operation. In the steelmaking process, iron ore, coke and limestone flux are melted in a furnace. When the metallurgical process is completed, lime has combined with the silicates and aluminates of the ore and coke and formed a nonmetallic product (slag) which can be subjected to controlled cooling from the molten state to yield a porous, glassy material. Slag has many applications in the construction industry. The statistics relative to expanded slag production are included in those of clay and shale.

Although Canada does not produce large amounts of fly ash, the technology of fly-ash processing and utilization is well advanced. The largest single use for fly ash is as a cementitious material where its pozzolanic qualities are utilized. Use of fly ash as a lightweight aggregate could become of increasing importance. International Brick and Tile Ltd. of Edmonton, Alberta, which produces brick using fly ash and bottom ash as raw material, was taken over by Great West Steel Industries Ltd. of Vancouver in 1972. Ontario Hydro produces nearly 450,000 tons a year of fly ash from three coal-fired stations. Experimentation continues towards successful utilization of this material at the Lakeview plant in the production of pozzolan, iron oxide and lightweight pellets. Disposal costs of $2 to $3 a ton add incentive to such programs.

Specifications

There are as yet no Canadian Standards Association (CSA) specifications for the lightweight aggregates. Production and application are based on the American Society for Testing and Materials (ASTM) designations as follows: ASTM Designations C 332-56 T – Lightweight Aggregates for Insulating Concrete; C 330 – Lightweight Aggregates for Structural Concrete; and C331 – Lightweight Aggregates for Concrete Masonry Units.

Outlook

Demand for all lightweight aggregates will continue to increase as use in structural concrete and for insulation purposes becomes more popular. In view of increased costs of energy, the amount of insulation which can be economically installed in new housing and, indeed, in older housing has about doubled during the past years thereby placing great demand pressure on the suppliers of these materials. The four main lightweight materials — perlite, pumice, vermiculite and expanded clays — are interchangeable for many applications and can, along with some synthetic materials, be considered substitutes or alternates for each other.

The United States is the source of most of the lightweight raw materials consumed in Canada, exclusive of clay, shale and slag. The U.S. reserves are sufficient both for its domestic requirements and for exports to meet Canada's projected needs for many years.

Table 5. Lightweight aggregate plants in Canada, 1974

Company	Location	Product
Atlantic Provinces		
Avon Aggregates Ltd.	Minto, N.B.	Expanded shale
Quebec		
F. Hyde & Company, Limited	Montreal	Vermiculite
Laurentide Perlite Inc.	Charlesbourg West	Perlite
Masonite Canada Ltd.	Gatineau	Perlite
Perlite Industries Reg'd.	Ville-St-Pierre	Perlite
Vermiculite Insulating Limited	Lachine	Vermiculite
Ontario		
Canadian Gypsum Company, Limited	Hagersville	Perlite
Canadian Johns-Manville Company, Limited	North Bay	Perlite
Domtar Construction Materials Ltd.	Caledonia	Perlite, shale
	Mississauga	Expanded shale
Grace Construction Materials Ltd.	St. Thomas	Vermiculite
	Ajax	Vermiculite
National Slag Limited	Hamilton	Slag
Prairie Provinces		
Cindercrete Products Limited	Regina, Sask.	Expanded clay
Consolidated Concrete Limited	Calgary, Alta.	Expanded shale
Domtar Construction Materials Ltd.	Calgary, Alta.	Perlite
Echo-Lite Aggregate Ltd.	St. Boniface, Man.	Expanded clay
Consolidated Concrete Limited Edcon Block Division	Edmonton, Alta.	Expanded clay
Grace Construction Materials Ltd.	Winnipeg, Man.	Vermiculite
Kildonan Concrete Products Ltd.	St. Boniface, Man.	Expanded clay
Northern Perlite & Vermiculite Limited	St. Boniface, Man.	Perlite Vermiculite
British Columbia		
Grace Construction Materials Ltd.	Vancouver	Vermiculite
Ocean Construction Supplies Limited	Vancouver	Pumice[1]
Westroc Industries Limited	Vancouver	Perlite

Source: Company data.
[1] Pumice is used in concrete block manufacture.

World review

The United States and Greece are the main producers of perlite, with smaller quantities mined in Algeria, Turkey, the Philippines and New Zealand. New Zealand could become a major producer if huge deposits owned by Consolidated Silver Mining Co. are developed for export markets.

The major producers of pumice include the United States, Italy, West Germany and Greece, although production is recorded from other countries. As with other low-cost lightweight material, transportation costs are the main factors in determining the competitiveness of pumice. Prices have not varied greatly in recent years.

The use of fly ash should increase with the added incentives provided by environmental control. Two cement companies in the United States have begun to blend fly ash with portland cement at three plants to produce portland-pozzolan cement for general construction use. Using only about 20 per cent of ash production, industry in North America falls far short of European enterprises, which use as much as 80 per cent of production.

In the United States, W.R. Grace and Company, Zonolite Division is by far the largest producer of vermiculite, with mines in Montana and South Carolina. Through the Palabora Mining Co. Ltd. the Union of South Africa remains the second largest producer.

The unit price has shown a steady but unspectacular rate of increase during the past few years and is likely to continue to do so in pace with a steady increase in demand and normal inflationary conditions.

Table 6. Value of construction in Canada, 1972-74

	1972	1973	1974[1]	Change 1973-74
	(millions of dollars)			(%)
Building construction				
Residential	5,870.6	7,133.0	7,863.6	+ 10.2
Industrial	926.7	1,075.8	1,275.3	+ 18.5
Commercial	1,706.2	2,089.1	2,598.1	+ 24.4
Institutional	1,249.3	1,151.5	1,240.1	+ 7.7
Other building	574.7	680.1	833.7	+ 22.6
Total	10,327.5	12,129.5	13,810.8	+ 13.9
Engineering construction				
Marine	145.6	149.9	181.9	+ 21.4
Highways, aerodromes	1,670.8	1,872.1	2,110.2	+ 12.7
Waterworks, sewage systems	714.3	831.5	1,002.6	+ 20.6
Dams, irrigation	77.9	87.0	110.6	+ 27.1
Electric power	1,235.2	1,609.3	1,834.8	+ 14.0
Railway, telephones	666.1	795.0	939.7	+ 18.2
Gas and oil facilities	1,385.7	1,531.2	1,833.0	+ 19.7
Other engineering	1,065.8	1,132.8	1,329.7	+ 17.4
Total	6,961.4	8,008.8	9,342.5	+ 16.7
Total construction	17,288.9	20,138.3	23,153.3	+ 15.0

Source: Statistics Canada.
[1] Intentions.

Table 7. Canada, house construction by province

	Starts			Completions			Under Construction		
	1973	1974	% diff.	1973	1974	% diff.	1973	1974	% diff.
Newfoundland	4,831	4,911	+ 2	4,478	4,446	− 1	3,737	4,173	+12
Prince Edward Island	2,122	1,334	−37	1,789	1,664	− 7	1,192	860	−28
Nova Scotia	7,734	6,008	−22	5,534	6,604	+19	7,117	6,349	−11
New Brunswick	7,235	5,861	−19	7,036	6,812	− 3	4,534	3,550	−22
Total (Atlantic Provinces)	21,922	18,114	−17	18,837	19,526	+ 4	16,580	14,932	−10
Quebec	59,550	51,642	−13	55,260	58,596	+ 6	39,280	31,487	−20
Ontario	110,536	85,503	−23	98,262	104,360	+ 6	98,566	78,517	−20
Manitoba	11,531	8,752	−24	10,727	12,164	+13	9,088	5,668	−38
Saskatchewan	6,386	7,684	+20	5,421	6,487	+20	3,876	5,001	+29
Alberta	20,977	19,008	− 9	23,470	21,570	− 8	12,734	9,940	−22
Total (Prairie Provinces)	38,894	35,444	− 9	39,618	40,221	+ 2	25,698	20,609	−20
British Columbia	37,627	31,420	−16	34,604	34,540		27,112	22,861	−16
Total Canada	268,529	222,123	−17	246,581	257,243	+ 4	207,236	168,406	−19

Source: Statistics Canada.

Aluminum

M.J. GAUVIN

The shortage of aluminum that existed in 1973 continued through most of 1974. During this time world prices rose substantially, and the aluminum industry operated at a high percentage of capacity but was unable to satisfy the total volume of demand. Some of the developments that buffetted the industry during the year were: the formation of the International Bauxite Association which affected the structure of the bauxite suppliers and the price of this raw material; continuing high oil prices resulted in increases of up to 60 per cent in power costs; declines in North American housing starts and automobile production in the second half of the year; and the Cost of Living Council freeze on aluminum prices in the first half of the year, the period of greatest demand. The supply situation made a rapid turn-around during the fourth quarter as demand softened in many markets at once with the lowering of economic activity in most countries. At year-end, consumers inventories were built up, and producers were starting to reduce production to avoid excessive accumulation of stocks. However, 1974 was still a year of high profitability for most aluminum producers, but not nearly as high as had been anticipated early in the year.

Canada

No economic deposits of bauxite, the predominant ore of aluminum, are found in Canada. Bauxite is imported for the production of alumina by the Bayer process. Alumina is an aluminum oxide intermediate product which is reduced in an electric furnace to aluminum metal by the Hall-Heroult process. Approximately 4.5 tons of bauxite are refined to two tons of alumina, which in turn are smelted to one ton of aluminum. The Hall-Heroult process consumes vast quantities of electric power, between 7 and 8 kWh per pound of aluminum produced, and Canada's aluminum smelters are advantageously located near large low-cost power sources. Because transportation costs are such an important factor in the import of raw materials and export of aluminum, these smelters are all located near ocean shipping ports.

Production. Canadian primary aluminum output increased to 1,125,329 tons* in 1974 from 1,037,859 tons the previous year. Two companies operate primary aluminum smelters in Canada, namely Aluminum Company of Canada, Limited (Alcan), a subsidiary of Alcan Aluminium Limited, of Montreal (also referred to as Alcan) and Canadian Reynolds Metals Company, Limited, a subsidiary of Reynolds Metals Company of Richmond, Virginia. The Canadian primary aluminum industry operated at an average rate of 93 per cent of capacity in 1974. Operational and equipment problems prevented the industry from producing a higher tonnage.

Some 2,993,441 tons of bauxite were imported from Guyana, Guinea, Sierra Leone, and elsewhere to produce alumina at Alcan's refinery at Arvida, Quebec, the only alumina refinery in Canada. It has a capacity of 1,387,000 tons a year and supplies Alcan's four smelters in Quebec. Imports of bauxite from Guinea increased sevenfold to 972,270 tons in 1974 compared with 1973 as the Compagnie des Bauxites de Guinée in which Alcan hold a 13.5 per cent interest came into full production.

In 1974, Alcan's five Canadian smelters produced 963,000 tons of aluminum, an increase of 10.4 per cent compared with their output of 872,000 tons in 1973. Alcan Aluminium Limited, a multinational company, has wholly- and partly-owned smelters in Norway, Japan, Great Britain, Sweden, Spain, Australia, India, Brazil and Italy. In 1974, Alcan's total production, including Canadian production, was a record 2,174,000 tons, up from 2,020,000 tons in 1973.

The Canadian Reynolds Metals Company Limited operates a smelter at Baie-Comeau, Quebec. Its output of aluminum ingot in 1974 was 146,500 tons.

Canadian Reynolds obtains most of its alumina from the United States while Alcan imports alumina mainly from Australia and Jamaica. Total imports of alumina in 1974 from all sources was 973,964 tons.

Some expansion of Canadian primary smelting capacity began in 1974. Alcan initiated two modest expansions in ingot capacity of 25,000 tons each at the Arvida and Kitimat smelters which are expected to be completed in 1976. Alcan plans a progressive rebuilding and eventual expansion of its Canadian smelting capacity by some 300,000 tons or about 30 per cent. The timing of the expansion program will depend on

* The short ton (2,000 pounds) is used throughout unless otherwise stated.

economic factors. Aluminum Company of America (Alcoa) cancelled its plans to build a 60,000-ton-a-year smelter in the Valleyfield area of Quebec.

Canadian exports of aluminum, mainly in ingot form but also including further fabricated materials, was 803,313 tons; practically unchanged from 1973. The value of 1974 exports increased 36 per cent to $539,423,000 from $396,526,000 in 1973 because of higher prices.

Consumption. Canadian consumption of primary aluminum is estimated at 427,000 tons, 16.6 per cent more

Table 1. Canada, aluminum production and trade, 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Production	1,037,859	..	1,125,329	..
Imports				
Bauxite ore				
Guyana	1,559,635	12,280,000	1,253,359	10,418,000
Guinea	132,898	1,258,000	972,270	10,344,000
Surinam	464,703	7,576,000	349,048	7,830,000
Sierra Leone	393,668	2,982,000	346,146	2,656,000
United States	21,541	716,000	34,669	1,913,000
People's Republic of China	42,610	983,000	37,949	746,000
Other countries	312,421	1,666,000	—	—
Total	2,927,476	27,461,000	2,993,441	33,907,000
Alumina				
Australia	367,829	24,182,000	424,571	37,127,000
United States	312,522	21,921,000	224,779	18,641,000
Jamaica	237,156	16,319,000	183,462	12,757,000
West Germany	3	1,000	102,267	9,141,000
Guyana	2,298	147,000	26,220	1,803,000
Surinam	4,228	272,000	12,408	821,000
Other countries	16,054	1,077,000	257	117,000
Total	940,090	63,919,000	973,964	80,407,000
Aluminum and aluminum alloy scrap	11,339	2,138,000	6,433	2,484,000
Aluminum paste and aluminum powder	5,147	3,306,000	4,320	3,741,000
Pigs, ingots, shots, slabs, billets, blooms and extruded wire bars	49,535	25,899,000	52,856	38,524,000
Castings	650	1,385,000	897	2,222,000
Forgings	752	2,388,000	777	2,712,000
Bars and rods, nes	4,490	3,501,000	3,106	4,258,000
Plates	17,201	11,631,000	15,211	13,801,000
Sheet and strip up to .025 inch thick	28,591	20,324,000	32,296	27,484,000
Sheet and strip over .025 inch up to .051 inch thick	9,131	7,893,000	10,114	10,966,000
Sheet and strip over .051 inch up to 1.25 inch thick	19,052	11,821,000	19,692	17,880,000
Sheet over 1.25 inch thick	25,444	15,440,000	23,725	18,302,000
Foil or leaf	1,087	1,096,000	1,336	1,964,000
Converted aluminum foil		3,777,000		5,635,000
Structural shapes	3,506	7,524,000	3,196	7,207,000
Pipe and tubing	1,266	2,115,000	2,204	4,097,000
Wire and cable excl. insulated	1,814	1,995,000	2,305	3,548,000
Aluminum and aluminum alloy fabricated materials, nes		11,499,000		16,994,000
Total aluminum imports		225,112,000		296,133,000

Table 1 (cont'd)

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Exports				
Pigs, ingots, shot, slab, billets, blooms, and extruded wire bars				
United States	423,683	187,002,000	415,817	250,903,000
United Kingdom	69,835	33,214,000	76,852	52,321,000
Japan	93,044	41,448,000	80,874	47,593,000
Netherlands	21,044	9,980,000	33,927	19,610,000
Brazil	12,960	5,616,000	25,030	15,269,000
Italy	18,782	9,203,000	14,526	9,524,000
West Germany	22,714	11,338,000	12,217	7,605,000
Israel	11,280	4,592,000	12,127	7,568,000
Turkey	16,447	7,439,000	9,895	6,674,000
Malaysia	5,212	2,592,000	7,104	4,926,000
Hong Kong	8,317	4,238,000	7,403	4,922,000
Other countries	68,305	31,563,000	55,460	35,349,000
Total	771,623	348,225,000	751,232	462,264,000
Castings and forgings				
United States	1,927	4,569,000	1,206	5,463,000
France	31	490,000	44	631,000
Netherlands	3	10,000	18	138,000
Brazil	—	—	115	100,000
Other countries	120	88,000	48	189,000
Total	2,081	5,157,000	1,431	6,521,000
Bars, rods, plates, sheets and circles				
United States	11,288	6,366,000	12,840	9,007,000
Portugal	1,302	606,000	7,058	4,271,000
United Kingdom	220	135,000	4,350	2,156,000
Spain	242	142,000	2,009	1,195,000
Mexico	1,176	806,000	1,281	885,000
Jamaica	622	467,000	775	778,000
Colombia	1	1,000	1,113	664,000
Netherlands	656	327,000	734	532,000
Bangladesh	—	—	387	399,000
Indonesia	338	187,000	437	350,000
Other countries	2,758	2,061,000	2,430	2,185,000
Total	18,603	11,098,000	33,414	22,422,000
Foil				
Brazil	—	—	126	192,000
United States	51	77,000	254	169,000
Jamaica	7	8,000	19	27,000
Honduras	—	—	20	25,000
Other countries	23	22,000	46	63,000
Total	81	107,000	465	476,000

Table 1 (concl'd)

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Exports (cont'd)				
Fabricated materials, nes				
United States	5,905	4,849,000	8,511	7,035,000
United Kingdom	752	1,092,000	950	1,728,000
Tanzania	1	1,000	2,235	1,480,000
Cuba	—	—	1,157	923,000
Iran	—	—	1,533	839,000
Dominican Republic	24	29,000	282	272,000
Other countries	3,999	3,130,000	2,103	1,897,000
Total	10,681	9,101,000	16,771	14,174,000
Ores and concentrates				
United States	24,696	2,515,000	25,057	3,350,000
Italy	1,525	207,000	1,820	319,000
Spain	905	130,000	1,438	221,000
France	1,536	222,000	1,047	192,000
United Kingdom	1,008	170,000	995	172,000
Sweden	260	40,000	462	107,000
Other countries	2,317	523,000	1,251	244,000
Total	32,247	3,807,000	32,070	4,605,000
Scrap				
United States	40,621	13,957,000	47,466	24,315,000
Japan	4,006	1,677,000	3,736	2,001,000
West Germany	3,721	647,000	1,525	753,000
Spain	3,117	776,000	3,220	664,000
Italy	1,750	452,000	699	425,000
Brazil	1,133	384,000	741	347,000
France	451	134,000	217	139,000
Netherlands	518	156,000	225	95,000
Other countries	2,828	848,000	637	222,000
Total	58,145	19,031,000	58,466	28,961,000
Total aluminum exports		396,526,000		539,423,000

Source: Statistics Canada.
p Preliminary; — Nil; nes Not elsewhere specified; . . Not available.

than the 365,728 tons consumed in 1973. Alcan started construction on the $13 million first phase of a projected $28 million casting centre at Arvida. The first phase is due to be completed in 1975, and when all three phases are completed the centre will have a rated annual casting capacity of over 380,000 tons of ingot products. Alcan's subsidiary, Alcan Canada Products Limited is installing a second continuous annealing line at its Kingston, Ontario works. The $4 million installation complements the $14 million, second cold-rolling mill now under construction and will increase the plant's rolling capacity of sheet and plate to 150,000 tons annually. Reynolds Aluminum Company of Canada Ltd. is progressing with a $5 million expansion of its Cap-de-la-Madeleine, Quebec sheet and foil mill which will be completed in 1975.

World developments

International Bauxite Association. The most important development in the international aluminum scene in 1974 was the formation of the International Bauxite Association (IBA). The IBA was formed in March 1974, when representatives of seven countries met in Conakey, Guinea, to draft an agreement to further the interests of bauxite-producing countries. The original members were Australia, Guinea, Guyana, Jamaica, Sierre Leone, Surinam and Yugoslavia who together produce about 70 per cent of the noncommunist world's bauxite, but only about 3 per cent of its aluminum. The first annual meeting of the Association was held in Georgetown, Guyana in November, 1974 at which Haiti, Ghana and the Dominican Republic joined the Association. One of the aims of the Association is to develop a uniform pricing formula for bauxite tied to ingot prices. This formula will also take into consideration such items as the grade of the bauxite, transportation and operating costs and a floor price for bauxite. Jamaica, Haiti, Surinam, Guyana and the Dominican Republic have moved ahead of the IBA task force on prices and have set new bauxite levies of their own.

On June 4, 1974, the government of Jamaica passed its Bauxite Production Levy Act which increased sixfold the basic rate of levy for bauxite mines. It also gave the government the right to acquire equity participation in the mining operations and to buy back the lands held by the aluminum companies. The rate of levy is to be based on the average realized price of a short ton of aluminum and was set at 7½ per cent for 1974, rising to 8 per cent in 1975 and 8½ per cent in 1976. The Act also specifies a minimum output level for the country's bauxite producers of 14 million tons in 1974. The aluminum companies involved are Alcan Jamaica Limited; Alcoa Minerals of Jamaica Inc.; Reynolds Jamaica Mines Limited; Kaiser Bauxite Company; Alumina Partners of Jamaica (Alpart), and Revere Jamaica Alumina Ltd. After preliminary talks with all the companies, Jamaica started its Phase II negotiations with Kaiser and in November signed an agreement with Kaiser Aluminum & Chemical Corporation providing for the purchase by Jamaica of 51 per cent of Kaiser's wholly-owned subsidiary, Kaiser Bauxite Company, and reacquisition of some 40,000 acres of land. The government allowed Kaiser a lower

Table 2. Canada, primary aluminum production, trade and consumption, 1965-74

	Production	Imports	Exports	Consumption[1]
		(short tons)		
1965	830,505	6,945	707,512	213,094
1966	889,915	16,923	716,382	243,301
1967	963,343	8,176	760,649	217,484
1968	979,171	15,043	862,634	242,390
1969	1,078,717	11,531	886,688	269,027
1970	1,061,020	13,425	839,598	275,743
1971	1,120,951	17,527	890,160[r]	322,081
1972	1,012,132	38,741[r]	770,869[r]	333,550
1973	1,037,859	49,535	771,623	365,728
1974[p]	1,125,329	52,856	751,232	427,000

Source: Statistics Canada.
[1] Excluding aluminum metal used in the production of secondary aluminum.
[p] Preliminary; [r] Revised.

bauxite levy in the first years of the agreement and guaranteed Kaiser a supply of bauxite. In December, Revere Copper and Brass Inc. and the Jamaican government reached a similar agreement but with the bauxite levy subject to a special rebate if Revere proceeds with a 600,000 ton expansion of its alumina refinery in Jamaica. Phase II negotiations between the Jamaican government and the other producers will continue in 1975.

Following the moves of the Jamaican government, Surinam, Guyana, Haiti, Guinea, and the Dominican Republic moved to increase revenues from bauxite production. Surinam reached agreement in November with a subsidiary of Aluminum Company of America which calls for bauxite revenues of about $10 a metric ton. Guyana and Reynolds Metals Company could not reach agreement, and near the end of 1974 the government of Guyana announced the nationalization of Reynolds bauxite operations effective January 1, 1975. Haiti reached a tentative agreement with Reynolds in December which provides a bauxite tax of $9.33 a long dry ton and which is subject to further negotiations to establish a final agreement in 1975. The other bauxite producing countries had not set new levies or concluded new taxing agreements with the producing companies at the end of 1974.

Australia surpassed Jamaica as the largest producer of bauxite in 1972 and, with its very extensive reserves, should retain its leading position in the foreseeable future. World bauxite production was about 73 million tons in 1974, up 6 per cent from the 69 million tons produced in 1973. Most bauxite producers increased production in 1974 over 1973. In Australia, the Weipa mining operation of Comalco Limited increased shipments of bauxite by 300,000 tons to 9.3 million tons. The Weipa deposit, located about 360 miles northwest of Cairns, is the largest single bauxite mining operation in the world and the deposit contains more than 2,200 million tons of commercial grade bauxite.

Production of bauxite in the Republic of Guinea increased by over 2 million tons in 1974 as the $320 million Boke project of Compagnie des Bauxites de Guinée (CBG) experienced its first full year of production. Shipments from Boke were about 4 million tons in 1974. The ultimate production capacity of 9.9 million tons a year will be reached in 1979. The company is owned 49 per cent by the government of Guinea and 51 per cent by Halco Mining Company. Alcan has a 27 per cent interest in Halco and expects the shipments it will receive from CBG to grow from 1.3 million tons in the first year of operation to 2.6 million tons in 1979. Noranda Mines Limited bought Olin Corporation's 38.5 per cent interest in Frialco. Frialco owns 51 per cent of the bauxite mining and alumina producing company Friguia and the government of Guinea owns 49 per cent.

Brazil appears to be in the forefront of future development plans. Major deposits of bauxite in northern Brazil in the basin of the Amazon River are

Table 3. Canada consumption of aluminum at first processing stage

	1971	1972	1973	1974p
	(short tons)			
Castings				
Sand	1,486	1,468	1,799	
Permanent-mould	15,468	13,351	14,930	
Die	23,573	28,120	27,408	
Other	117	182	144	
Total	40,644	43,121	44,281	..
Wrought products				
Extrusions including tubing	79,179	87,588	102,002	
Sheet, plate, coil and foil	92,941	104,400	129,373	
Other wrought products (including rod, forgings and slugs)	98,680	87,630	76,513	
Total	270,800	279,618	307,888	..
Destructive uses				
Non-aluminum base alloys, powder and paste deoxidizers and other	10,637	10,811	13,559	
Total consumed	322,081	333,550	365,728	..
Secondary aluminum[1]	33,007	35,209	42,749	..
Receipts and inventories at plants	Metal Entering Plant		On Hand December 31	
	1973	1974	1973	1974
Primary aluminum ingot and alloys	323,352		70,480	
Secondary aluminum	38,067		3,794	
Scrap originating outside plant	57,139		6,936	
Total	418,558	..	81,210	..

Source: Statistics Canada.
[1] Aluminum metal used in the production of secondary aluminum.
p Preliminary; r Revised; .. Not available.

being explored and developed. Mineracao Rio do Norte S.A. is to be the operating company for the Oriximina deposit on the Trombetas River. Alcan Aluminium Limited heads the development of the project. Brazilian interests led by Companhia Vale do Rio Doce (CVRD), a state-owned company, hold 51 per cent of the project; Alcan holds 20 per cent and six other partners share the remainder. Reserves are over 500 million tons of bauxite and production is due to begin in 1978 at a rate of 3.3 million tons a year. Initially, all bauxite will be exported with Alcan's share being 1.3 million tons. A second major project based on northern Brazil bauxite has been agreed to by CVRD and five Japanese aluminum companies. The corporation, Alumino do Brazil, owned 51 per cent by CVRD, will build a large alumina-aluminum complex near Belem at the mouth of the Amazon River. When completed in 1985, the smelter will have a capacity of 600,000 tons of aluminum a year; initial production will begin in 1980 when an 80,000-tons-a-year potline comes on stream. A 1.2-million-tons-a-year alumina refinery will be built as well as a 2.7 kW hydroelectric plant. Total cost of the project is estimated at $3 billion. Development plans have not yet been announced for other bauxite deposits in the region. Cia Minera de Aluminio, owned 50 per cent by Alcoa, 30 per cent by The Hanna Mining Company and 20 per cent by Brazilian interests is expanding its bauxite-alumina-aluminum complex near São Paulo. Its annual capacity is scheduled to be doubled by 1976 to 430,000 tons of bauxite, 155,000 tons of alumina and 72,000 tons of aluminum.

New projects are being proposed for Indonesia. Alcoa has proposed to build an 800,000-ton-a-year alumina refinery on North Borneo based on the

Table 4. World primary aluminum production and consumption, 1973 and 1974

	Production		Consumption	
	1973	1974	1973	1974e
	(thousand short tons)			
United States	4,529	4,890	5,596	5,740
Europe[1]	3,138	3,644	3,575	3,693
Japan	1,209	1,233	1,735	1,484
Canada	1,038	1,125	366	427
Australia and New Zealand	356	363	200	227
Asia (excluding Japan and China)	377	380	410	354
Africa	275	325	121	131
America (excluding United States and Canada)	271	274	375	372
Subtotal	11,193	12,234	12,378	12,428
Communist countries[2]	2,824	2,830	2,709	2,709
Total	14,017	15,064	15,087	15,137

Sources: World Bureau of Metal Statistics; for Canada, Statistics Canada; for United States production, U.S. Bureau of Mines Commodity Data Summaries.
[1] Includes Yugoslavia. [2] Excludes Yugoslavia.
[e] Estimated.

Kalimantan bauxite deposits. The Indonesian government and a group of five Japanese aluminum producers have reached agreement to undertake jointly the $900 million Asahan aluminum-hydroelectric project in northern Sumatra. The 250,000-ton-a-year smelter and accompanying 425 megawatt hydroelectric generating plant is expected to start production in 1979. An international consortium of nine companies has announced plans for a 1.7-million-ton-a-year alumina refinery on Mindanao Island in the Philippines in place of the facility originally planned for Comalco's Weipa, Australia, bauxite operation. The undertaking is scheduled for completion in 1979. Alcan has postponed construction of a 970,000-ton-a-year alumina refinery on Aughinish Island at the mouth of the Shannon River in Ireland. The plant has been scheduled for start up in 1978.

Development of the Alwest Pty. 350,000-ton-a-year alumina plant in Western Australia has been held up by environmental objections and by governmental restrictions on foreign investments. Pacminex Pty. Ltd., has reached agreement with the Western Australian government and work is proceeding on its aluminum refinery at Muchea. Initial capacity will be 400,000 tons a year rising to 1.2 million tons. Production is expected to begin in 1977. Alcoa brought additional capacity on stream at its Pinjarra refinery, Western Australia raising the plant's alumina capacity to more than 1.1 million tons a year. A further expansion will double the capacity to 2.2 million tons in 1976.

Table 5. Canadian primary aluminum smelter capacity, 1974

Smelter location	Annual capacity
	(short tons)
Aluminum Company of Canada, Limited	
Quebec	
Arvida	458,500
Isle-Maligne	130,000
Shawinigan	95,000
Beauharnois	51,500
British Columbia	
Kitimat	300,000
Total Alcan capacity	1,035,000
Canadian Reynolds Metals Company, Limited	
Quebec	
Baie-Comeau	175,000
Total Canadian capacity	1,210,000

Source: Compiled in Mineral Development Sector from various company reports.

Sumitomo Chemical Co., completed the 110,000 tons expansion of its Kikumoto refinery in Ehime, Japan in 1974. Capacity of the refinery is now 950,000 tons of alumina a year. Mitsui Aluminum Company, plans to double the capacity of its Kitakyushu refinery to 440,000 tons a year late in 1976.

Bauxite and alumina were not in short supply during 1974. During most of the year, aluminum smelters were unable to meet the demand for aluminum metal despite the fact the industry was producing at high levels and that some new production facilities came into operation. The United States government stockpile was completely drawn down to meet consumers' requirements.

The first primary aluminum smelter in Argentina, at Puerto Madryn, with a capacity of 40,000 tons a year, started production in 1974. In Japan, Mitsubishi Chemical Industries Ltd., started up its new Sakaide II 110,000-ton-a-year aluminum smelter, and Nippon Light Metal Company completed the 48,000-ton-a-year expansion of its Niigata smelter bringing capacity up to 160,000 tons a year. A second potline at Pechiney Nederland NV's Wlissingen, Holland smelter came on stream thereby doubling the capacity to 195,000 tons a year. Alcan Aluminium (U.K.) Limited's new Lynemouth smelter completed its start-up program in 1974 and operated close to its capacity of 132,000 tons. The 110,000-ton-a-year first stage of the Nag Hamadi smelter in Egypt was in the start-up phase at the end of 1974. Alcan Aluminium Limited reached agreement to sell to the Kingdom of Norway half of its equity interest in A/S Ardal og Sunndal Verk, the largest aluminum producer in Norway, with an annual capacity of 360,000 tons.

Noranda Aluminum Inc., is doubling the capacity at its New Madrid, Missouri plant to 140,000 tons a year of aluminum, with completion scheduled for 1976. Also scheduled for completion in 1976 is a 60,000-ton-a-year expansion to Alcoa's Badin, North Carolina smelter. Capacity of Revere Copper and Brass, Inc.'s Scottsboro, Alabama smelter is to be tripled to 360,000 tons a year and will be partly financed by Japanese interests. Mexico's only aluminum smelter at Veracruz will be expanded by 50,000 tons to 100,000 tons a year in 1977. Construction is expected to start in Mexico in 1975 on a second aluminum smelter, part of a refinery-smelter project to be built by the Mexican and Jamaican governments and with up to 20 per cent industry participation. The refinery part of the project will be located in Jamaica. The government of Venezuela and five Japanese companies have reached agreement on the New Velem smelter project at Puerto Ordaz in northeastern Venezuela. The project is scheduled to have its first 77,000-ton-a-year potline on stream in 1977. Capacity will be expanded to 300,000 tons a year at a later date.

Table 6. Estimated world production of bauxite in 1974

	Production (millions of short tons)
Australia	20.2
Jamaica	16.9
Surinam	7.3
Guinea	6.7
France	3.5
Guyana	3.4
Greece	2.8
United States	2.2
Other noncommunist countries[1]	10.4
Total noncommunist countries	73.4
Communist countries	8.4
World Total	81.8

Source: United States Bureau of Mines Commodity Data Summaries, January 1975.
[1] Production of Yugoslavia included.

In Japan, Sumitomo Chemical Co.'s 110,000 new Toyo smelter is expected to have its first 55,000-ton stage operative early in 1975. Capacity is planned to be further increased to 220,000 tons by 1977. Sumikei Aluminum plans to start construction soon on a smelter at Sakata. The initial capacity of the smelter is 100,000 tons and it is expected to come on stream in 1977. In India, the first 28,000-ton-a-year stage of Bharat Aluminium Company's Korba smelter is to go on stream in 1975.

The Iranian Aluminum Company plans to increase the smelting capacity of its reduction plant at Arak, Central Iran, from 50,000 to 132,000 tons a year in 1977. Kaiser Aluminum & Chemical Corporation is to add a fifth potline at its Tema, Ghana, smelter run by the Volta Aluminum Company increasing capacity by 50,000 tons to 220,000 tons in 1976. Pechiney Ugine Kuhlmann Development, Inc., has been awarded a contract for the construction of an alumina-aluminum complex in the U.S.S.R. Annual capacity of the alumina refinery will be 1,100,000 tons and smelter capacity 550,000 tons. The Yugoslavian state-owned Energoinvest Corporation of Sarajevo continues to expand its aluminum production and is constructing a 93,000-ton-a-year smelter near Mostar which is scheduled to start production in 1975.

Technology

Pechiney Ugine Kuhlmann Development, Inc. and Alcan Aluminium Limited have agreed to share equally in the construction and operation of a pilot plant near Marseilles, France, for joint development of a process to extract alumina from non-bauxite raw materials such as clays and shales. The pilot plant is scheduled to produce 20 tons a day of high-grade alumina using Pechiney's H-Plus process. Estimated capital costs and operating expenses of the plant are about $25 million. Pechiney claims that the process produces a purer alumina and reduces smelting costs. If the process proves feasible it could free aluminum producers from dependence on bauxite, most of which is mined in countries that are members of the International Bauxite Association. Construction of the plant is to start in 1975 and it is expected that sufficient data to accurately assess the process will be available by 1979.

A non-bauxite aluminum ore research project is underway in Boulder City, Nevada. The research facility, built by the United States Bureau of Mines, is capable of producing 600 pounds a day of alumina. A series of tests will be made over the next three years on various methods of extracting alumina from clays, anorthosite, alunite and dawsonite. The research is being funded equally by the Bureau of Mines and eight North American producers, including Alcan.

Reynolds Metals Company demonstrated that it could produce alumina by running Oregon laterite through the existing bauxite-alumina facilities of its Hurricane Creek, Arkansas, alumina refinery. Laterite is lower in alumina and higher in silica than metallurgical grade bauxite. Reynolds and the Philippine government will be exploring the possibility of using local bauxite or other aluminum bearing materials for processing into alumina as a source of feed for their planned joint aluminum reduction plant.

Tests are continuing on using alunite as an alternative to clay in the production of alumina at a pilot plant located at Golden, Colorado. The plant is a joint venture of National Steel Corporation, Southwire Aluminum Company and Earth Sciences Incorporated. If the process proves out, the three partners plan to construct a 500,000-ton-a-year alunite-alumina plant in Utah as well as facilities for producing 250,000 tons of potassium sulphate and 500,000 tons of triple superphosphate a year as valuable byproducts. In 1975, Poland is to start construction of a plant with a capacity of 115,000 tons of alumina a year. The plant will use a non-bauxite ore such as alunite. In addition, the plant will have a capacity to produce 300,000 tons of portland cement a year.

The Aluminum Company of America expects its new Alcoa smelting process to substantially cut energy consumption per pound of aluminum produced about 30 per cent below the national average. In the process, alumina is combined with chlorine to form aluminum chloride which, in turn, is separated into molten aluminum and chlorine at relatively low temperatures. Alcoa will give the process its first commercial test when its 30,000-ton-a-year smelter at Palestine, Texas, comes on stream in 1976. The smelter may be expanded to 300,000 tons a year if the process proves commercial.

Uses

Characteristics such as lightness combined with strength, pleasing appearance, corrosion resistance, conductivity and heat reflectivity provide many advantages favouring the use of aluminum. It may be cast, rolled, extruded and forged with ease compared with many of its competitive materials. In the United States, which is the world's largest market, the construction field continued to be the largest consumer in 1974, accounting for 23.4 per cent of shipments, according to the Aluminum Association. Transportation, another major user, was in second place with 18.0 per cent, followed by containers and packaging 16.6 per cent, electrical uses 13.7 per cent, consumer durables 8.5 per cent, and machinery and equipment 7.4 per cent. In many of the other main consuming countries transportation ranks first as a consumer.

The importance of housing construction to the aluminum industry is obvious when one considers that the average new conventional or mobile home in the United States contains about 1,000 pounds of aluminum. Transportation reflects very high manufacturing activity in trailers, semi-trailers, trucks and buses. The increasing use of aluminum cans for beer and soft drinks continues to be a major growth factor, aided by public acceptance of the efforts of aluminum manufacturers, brewers and bottlers to recycle the used cans.

New markets

There are two fields that have prospects of greatly increased consumption of aluminum. The first is the automotive, where the average use of aluminum in passenger cars manufactured in North America rose to 82 pounds in 1974 from 76 pounds in 1973. The need to decrease vehicle weight to counteract the extra weight of increased safety and pollution control devices and to conserve energy is apparent. Aluminum bumper reinforcement bars as well as all-aluminum bumpers and some interior panels have become accepted, with the prospect for aluminum exterior panels to appear on some 1976 model cars. Housings for the much-heralded Wankel rotary engine should contain considerable quantities of aluminum. With the advent of better joining techniques, aluminum radiators are a distinct possibility. The second major field is cryogenic tanks for holding liquefied natural gas (LNG). There are extensive plans to ship this form of energy from overseas natural gas producers to areas experiencing an energy shortage, such as the United States, Europe and Japan. Aluminum is expected to be used in both the ships transporting LNG and for onshore storage vessels.

Prices

The strong demand for aluminum in 1973 carried well into 1974. Aluminum was in short supply, and prices in the United States were substantially lower than elsewhere in the world during most of the year. The United States published price for 99.5 per cent primary ingot was controlled until August 1, 1974 by the Cost of Living Council, and at the beginning of 1974 it was 29 cents a pound. The Cost of Living Council negotiated an agreement with aluminum producers under which the price was permitted to rise to 31.5 cents a pound on April 1, and to 33.5 cents on June 1, 1974. Prices were raised to 36 cents a pound on August 1. On September 3, a further increase to 39 cents a pound became effective where it remained at the end of the year. Canadian prices are not quoted but follow United States prices quite closely. In the first half of the year, ingot prices in Europe and Japan ranged up to 52 cents a pound. As demand slowed and shortages ended, world and dealer prices fell to United States levels by autumn and, at the end of 1974, had dropped below the United States producers' price.

Outlook

Total world consumption of primary metal in 1973 increased over consumption in 1972 at a record 16 per cent. Consumption in 1974 increased by about 3 per cent over that of 1973, but a substantial decline is foreseen for 1975. However, the long-term growth pattern of 7 to 8 per cent a year should continue over the next five years. During the fourth quarter of 1974, a sharp reduction in aluminum shipments led to a large increase in producer inventories. Faced with lower demand and expectations of a further decrease in shipments, producers began to cut back primary production and further cutbacks were instituted during the first quarter of 1975. New capacity scheduled for completion in the next few years is estimated to increase total aluminum capacity at a rate of less than 6 per cent a year. When the economies of the world improve, a return to full production will occur. With United States government stockpiles now depleted, any strong upsurge in demand could see a shortage of metal develop, accompanied by price increases.

During 1974, operating costs of aluminum companies rose at an unprecedented rate. The upward pressures on operating costs and, therefore, aluminum prices as a result of increased oil and power costs and bauxite levies will continue.

Prospects are for an increase in the use of aluminum in the 1976 model automobile and further increases in the average amount of aluminum per automobile in subsequent years for light weight and gasoline conservation. The need to conserve energy will spur the growth of the recycling industry. Recycled metal consumes only 15 per cent of the energy required to extract aluminum from virgin material.

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
32910-1	Bauxite	free	free	free
35301-1	Aluminum pigs, ingots, blocks, notch bars, slabs, billets, blooms and wire bars	free	1¢ per lb	5¢ per lb
35302-1	Aluminum bars, rods, plates, sheets, strips, circles, squares, discs and rectangles	free	2¢ per lb	7.5¢ per lb
35303-1	Aluminum channels, beams, tees and other rolled, drawn or extruded sections and shapes	free	12½%	30%
35305-1	Aluminum pipes and tubes	free	12½%	30%
92820-1	Aluminum oxide and hydroxide; artificial corundum (this tariff includes alumina)	free	free	free

United States

Item No.		
417.12	Aluminum compounds: hydroxide and oxide (alumina)	free
601.06	Bauxite	free
618.01	Unwrought aluminum in coils, uniform cross section not greater than 0.375 inch	1.2¢ per lb
618.02	Other unwrought aluminum, excluding alloys	1¢ per lb
618.04	Aluminum silicon	1¢ per lb
618.06	Other aluminum alloys	1¢ per lb
618.10	Aluminum scrap (expires June 30, 1975)	free

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.
Various tariffs are in effect on more advanced fabricated forms of aluminum.

Antimony

G.R. PEELING

Canada's production of antimony is derived as a byproduct of lead smelting operations, principally in the form of antimonial lead but also as antimonial dross and, in much smaller quantities, as high-purity antimony metal. The value of the antimony content of primary antimonial lead produced in 1974 was $839,000 compared with $1,192,118 in 1973. The value of antimony contained in ores and concentrates produced in 1974 was $4,722,000 compared with $2,614,642 in 1973. The quantity of antimony contained in ores and concentrates is withheld to protect the confidentiality of the producer.

Antimony metal, antimony oxide and antimony salts are imported to meet Canadian needs. Regulus (metal) import statistics were discontinued in 1964. Imports of antimony oxide in 1974 totalled 1,755,600 pounds of which Britain supplied 73 per cent, the United States 17 per cent and Bolivia 10 per cent.

Cominco Ltd., which operates a lead smelter and refinery at Trail, British Columbia, is the main producer of primary antimonial lead in Canada. Its antimonial lead has a variable antimony content up to 23 per cent, depending on the customers' requirements. Cominco Ltd. produced 244 tons of antimonial lead in 1974 compared with 830 tons in 1973. The decrease in production was caused by a four-month strike which shut down Cominco's operations at Trail in 1974. The only other primary producer of antimonial lead is Brunswick Mining and Smelting Corporation Limited, Smelting Division, which operates a lead smelter at Belledune, New Brunswick. About 38,100 pounds of antimonial lead (11.7 per cent antimony content) was produced at the plant in 1974. Secondary smelters recovered antimonial lead from scrap metal but no recent information is available concerning this production. In 1972, these smelters reclaimed about 48,000 short tons* of antimonial lead from scrap.

Domestic sources and occurrences

Most of the antimonial lead produced at Trail is a byproduct of the lead concentrate obtained from ores of Cominco's Sullivan mine at Kimberley, British Columbia. Other sources are the lead–silver ores and concentrates shipped to Trail from other Cominco mines and from custom shippers. The lead bullion produced from the smelting of these ores and concentrates contains about one per cent antimony, which is recovered in anode residues from the electrolytic refining of the lead bullion, and in furnace drosses produced during purification of the cathode lead. These residues and drosses are treated to yield antimonial-lead alloy to which refined lead may be added to produce marketable products of the required grade. At Belledune, the Brunswick Mining and Smelting plant recovers antimonial lead alloys of whatever grade the market demands.

Consolidated Durham Mines & Resources Limited operates Canada's only antimony mine. It mines low-angle dipping veins containing stibnite, Sb_2S_3, at its Lake George property near Fredericton, New Brunswick. The mine has five levels with the bottom level 545 feet below surface. The mill output is between 150 and 200 tons a day with a total production in 1974 of 58,106 tons. Concentrates, which average slightly over 65 per cent antimony, are shipped mainly to Europe with small amounts going to the United States and Japan. As of June 30, 1974, reserves in the Hibbard zone were 155,225 tons grading 4.63 per cent antimony after dilution. Additional reserves of 46,695 tons grading 5.03 per cent antimony were located just east of the Hibbard zone late in 1974. The Prout zone contains an estimated 41,259 tons (as of June 30, 1974) grading 2.42 per cent antimony. Reserves are sufficient to sustain the operation at its present level for at least three and a half years.

Equity Mining Capital Limited is continuing exploration of its silver–gold–copper–antimony property near Houston, British Columbia. Reserves, mineable by open pit, are 43,511,000 tons grading 2.78 ozs. silver, 0.026 oz. gold, 0.33 per cent copper and 0.085 per cent antimony a ton. Initial bench scale studies indicate that the antimony can be extracted from the concentrates and that the antimony could become an important byproduct of the operation. The feasibility study will not be completed before the middle of 1975. If the property is brought into production it will be at a reported mining rate of between 4,500 and 6,000 tons a day.

* The net or short ton (2,000 pounds) is used throughout unless otherwise stated.

Table 1. Canada, antimony production, imports and consumption, 1973-74

	1973		1974[p]	
	(pounds)	($)	(pounds)	($)
Production				
Antimonial lead alloy	1,660,331	1,192,118	466,000	839,000
Antimony in ores and concentrates	..	2,614,642	..	4,722,000
Total	..	3,806,760	..	5,561,000
Imports				
Antimony oxide				
United Kingdom	1,122,400	728,000	1,284,100	1,542,000
United States	315,000	273,000	295,200	412,000
Bolivia	—	—	176,300	126,000
Honduras	49,700	11,000	—	—
Total	1,487,100	1,012,000	1,755,600	2,080,000
Consumption				
Antimony regulus (metal) in production of				
Antimonial lead alloys	597,054		1,752,717	
Babbitt	144,173		100,123	
Solder	32,106		118,457	
Type metal	35,138		28,579	
Other commodities[1]	171,095		169,000	
Total	979,566		2,168,876	

Source: Statistics Canada.
[1] Includes foil, bronze, lead-base alloys, drop shot and other minor commodities.
[p] Preliminary; — Nil; .. Not available.

Table 2. Antimony, Canadian production, imports and consumption, 1965-74

	Production[1] all forms	Imports regulus	Consumption[2] regulus
		(pounds)	
1965	1,301,787	..	659,637
1966	1,405,681	..	1,098,162
1967	1,267,686	..	1,190,179
1968	1,159,960	..	1,169,631
1969	820,122	..	1,305,742
1970	726,474	..	1,142,009
1971	323,525	..	1,461,763
1972	..	..	2,026,300
1973	..	..	979,566
1974[p]	..	..	2,168,876

Source: Statistics Canada.
[1] Antimony content of antimonial lead alloy. [2] Consumption of antimony regulus (metal), as reported by consumers. Does not include antimony in antimonial lead produced by Cominco Ltd.
[p] Preliminary; .. Not available.

World review

World mine production of antimony in 1974, as estimated by the United States Bureau of Mines, totalled 78,700 tons, 2,281 tons more than in 1973.

Antimony is produced from ores and as a smelter byproduct in about 25 countries. The major sources of ore are the Republic of South Africa, the People's Republic of China, Bolivia, U.S.S.R., Mexico, Turkey and Yugoslavia. Prior to 1935, China, which reputedly has over 50 per cent of the world's reserves, produced two thirds of the annual world output of antimony, but during the Chinese-Japanese War the centre of production shifted to the Americas. The United States, Mexico and Bolivia were the leading world suppliers of antimony during and immediately after The Second World War. In the years following the Korean War, the Republic of South Africa, the People's Republic of China and Bolivia became the major suppliers.

In the Republic of South Africa, Consolidated Murchison Limited operates the world's largest antimony mine, near Gravelotte in northeast Transvaal. It has a mining and milling capacity of 660,000 tons a year of stibnite ore averaging three per cent antimony. In 1974, the company produced 26,055 tons of cobbed ore and concentrates compared to 25,870 tons in 1973. As part of an expansion program, two new shafts are being sunk to allow the current milling rate to be maintained. The mine should be able to operate at its present level of output for another 8 or 9 years. In April 1974 the company began production of crude antimony oxide at its plant situated near the mine. The plant has an annual capacity of 7.2 million pounds of crude oxide all of which is purchased by Chemetron Corporation, a United States' company based in Chicago.

Bolivia is building a new antimony smelter at Oruro with Czechoslovakian backing, and it is scheduled to be in production by August of 1975. Its projected annual capacity is 5,500 tons a year of 99.6 per cent antimony regulus and 1,100 tons a year antimony alloys. The Bolivian government has given approval to Bolivian and Brazilian private interests to establish a low grade antimony volatization plant at Tupiza in southern Bolivia. The plant, operated by Antinonio Túpiza S.A., will have a capacity of 7,700 tons a year of 65 per cent antimony oxides. Approval for an associated smelter has not yet been given.

New antimony mines in Thailand and Australia were brought into production in 1974. In Thailand, the new mines in the Banpin district began shipping antimony concentrates grading 63 to 64 per cent antimony to Hibino Metal Industry Company late in 1974. Australian Antimony Corporation commenced open-cut mining at its Wild Cattle Creek mine in New South Wales in January 1974.

N.L. Industries Inc. operates the world's largest antimony smelter for ores and concentrates at Laredo, Texas, producing antimony metal and oxide, mainly from imported Mexican, South African and Bolivian ores and concentrates. The United States' mine production of antimony in 1974 was estimated to be 634 tons, 85 tons more than in 1973. Recovery of antimony in antimonial lead scrap is a major source of supply. This secondary supply represents a substantial portion (up to 60 per cent) of total antimony supply in the United States and other highly industrialized countries.

In 1973, favourable economic conditions resulted in higher production and consumption. This trend continued through the first half of 1974, with prices reaching an all-time high as a result of a shortage of antimony ore. Late in the summer, the trend reversed as the world economy slowed down and consumption

Table 3. Canadian consumption of antimonial lead alloy[1], 1972-74

	1972	1973	1974
		(pounds)	
Batteries	1,886,320	1,912,526	2,363,462
Type metal	222,000	201,182	246,000
Babbitt	56,767	1,913	17,856
Solder	223	6,518	6,142
Other uses	3,515	1,000	5,044
Total	2,168,825	2,123,139	2,638,504

Source: Statistics Canada.
[1] Antimony content of primary and secondary antimonial lead alloy.

Table 4. Canadian consumption of antimonial lead alloy[1], 1965-74

	(pounds)		(pounds)
1965	2,775,241	1970	1,400,402
1966	2,593,733	1971	2,175,085
1967	2,496,032	1972	2,168,825
1968	2,124,903	1973	2,123,139
1969	2,321,770	1974	2,638,504

Source: Statistics Canada.
[1] Antimony content of primary and secondary antimonial lead alloys.

Table 5. World mine production of antimony, 1972-74.

	1972	1973	1974[e]
		(short tons)	
Republic of South Africa	16,062	17,306	18,000
Bolivia	14,472	16,462	16,500
People's Republic of China[e]	13,000	13,000	*
U.S.S.R.	7,700	7,800	*
Thailand	5,208	3,750	*
Turkey	2,982	3,696	*
Mexico	3,280	2,632	3,500
Yugoslavia	2,177	1,900	3,000
Australia	1,504	1,652	*
Italy	1,324	1,510	*
Morocco	917	1,249	*
Guatemala	992	1,060	*
Peru	881	900	
United States	489	545	600
Canada	. .	. .	. .
Other countries	1,931	2,010	37,100
Total	72,919	75,472	78,700

Sources: For Canada, Statistics Canada. For other countries, U.S. Bureau of Mines *Minerals Yearbook* Preprint 1973; Commodity Data Summaries, January 1975 for 1974.
* Included in "Other countries".
[e] Estimated; . . Not available.

declined. By the end of 1974, the situation had completely changed; consumption and production had declined, prices weakened and in the United States, stocks at year-end of primary antimony metal were 10,500 tons, the largest in recent years.

The United States was again the noncommunist world's largest consumer of antimony and continued to depend on foreign suppliers (particularly the Republic of South Africa, Bolivia, Chile and Mexico) for much of its requirements. Its consumer requirements in 1974 were about 20 per cent of the world primary supply.

There were no sales by the General Services Administration (GSA) of the United States from the government stockpile in 1974. Sales in 1973 had reduced the stockpile to 40,700 tons, exhausting that portion of the stockpile which Congress had given the GSA authority to sell. A bill authorizing the disposal of the remaining 40,700 tons of regulus from the stockpile was introduced in the House of Representatives in June 1974, but no action had been taken on the bill by the end of the year.

There may be a movement towards the formation of an international antimony producers' group. Bolivia called for a meeting of antimony, bismuth and tungsten producers to take place in LaPaz early in 1975.

Uses

Antimony is used principally as an ingredient in many alloys and in the form of oxides and sulphides.

Antimony hardens and strengthens lead and inhibits chemical corrosion. The use of antimonial lead in storage batteries remains its major outlet, but due to technological developments the antimony content in batteries has been progressively reduced in recent years, from about 12 per cent to current levels which vary from 3 to 6 per cent of the antimonial lead contained. Antimonial lead alloys are also used for power transmission and communications equipment, printing metal, solder, ammunition, chemical pumps and pipes, tank linings, roofing sheets and antifriction bearings.

Antimony oxide, Sb_2O_3, usually produced directly from high-grade sulphide ore, is used extensively in plastics and in flameproofing compounds.

Antimony trioxide or trichloride in an organic solvent has long been recognized as having significant flame retardant properties and is now used extensively in carpets, rugs and carpet underlay. The trioxide is also a glass former, and is sought for its ability to impart hardness and acid resistance to enamel coverings for bathtubs, sinks, toilet bowls and refrigerators. The pentasulphide, Sb_2S_5, is used as a vulcanizing agent by the rubber industry. Burning antimony sulphide creates a dense white smoke that is used in visual control, in sea markers and in visual signaling.

Antimony is valuable for paint formulation since its high hiding power and various chemical compounds produce a wide range of pigments. High-purity metal is used by manufacturers of indium–antimony

Table 6. Industrial consumption of primary antimony in the United States, by class of material produced.

Product	1972	1973	1974p	Product	1972	1973	1974p
	(short tons antimony content)				(short tons antimony content)		
Metal products				**Nonmetal products**			
Ammunition	64	122	139	Ammunition printers	23	18	10
Antimonial lead	6,149	8,027	4,459	Fireworks	4	5	5
Bearing metal and bearings	559	527	386	Flameproofing chemicals and compounds	2,280	2,906	2,067
Cable covering	19	12	59	Ceramics and glass	1,695	1,917	1,324
Castings	39	65	—	Matches	—	—	—
Collapsible tubes and foil	20	12	18	Pigments	644	644	290
Sheet and pipe	108	97	68	Plastics	2,391	2,920	694
Solder	177	191	123	Rubber products	587	693	337
Type metal	142	134	76	Other	1,118	2,219	1,164
Other	105	104	46	Total	8,742	11,322	5,891
Total	7,382	9,291	5,374	Grand total	16,124	20,613	11,265

Source: U.S. Bureau of Mines, *Minerals Yearbook* Preprint 1973, and Mineral Industry Surveys.
p Preliminary; — Nil.

and aluminum-antimony intermetallic alloys as a semiconductor in transistors and rectifiers.

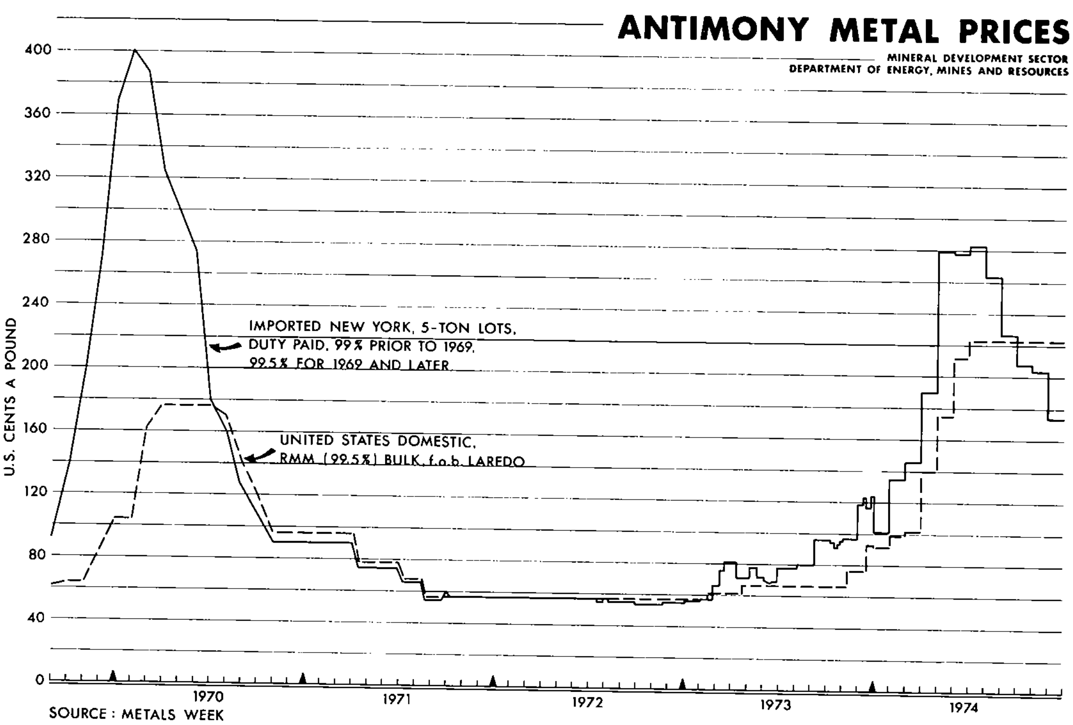
Outlook

The major use of antimony is expected to continue to be as antimonial lead for storage batteries. Battery usage continues its steady growth in Europe, North America and Japan and there has been rapid growth in countries such as Spain and Brazil where automobile populations are increasing rapidly. As less developed countries become more industrialized and advance economically, demand for batteries is expected to rise. The development of an economical battery-powered electric vehicle could sharply increase the consumption of antimony. The United States Postal Service has ordered 350 electric-powered delivery trucks with a 500 pound payload for 1975. If the test program continues to meet expectations, the Postal Service projects a potential demand of 5,000 electric delivery vehicles a year. Similar electric-powered delivery vehicle and bus vehicle programs are under way in Japan and the European Economic Community countries, notably Britain, Germany and France. Noteworthy expansion in the use of battery-powered vehicles is likely throughout the 1980s.

Antimony has been replaced by calcium in the manufacture of sealed maintenance-free batteries and some automobile manufacturers are now placing the maintenance-free batteries in their new car production. It is not yet certain how depressing an effect this will have on future consumption of antimony.

The use of antimony oxide as a flame retardant, especially for plastics, is expected to grow and should more than offset any decline in some of the metal's historic uses or its replacement by other metals. In the United States, regulations for flammability standards for children's sleepwear and new flammability standards for motor vehicle interiors are likely to increase the use of flame retardants. Requirements for fire retardants in television sets will go into effect in July 1975. Substitutes for antimony oxide are available, but they are not as effective.

The outlook for antimony appears favourable, with the production of batteries and flame retardants seen as the major growth areas. Antimony prices have fluctuated over a wide range during the past several years and it appears that prices in 1975 will decline from the all-time record highs in 1974. The price should start to strengthen again late in 1975 or early in 1976 as general economic activity picks up.



Prices

Antimony metal prices, on a strong upward trend in 1973, continued their rise during the first half of 1974. At the start of the year, metal was quoted in Europe at £1,400 a metric ton and climbed to a high of £3,000 a metric ton by the beginning of June; thus a 270 per cent price increase in 1973 was followed by a further 114 per cent price increase during the first half of 1974. Reports of metal and ore shortages, plus the small offerings at firm prices by the People's Republic of China at the spring Canton fair, added to the upward price push. During the second half, easing of the technical supply squeeze, high consumers' stocks, and a slumping world economy, contributed to a decline in prices. The European antimony metal price declined and at year-end was between 1,150 and 1,400 a metric ton.

United States dealer prices followed the European pattern. The New York dealers' price (99.5% Sb, 5-ton lots, duty paid) opened the year at $1.00–$1.30 a pound and rose to a monthly average high in July of $2.83. The year-end dealer price closed at $1.75 a pound. The United States domestic price of antimony (RMM brand) as quoted in *Metals Week*, in bulk, 99.5 per cent, fob Laredo, Texas, was $0.92 a pound at the beginning of the year. It increased steadily during the first half and in July was quoted at $2.23. This price held to the end of December. The domestic price of Lone Star brand (99.8 per cent Sb) opened the year at $1.09, was quoted at $2.65 in July and remained unchanged during the rest of the year.

Antimony lump-ore prices, 60 per cent antimony content as quoted in *Metals Week*, reflected the general market trends. The quote at the beginning of the year was a split price of $17.65–$18.65 (U.S.) a short ton unit (stu). The quote reached a high of $37.47–$38.57 a stu at the start of the fourth quarter then declined to $31.00–$32.00 by year-end.

Tariffs

Canada

Item No.		Most Favoured Nation
33000-1	Antimony, or regulus of, not ground, pulverized or otherwise manufactured	free
33502-1	Antimony oxides	12 1/2%

United States

Item No.		Most Favoured Nation
601.03	Antimony ore	free
632.02	Antimony metal unwrought on and after Jan. 1, 1972	1¢ per lb.

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Asbestos

F.E. HANES

Although Canadian production of asbestos fibre increased during the first five months of 1974 compared with the same period in 1973, total production of asbestos by the end of the year had dropped 2 per cent from the previous year's record high. Chrysotile is the only type of asbestos fibre produced in Canada. Canadian production (shipments) of asbestos fibre in 1974 was 1,824,000 short tons valued at $310,680,000 compared with 1,862,976 short tons valued at $234,323,000 in 1973. Approximately 84.7 per cent of total production came from Quebec, almost 5 per cent from British Columbia, 4.9 per cent from the Yukon, 4.4 per cent from Newfoundland and less than 1 per cent from Ontario.

Canada exported a total of 1.773 million short tons of asbestos — consisting of crude, milled fibres and shorts, amounting to 97.4 per cent of the total Canadian production. The United States' market absorbed 41.5 per cent of Canada's asbestos product during 1974, far ahead of the purchases made by Japan, West Germany and the United Kingdom, who absorbed 8.2, 7.9 and 6.4 per cent, respectively.

Total fibre exported to all countries by Canada in 1974 was down 5.3 per cent compared with the 1973 figure. United States, the largest consumer of fibre, was down more than 4.7 per cent, while approximately half the other importing countries consumed less asbestos fibre in 1974 than in 1973. The value of Canadian exports of manufactured asbestos products in 1974 was $10,013,000, an increase of 53.5 per cent over 1973. The value of imports of manufactured asbestos products increased 39.9 per cent to $23,053,000 in 1974 compared with the 1973 import value of $16,478,000.

Canadian developments

The major developments of the asbestos producing mines in Canada are listed in Table 2.

Lake Asbestos of Quebec, Ltd. continued expansion and renovation of the mill at its National Mines Division near Thetford Mines, Quebec to a designed capacity of 80,000 tons a year (tpy). A magnetic concentrator has been installed to effect a primary separation of ore from waste. In the milling circuit an impact crusher with improved reduction ratio has been installed followed by fine crushers designed to liberate short fibres of Groups 6 and 7. A system of tailings pelletization, similar to the company's installation at Black Lake, will be used to minimize airborne dust from the tailings pile.

Prospective producers

Abitibi Asbestos Mining Company Limited, in Maizerats Township about 52 miles north of Amos, Quebec, operated its pilot plant on bulk samples from the property. Market evaluation of the product continued. Development is planned for 1976 and production of fibre in 1978 at a capacity expected to be 150,000 tpy. Brinco Limited holds approximately 55 per cent interest in the Abitibi asbestos property consisting of 7,700 acres in the Abitibi district. The deposit is estimated to contain 100 million tons of asbestos-bearing rock containing 3.5 per cent recoverable asbestos fibre.

Rio Algom Mines Limited continued evaluation and testing of the deposit on the property of McAdam Mining Corporation Limited, about 20 miles east of Chibougamau, Quebec. Feasibility studies and testing are also being continued on the Lili property of Pathfinder Resources Ltd., about 2.5 miles from the mine of Canadian Johns-Manville Company, Limited, in Quebec.

Celtic Minerals Ltd. is proposing to investigate a property located in Cleveland Township, some 100 miles southeast of Montreal.

United Asbestos Inc., (formerly Allied Mining Corporation) is developing its property 17 miles southwest of Matachewan and 40 miles south of Timmins, Ontario. Production is due to commence in July 1975, at 35,000 tpy rising to 100,000 tpy by 1976. United has budgeted $26 million for the cost of the project which has an estimated life span of over 20 years.

In western Canada, Cassiar Asbestos Corporation Limited at its Cassiar and Clinton mines produced over 200,000 tons of fibre in 1974 in the British Columbia and Yukon areas. The Company is exploring other potential deposits in the areas of the producing mines. In the Yukon Territory, American Smelting and Refining Company (owner of Lake Asbestos of Quebec) is diamond drilling on the Rex Asbestos property.

World production and development in major markets

Total world production of asbestos fibre in 1974 amounted to 4,567,000 short tons. Chrysotile made up 91 per cent of this amount, while the remaining asbestos production was roughly made up of 6 per cent crocidolite (blue asbestos) and 3 per cent amosite. There was approximately one per cent of other types of fibre produced; e.g., tremolite/anthophyllite, principally in the United States. Canada and the U.S.S.R. were the two major chrysotile producers. Canada's production of 1,824,000 short tons was entirely chrysotile, while the U.S.S.R. had a minor, but important, production of anthophyllite which may be used in place of crocidolite and/or amosite in the manufacture of products requiring great strength.

Production of asbestos fibres in 1974 in Communist countries other than Yugoslavia was estimated to be 1.7 million short tons in Groups 1 to 6*. Approximately 200,000 tons a year were exported to Eastern Europe including Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Poland and Romania. Some Russian fibre was also exported to France, Japan and West Germany.

South Africa has the only commercial deposit of amosite and is an important producer of crocidolite as well as chrysotile. Crocidolite is also found in China, Australia and Bolivia.

Production and apparent world consumption by major world asbestos producers in 1973 are shown in the accompanying graph compiled by the Department of Industry, Trade and Commerce.

Cassiar Asbestos is exploring the Pyke Asbestos property in New Zealand where it is investigating a fibre of good quality but low grade which may not be sufficiently attractive to merit further investigation.

*Commodity Data Summaries, 1975, Bureau of Mines, United States Department of the Interior.

Table 1. Canada, asbestos production and trade, 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Production (shipments)				
By type				
Crude, groups 1,2 and other milled	45	50,000	..	..
Group 3, spinning	26,020	11,078,000	..	..
Group 4, shingle	519,016	103,227,000	..	..
Group 5, paper	292,554	45,583,000	..	..
Group 6, stucco	305,703	32,684,000	..	..
Group 7, refuse	719,272	41,791,000	..	..
Group 8, sand	366	10,000	..	..
Total	1,862,976	234,323,000[1]	1,824,000	310,680,000[1]
By province				
Quebec	1,518,726	177,887,119	1,545,000	242,175,000
British Columbia	108,966	21,102,892	91,000	26,554,000
Yukon	100,734	13,915,140	90,000	22,300,000
Newfoundland	98,622	17,529,667	81,000	17,880,000
Ontario	35,928	3,888,085	17,000	1,771,000
Total	1,862,976	234,322,903	1,824,000	310,680,000
Exports				
Crude				
United States	12	15,000	159	48,000
Japan	10	8,000	17	18,000
France	4	4,000	6	7,000
Italy	6	10,000	6	3,000
West Germany	3	2,000	—	—
Total	35	39,000	188	76,000
Milled fibre (groups 3, 4 and 5)				
United States	223,482	51,573,000	217,877	64,678,000
West Germany	105,879	20,472,000	107,416	27,029,000
United Kingdom	75,715	18,263,000	61,547	19,729,000
Japan	53,883	9,833,000	52,711	13,173,000

Table 1 (cont'd)

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Exports (cont'd)				
France	58,542	13,432,000	46,038	13,119,000
Spain	40,438	8,936,000	35,497	10,697,000
Mexico	28,087	7,735,000	28,893	9,593,000
Australia	35,786	7,146,000	37,851	9,175,000
Belgium and Luxembourg	36,891	8,689,000	29,900	8,889,000
Italy	22,326	5,146,000	23,534	6,994,000
Colombia	12,903	2,749,000	18,291	5,548,000
Yugoslavia	4,731	1,131,000	7,409	2,416,000
Other countries	228,007	49,702,000	207,390	56,213,000
Total	926,670	204,807,000	874,354	247,253,000
Shorts (groups 6, 7, 8 and 9)				
United States	548,412	41,428,000	517,273	49,083,000
Japan	108,699	9,995,000	92,916	10,734,000
United Kingdom	54,223	3,900,000	50,926	4,798,000
Netherlands	26,457	1,979,000	36,222	3,230,000
West Germany	38,464	2,840,000	33,277	3,124,000
France	30,549	2,040,000	24,695	1,997,000
Spain	12,001	1,241,000	13,035	1,708,000
Belgium and Luxembourg	23,617	1,970,000	15,943	1,581,000
South Korea	5,705	671,000	10,250	1,533,000
Australia	18,897	1,165,000	12,713	1,368,000
Malaysia	4,581	568,000	10,628	857,000
Brazil	5,955	447,000	13,448	837,000
Argentina	6,626	553,000	6,755	722,000
Thailand	5,395	589,000	4,985	711,000
Mexico	3,670	364,000	5,085	645,000
Other countries	51,675	4,878,000	50,303	5,665,000
Total	944,926	74,628,000	898,454	88,593,000
Grand total crude, milled fibres and shorts	1,871,631	279,474,000	1,772,996	335,922,000
Manufactured products				
Brake linings and clutch facings				
United States		468,000		864,000
Guatemala		34,000		72,000
Ecuador		52,000		65,000
Lebanon		16,000		52,000
France		9,000		49,000
Australia		3,000		34,000
Honduras		13,000		18,000
Thailand		34,000		14,000
United Kingdom		10,000		13,000
Other countries		60,000		132,000
Total		699,000		1,313,000
Asbestos and asbestos cement building materials				
United States		1,346,000		3,704,000
Australia		192,000		580,000
Iraq		—		336,000
Saudi Arabia		24,000		153,000
United Kingdom		50,000		137,000
Netherlands		189,000		73,000

Table 1 (concl'd)

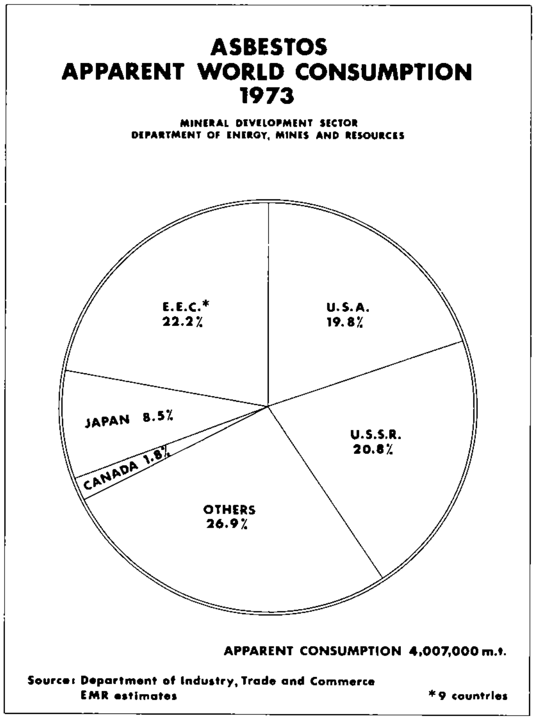
	1973		1974p	
	(short tons)	($)	(short tons)	($)
Exports (concl'd)				
Japan		6,000		59,000
Kenya		6,000		25,000
Spain		10,000		25,000
Other countries		247,000		124,000
Total		2,070,000		5,216,000
Asbestos basic products, nes				
United States		3,042,000		3,213,000
Brazil		3,000		36,000
France		27,000		33,000
United Kingdom		167,000		30,000
Ireland		—		27,000
Switzerland		77,000		21,000
Netherland Antilles		4,000		18,000
Other countries		434,000		106,000
Total		3,754,000		3,484,000
Total exports, asbestos manufactured		6,523,000		10,013,000
Imports				
Asbestos, unmanufactured	4,959	992,000	4,334	1,266,000
Asbestos, manufactured				
Cloth, dryer felts, sheets, woven or felted		1,646,000		2,976,000
Packing		1,392,000		1,892,000
Brake linings		4,788,000		5,296,000
Clutch facings		1,024,000		1,350,000
Asbestos cement shingles and siding		112,000		112,000
Board and sheets		838,000		702,000
Asbestos and asbestos cement building materials, nes		3,678,000		8,203,000
Asbestos and asbestos cement basic products, nes		3,000,000		2,522,000
Total asbestos, manufactured		16,478,000		23,053,000
Total asbestos, unmanufactured and manufactured		17,470,000		24,319,000

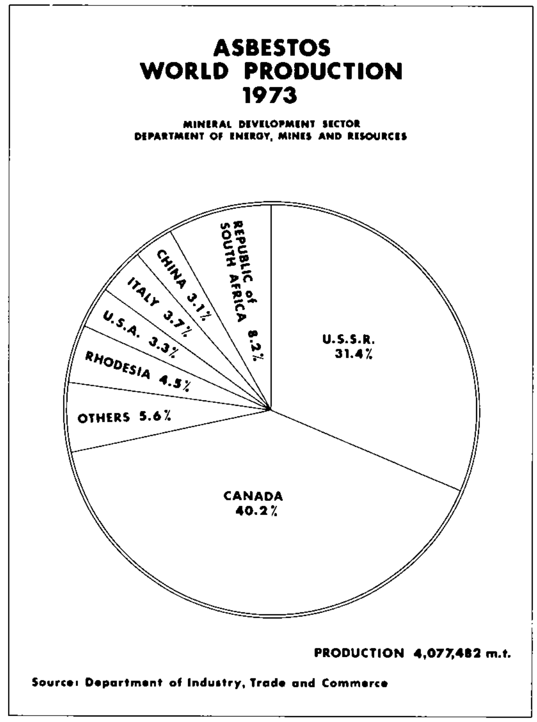
Source: Statistics Canada.
[1] Value of containers not included.
p Preliminary; — Nil; nes not elsewhere specified; . . Not available.

The Governor of Oaxaca stated that Mexico will save up to 150 million pesos in foreign exchange through intensive exploitation of the asbestos-bearing deposits in the Cuicatian District. The mine is to be an open-pit operation and will initially employ 300 workers.

Asbestos deposits are being explored or developed in other areas. To meet a strong rising demand in Eastern Europe and the U.S.S.R., a new project is planned for the Kiyembayez field in the U.S.S.R. Production of 250,000 tons of fibre is scheduled for 1979. Expansion to 500,000 tons a year is scheduled for 1982.

Two mines in the United States closed, while a third doubled its production: Johns-Manville Corporation closed its operations at Coalinga in California, and Pacific Asbestos Corporation, Limited closed its Copperopolis mine in Calaveras County; and Union Carbide Corporation announced it would double its production capacity at its California mine in San Benito County. General Aniline and Film Corporation has announced it will close its Lowell mine at Orleans





County, Vermont, in 1975.

Canada exports 97.4 per cent of its total chrysotile fibre production to approximately 70 countries. More than 79 per cent of the export figure of 1.77 million tons is purchased by 10 countries in the following order: U.S.A. (41.5), Japan (8.2), West Germany (7.9), United Kingdom (6.3), France (3.99), Australia (2.85), Spain (2.7), Belgium and Luxembourg (2.59), Mexico (1.9) and Italy (1.3) per cent. Most of the production of the U.S.S.R. is consumed internally although Russia is shipping asbestos to some eastern European countries, France, Japan and West Germany. With rising demand and tight supplies along with interest in outside development of asbestos deposits, Russia may increase exports beyond the 500,000 tons reported in 1973. South Africa, which produces chrysotile, crocidolite and amosite, exports to countries throughout the world. Japan, Britain, Spain, Italy and West Germany are its most important customers.

Measured and indicated reserves of asbestos in the world were 96 million tons in 1974*. Inferred reserves of 53 million tons have been reported.

* *Commodity Data Summaries*, 1975, Bureau of Mines, United States Department of the Interior.

Fibre groups, uses and technology

To evaluate the quality of asbestos fibre there are five basic properties which must be considered: fibre length distribution, fibre bundle diameter distribution, harshness, tensile strength and surface activity. Other properties governing quality are iron content, colour and dust content. The major standard on a length basis is that developed by the industry in Quebec, whereby asbestos is classified and priced by groups from the longest fibre corresponding to No. 1 to the shortest, No. 9. Because there are more than 3,000 uses for asbestos, it is more appropriate to classify the groups in categories and describe the major purposes the fibres serve than to list the products in which they are used.

Long fibres, Crudes No. 1 and 2 and group 3— used in the textile industry, as electrical insulation, as a filtration medium and as reinforcing fillers in asbestos-cement products where great strength is required.

Medium-length fibres, Groups 4,5,6—reinforcing fillers in asbestos-cement products, friction materials such as brake linings and clutch facings, paper and pipe coverings.

Short fibres, Groups 7,8,9—reinforcing fillers in plastics, floor tile, asphalt, and in paints and oil-well muds.

A 1973 report indicated that 70 per cent of world

Table 2. Canadian asbestos producers, 1974

Company	Mine Location	Mill Capacity	Remarks
		(st ore/day)	
Advocate Mines Limited	Baie Verte, Nfld.	7,500	Open pit.
Carey-Canadian Mines Ltd.	East Broughton, Que.	5,500	Open pit.
Asbestos Corporation Limited			World's major independent asbestos producer.
Asbestos Hill mine	Putuniq, Que.	6,000	Annual rated capacity at 300,000 tons of concentrate. Final processing to 100,000 tons of fibre at Nordenham, W. Germany.
British Canadian mine	Black Lake, Que.	12,400	Open pit, two milling plants, may operate 7 days/week in 1975.
King Beaver mine	Thetford Mines, Que.	12,000	Underground and open pit. Mine and mill closed by fire in mill Dec. 8, 1974.
Normandie mine	Black Lake, Que.	7,500	Open pit, may operate 7 days/week in 1975.
Bell Asbestos Mines Ltd.	Thetford Mines, Que.	3,000	Underground. Has negotiated deal with Asbestos Corp. to mine common boundary ore.
Lake Asbestos of Quebec, Ltd.	Black Lake, Que.	9,000	Open pit. Purchased assets of National Asbestos Mines Limited.
National Mines Division	Thetford Mines, Que.	3,500	Open pit. Mill expansion from 50,000 tons fibre/yr. to 80,000 tons fibre/yr. planned by late 1974.
Canadian Johns-Manville Company, Limited			Western world's largest known asbestos deposit.
Jeffrey mine	Asbestos, Que.	33,000	Open pit. Expanded complex designed to maintain annual output at a minimum of 600,000 tons of fibre.
Reeves mine	Timmins, Ont.	5,000	Open pit. Closed temporarily at end of year.
Hedman Mines Limited	Matheson, Ont.	300	Open pit. The plant is designed to turn out Group 7 fibre.
Cassiar Asbestos Corporation Limited			
Cassiar mine	Cassiar, B.C.	3,300	Open pit. Output lower because of mining problems.
Clinton mine	Clinton Creek, Yukon	4,000	Open pit. Mill operated at 4,000 tpd in 1974. Ore reserves sufficient for 3 years operation.

Source: Mineral Development Sector.

fibre production was used in the production of asbestos-cement building materials and asbestos-cement pipe. Domestic consumption in the United States in 1973 based on a United States Bureau of Mines survey reported a consumption breakdown as follows: construction materials, 30 per cent; floor tile, 21 per cent; friction products, 8 per cent; paper, 10 per cent; asphalt felts, 5 per cent; packing and gaskets, 3 per cent; insulation, 1.5 per cent; textiles, 1.5 per cent and others, 20 per cent.

Proposed regulations on asbestos transportation and use in Canada will shortly be released under the new Hazardous Products Act by the Canadian Departments of Health and Welfare and Consumer and Corporate Affairs. Industry has been alerted to the fact that the impending regulations would ban the importation of crocidolite and the sale of consumer products containing free asbestos fibres. The sale of non-consumer products containing asbestos would also be regulated by identifying shipments with labels to protect contents and safe use. The labelling would alert workers, unions, management and the public to the hazardous nature of the contents of the shipment.

Table 3. Canada, asbestos production and exports, 1965-74

	Crude	Milled	Shorts	Total
		(short tons)		
Production[1]				
1965	163	659,598	728,451	1,388,212
1966	215	735,972	752,868	1,489,055
1967	188	705,295	746,521	1,452,104
1968	290	777,006	818,655	1,595,951
1969	7,017	687,924	916,227	1,611,168
1970	7,252	737,037	917,355	1,661,644
1971	2,029	753,241	879,309	1,634,579
1972	101	807,327	879,623	1,687,051
1973	45	837,590	1,025,341	1,862,976
1974p	..	..	..	1,824,000
Exports				
1965	123	630,777	688,504	1,319,404
1966	172	732,585	713,405	1,446,162
1967	229	653,280	688,535	1,342,044
1968	202	723,136	736,330	1,459,668
1969	135	778,641	785,986	1,564,762
1970	101	824,324	738,007	1,562,432
1971	115	780,137	795,485	1,575,737
1972	112	784,828	848,157	1,633,097
1973	35	926,670	944,926	1,871,631
1974p	188	874,354	898,454	1,772,996

Source: Statistics Canada.
[1] Producers' shipments.
p Preliminary; .. Not available.

Outlook

A serious fire in December 1974 completely destroyed the King-Beaver mill of the Asbestos Corporation, Thetford, Quebec, displacing 850 employees and causing a loss of over 30 per cent of the Company's production. This disaster, and the closure of the Reeves mine late in 1974 were factors in creating an extremely tight fibre supply situation. Some other asbestos producers could not meet their commitments because of production problems. The strong demand for fibre continued into 1974, with only a 2 per cent reduction in volume by the year-end. Any further curtailment of asbestos fibre production in 1975 will reduce supplies to the manufacturers of asbestos products.

The major percentage of the Canadian asbestos exported to the United States is used in the construction field. During the period from October 1973 to October 1974, contracts for planned construction projects in the United States totalled $94 million, 5.2 per cent less than in the previous twelve months. Housing construction contracts were down 22.7 per cent. There is some indication that total construction will improve by 8 per cent and housing construction by 12 per cent in the twelve months ending in October 1975.

Late in 1974 negotiations between labour and management to resolve wage disparity were being intensified in the face of escalating cost of living and health-hazard conditions.

Either the tight supply situation will be alleviated by a drop in demand caused by continuing recession in industries dependent on asbestos fibre or an uptrend in the economy of asbestos consuming industries will impose new demands on suppliers. The latter situation will lend impetus to expansion of existing mines and development of new properties both in Canada and abroad, to meet a projected demand for an extra 550,000 tons a year of fibre by 1977.

Developments in many parts of the world have not kept pace with the increased demand. If development of properties in Ontario and Quebec currently under investigation proceeds and if early reinstatement of losses recently experienced by some companies be made, Canada should maintain its dominant position as the western world's largest producer. If Canadian developments do not keep pace with the increased demand the producers could lose their markets to foreign producers who would probably supply fibre on long-term agreements.

Prices

Canadian prices that had risen 8 per cent in 1973, were raised three times in 1974 reflecting a good market demand and a tight supply situation. Quoted prices for Quebec asbestos rose 26.5 per cent during the year.

Canadian asbestos prices[1] quoted in Asbestos[2]

	($ per short ton)
Quebec, fob mines	
Crude No. 1	2,842
Crude No. 2	1,544
Group	
No. 3 (spinning fibre)	681-1,130
No. 4 (asbestos-cement fibre)	350-640
No. 5 (paper fibre)	235-322
No. 6 (waste, stucco, plaster)	198-211
No. 7 (refuse, shorts)	83-162
Cassiar, fob North Vancouver, B.C.	
Canadian group	
No. 3 (nonferrous spinning fibre)	
AAA grade	1,560
AA grade	1,240
A grade	945
No. 4 AC grade (asbestos cement) (single fibre)	680
No. 4 AK grade	485
No. 4 CP grade	456
No. 4 AS grade	420
No. 4 CT grade	412
No. 5 AX grade	385
No. 5 CY grade	270
No. 5 AY grade	270

[1] As of January 1, 1975. [2] *Asbestos* is a magazine published monthly by Stover Publishing Company.

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
		(%)	(%)	(%)
31210-1	Asbestos, crude	free	free	25
31215-1	Asbestos, yarns, wholly or in part of asbestos, for use in manufacture of clutch facings and brake linings	7½	7½	25
31225-1	Asbestos felt, rubber impregnated for use in mcf floor coverings	free	free	25
31200-1	Asbestos, in any form other than crude, and all manufactures thereof, nop	15	22½	25
31505-1	Asbestos in any form other than crude, and all manufactures thereof, when made from crude asbestos of British Commonwealth origin, nop	free	12½	25
31220-1	Asbestos woven fabric, wholly or in part of asbestos for use in manufacture of clutch facings and brake linings	12½	12½	30

United States

Item No.		
518.11	Asbestos, not manufactured, crude, fibres, stucco, sand and refuse containing not more than 15 per cent by weight of foreign matter	free

Tariffs (concl'd)

United States (concl'd)

		On and after Jan. 1, 1970	On and after Jan. 1, 1971	On and after Jan. 1, 1972
		(%)	(%)	(%)
518.21	Asbestos, yarn, slivers, rovings, wick, rope cord, cloth, tape and tubing	5.5	4.5	4
518.51	Asbestos articles not specifically provided for	6	5	4.5
	Articles in part of asbestos and hydraulic cement	(¢ per lb)	(¢ per lb)	(¢ per lb)
518.41	Pipes and tubes and fittings thereof	0.2	0.18	0.15
518.44	Other	0.15	0.1	0.1

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Barite and Celestite

F.E. HANES

Total production of barite in Canada in 1974 was 86,300 short tons, a decrease of 15 per cent compared with the 1973 production of 101,580 short tons. Imports of barium carbonate in 1974 amounted to 5,961 short tons valued at $1,297,000 and represent an increase in volume of 1,068 short tons or 21.8 per cent and value of $611,000 or 89 per cent compared with 1973 values.

Barite ($BaSO_4$) is of value because of its weight (specific gravity 4.5) and chemical inertness. Its dominant use is as a weighting agent in muds that serve to counteract high pressures under the substrata when drilling oil and gas wells.

Barite is found in many countries of the world. The United States, the principal producer with about 20 per cent of the total production, is followed by West Germany with 7.7 per cent of the total. Canada is tenth in world production and exports 40 per cent of this mainly as crude barite to grinding plants in the United States and Venezuela. United States alone absorbs 82.5 per cent of this exported volume.

Production and occurrences in Canada

Barite is found in a variety of geological environments: as the principal mineral in veins along with fluorite, calcite and quartz; as a gangue mineral in some lead-zinc-silver deposits; and as irregular replacement deposits in sedimentary rocks. Pure barite is white and is most common in veins; impure barite may be near white, grey, brown or light red. Barite was produced only in Nova Scotia and British Columbia in 1974.

At the Walton, N.S. mine, operated by Dresser Minerals, a division of Dresser Industries, Inc., most of the production was obtained from low-grade stockpiles, waste dumps and the tailings pond. Mud and water inflows to the underground workings have not been effectively controlled, however, limited quantities of ore are still mined. Prior to flooding, the barite ore was mined from a large replacement deposit by a block-caving method and hoisted through the same shaft as a lead-zinc sulphide ore mined in conjunction with the barite. Most of the production was shipped in crude form to southwestern United States and the remainder was transferred to an affiliated company for use in offshore oil drilling in eastern Canada.

There were two barite producers in British Columbia in 1974. Baroid of Canada, Ltd., recovered barite from tailings at an abandoned lead-zinc mine near Spillimacheen, south of Golden. The tailings were fed as a slurry to separation tables, and the barite concentrate dewatered and shipped by rail for further processing in a grinding plant at Onoway, Alberta. Mountain Minerals Limited mined barite underground from vein deposits near Parson and Brisco in the eastern part of the province, and recovered crude barite from the tailings at the Mineral King mine near Invermere. The crude barite was shipped to the company's plant at Lethbridge, Alberta, for grinding.

There is no additional information on further development of Extender Minerals of Canada Limited to add to that reported in the 1973 *Barite and Celestite* Review. There was no production reported in 1974.

There are many occurrences of barite across Canada. Of note are occurrences at Buchans, Newfoundland where there is an estimated 0.5 ton of barite in tailings; in Nova Scotia near Brookfield on the mainland and east of Lake Ainslie on Cape Breton Island; in northern Ontario, in Yarrow, Penhorwood and Langmuir townships, and on McKellar Island in Lake Superior; at mile 397 in northern British Columbia, and north of mile 548 on the Alaska Highway. Current reports indicate that feasibility studies to develop an efficient separation between the barite and fluorite minerals are being made on the ore from the Lake Ainslie deposit on Cape Breton Island.

Two barite deposits of interest have been investigated by Nuspar Resources Ltd., formerly Spartan Explorations Ltd. The barite deposits are located in an area approximately 20 miles southwest of the MacMillan Pass in the Yukon.

Uses, consumption and trade

The dominant use for barite is as a weighting agent in oil and gas well drilling muds where its specific gravity assists in counteracting high pressure in oil and gas reservoirs. Principal specifications are usually a minimum specific gravity of 4.25, a particle size of at least 90 per cent minus 325 mesh, and a maximum of 0.1 per cent water-soluble solids.

In 1973, apparent consumption of barite in Canada was estimated to be 83,148 tons, based on an estimated 73,895 tons utilized in the oil well drilling industry.

Barite is used in paint as a special filler or "extender pigment". This is a vital constituent that provides bulk, improves consistency of texture, surface characteristics and application properties, and controls prime pigment settling and viscosity of paints. Specifications for barite for the paint industry call for 95 per cent $BaSO_4$, particle size at least minus 200 mesh, and a high degree of whiteness or light reflectance.

The glass industry uses barite to increase the workability, act as a flux, assist decolouration and increase the brilliance or lustre of glass. Specifications call for a minimum of 98 per cent $BaSO_4$, not more

Table 1. Canada, barite production, trade and consumption, 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Production (mine shipments)	101,580	1,052,275	86,300	1,300,000
Imports				
United States	31,505	1,192,000	12,281	779,000
People's Republic of China	75	4,000	550	4,000
India	—	—	39	4,000
France	—	—	3	. . .
Total	31,580	1,196,000	12,873	787,000
Exports				
United States	50,012	577,000	28,515	369,000
Venezuela	—	—	5,937	66,000
Emirates, U.A.	—	—	4	. . .
Total	50,012	577,000	34,456	435,000
	1972		1973	
Consumption[1]				
Well drilling	67,772e		73,895e	
Paints and varnish	2,633		1,474	
Glass and glass products[2]	7,176		7,296	
Rubber goods	222		263	
Other[3]	1,097		220	
Total	78,900		83,148	

Source: Statistics Canada.
[1] Available data reported by consumers and estimates by Mineral Development Sector. [2] Includes glass fibre and glass wool. [3] Includes miscellaneous chemicals, cleaners, detergents and miscellaneous products.
p Preliminary; — Nil; e Estimated; . . Less than one thousand dollars.

than 0.15 per cent Fe_2O_3, and a particle size range of 40 to 140 mesh. Consumption of barite in the glass industry, including glass fibre and glass wool, amounts to the largest percentage of total consumption, next to well-drilling uses.

The specifications vary for natural barite used as a filler in rubber goods, but the main factors are whiteness and particle size range.

The balance of Canada's barite was used in the manufacture of ceramic products, soaps and detergents.

There is, as yet, no barium chemicals industry in Canada. Barium chemicals include: barium carbonate, which is the most important; chemical or precipitated barium sulphate, referred to in the trade as blanc fixe; and lithopone, a chemically precipitated mixture of 70 per cent barium sulphate and 30 per cent zinc sulphide. Lithopone is a white pigment that has been largely replaced by titanium dioxide pigments. Specifications of barite for the barium chemicals industry call for 95 per cent $BaSO_4$, and not more than 2 per cent Fe_2O_3. Barite carbonate is imported into Canada in large quantities. In 1974, approximately 6,000 short tons were imported; this was an increase over the 1973 imports of 4,893 short tons or 21.8 per cent. Cost of the commodity increased from $686 to $1,297 or 89.1 per cent for the same period.

Table 2. Canada, barite production, trade and consumption, 1965-74

	Production[1]	Imports	Exports	Consumption[2]
	(short tons)			
1965	203,025	3,686	185,032	21,700
1966	221,376	4,165	199,054	26,500
1967	172,270	5,924	146,103	32,000
1968	138,059	7,901	116,491	29,500
1969	143,230	6,243	108,610	41,000
1970	147,251	7,526	99,544	55,200
1971	120,765	11,332	73,879	58,200
1972	77,261	21,803	20,188	78,900
1973	101,580	31,580	50,012	83,148
1974^p	86,300	12,873	34,456	..

Source: Statistics Canada.
[1] Mine shipments. [2] Includes estimates by the Mineral Development Sector.
^{p} Preliminary; .. Not available.

World review

There is worldwide production and considerable international trade in barite even though transportation costs in some cases may be nearly as great as the cost of the lump material. World production of barite in 1974 is estimated at 5.15 million tons of which 70 per cent was consumed in oil well drilling operations. By comparison, world production in 1973 was 4.76 million tons. Dependence on this industry as a principal market means that demand is subject to considerable fluctuation as the tempo of oil and gas exploration varies in time and in geographic location. Conversely, oil and gas exploration takes place throughout the world resulting in consistent world demand that is most economically served by production from many countries. The viability of any deposit is dominantly influenced by transportation costs to markets.

About 40 mines in the United States produced an estimated 1.1 million tons valued at 17.8 million dollars (1974), derived mostly from Nevada, Missouri and Arkansas, with smaller amounts from other states.

Mine production was up in most barite producing countries in 1974 with increases greater in those areas of most intense oil well drilling activity. Following the United States with 21.4 per cent of the total tonnage produced were West Germany (7.77); Ireland (6.3); Mexico (5.8); Peru (4.9); Italy (3.9); France (2.9); Greece (2.9); Morocco (2.4); Canada (1.9); Yugoslavia (1.9); other free world countries (18.8) and communist countries (19.0) except Yugoslavia. Canada and Yugoslavia with equal production were ninth in production. All countries with the exception of Canada and the United States increased their production in 1974 compared with 1973 volumes.

United States, the principal consumer of barite, used 1.7 million tons in 1974. Imports into the United States came from Ireland, 27 per cent; Peru, 26 per cent; Mexico, 20 per cent and others 27 per cent. Of the total consumption of barite in the U.S., 80 per cent was used in oil well drilling. The pattern of consumption of

Table 3. World mine production 1972-74 and reserves of barite 1974

	Mine production (000 short tons)			Reserves (000 short tons)
	1972	1973	1974^e	
United States	906	1,104	1,100	65,000
Canada	73	98	100	4,000
France	125	121	150	4,000
West Germany	406	360	400	7,000
Greece	94	121	150	4,000
Ireland	220	276	325	6,000
Italy	200	184	200	5,000
Mexico	288	281	300	4,000
Morocco	103	113	125	6,000
Peru	260	237	250	4,000
Yugoslavia	66	83	100	3,000
Other free world countries	653	889	970	55,000
Communist countries (except Yugoslavia)	870	894	980	33,000
World totals	4,264	4,761	5,150	200,000

Source: United States Bureau of Mines.
^{e} Estimated.

ground barite (excluding the barium chemicals industry) in the United States is similar to that in Canada.

Production of barite in Ireland will be augmented with additional planned production from the Milchem (U.K.) Ltd. which is rated at 60,000 tons a year and production from Magcobar (Ireland) Ltd. and Horace Taylor Minerals Ltd. could bring the total capacity in the U.K. and Ireland to 125,000 tons a year.

China's estimated annual production is in excess of 170,000 tons. China, with increasing domestic drilling, exported less barite in 1974 than in 1973. The increase of offshore drilling on the Indo-Pakistan shelf will result in larger markets for India and Pakistani deposits.

The great deal of drilling activity in Indonesia and the Philippines continues to offer encouragement for increased barite production in Australia and the Far East.

A new deposit of barite is being worked in France by the joint Company, Société Garrot-Chaillac, made up of the Société des Mines de Garrot, the Bureau de Recherches Géologiques et Minières (BRGM), Société des Talcs de Luzenac, and the BANEXI. The deposit is about 50 km from Chateauroux in the Indre area. The deposit is called the Rossignal deposit. It extends over an area of about 190,000 square metres and has an average thickness of 12 to 13 metres. Reserves are estimated at about 8 million tons of crude ore.

Outlook

With continuing acceleration in oil exploration activity throughout the world, demand for barite will continue strong during 1975. The industry, because of the 70–80 per cent utilization of total barite production for oil well drilling, will fluctuate as the progress of petroleum exploration develops.

Exploration for new deposits in Canada and feasibility studies presently underway could bring about changes in the production pattern and the quantity of output in the near future. Continued oil and gas well drilling activity in the Mackenzie Delta, Arctic regions, and off the east coast of Canada suggests a growing market for barite in these areas.

The only foreseeable deterrent to full development of barite production would be a replacement or barite substitute. Fer-O-Bar, developed by a subsidiary of Metallgesellschaft, is scheduled to be manufactured on a full production scale by 1975.

The process is unique, and there is skepticism regarding cost competitiveness, abrasive qualities, chemical reaction characteristics, and viscosity suspension qualities under all possible conditions that may be encountered.

It is reported that the relatively low cost and technical advantages of barite in the drilling-mud market make it unlikely that other materials will be substituted in this application. If continued high levels of drilling activity are maintained, the United States Bureau of Mines estimates that from 1974 to 1980, the average annual growth rate in U.S. barite demand could double the historical growth rate of about 2 per cent a year.

Prices

United States prices of barite according to Engineering and Mining Journal of December, 1974.

	($ a short ton)
Chemical and glass grade	
Hand picked, 95% $BaSO_4$	
not over 1% Fe	29.50–31.80
Magnetic or flotation, 96% $BaSO_4$	
not over 0.5% Fe	34.50
Imported drilling mud grade,	
specific gravity 4.20-4.30 cif	
Gulf ports	17–21
Canada	15
Ground	
Water, 99½% $BaSO_4$	
325 mesh, 50-lb bags	60–80
Dry ground drilling mud grade,	
83-93% $BaSO_4$, 3-12% Fe,	
specific gravity 4.20-4.30	40–47
Imported	
4.20-4.30 specific gravity	31

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
		(%)	(%)	(%)
49205-1	Drilling mud and additives	free	free	free
68300-1	Barites	free	10	25
92842-1	Barium carbonate	10	15	25
92818-1	Barium oxide, hydroxide peroxide	10	15	25
93207-5	Lithopone	free	12½	25

United States

Item No.			On and After January 1, 1972
472.02	Barium carbonate, natural, crude	free	
472.04	Barium carbonate, natural, ground		6%
			($ per lt)
472.10	Barium sulphate, natural		1.27
472.12	Barium sulphate, natural, ground		3.25
			(¢ per lb)
472.14	Barium sulphate, precipitated (blanc fixe)		0.3
473.72	Lithopone, containing under 30% zinc sulphide		0.43
473.74	Lithopone, containing 30% or more zinc sulphide		0.43 + 3.5

Sources. For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

CELESTITE

Celestite ($SrSO_4$), the main source of strontium, is used to produce commercial strontium compounds, principally strontium carbonate and strontium nitrate. It is used, in the sulphate form, in zinc flotation processing. Strontium carbonate is used in glass faceplates in colour television sets, where it improves the absorption of X-rays emitted by picture tubes operated at high voltages. An increasing use for this compound is in the manufacture of ferrites, a material required in the production of ceramic permanent magnets, which are used in small electrical motors.

Kaiser Celestite Mining Limited, a subsidiary of Kaiser Aluminum & Chemical Canada Investment Limited, and Canada's only producer of celestite, mined celestite ore from an open pit near Loch Lomond, Cape Breton Island, N.S. Concentrate was produced from a flotation mill at the mine site. The concentrate was shipped to the Point Edward, Nova Scotia plant of Kaiser Strontium Products Limited, for treatment with imported natural sodium carbonate to produce technical and chemical-grade strontium carbonate, commercial-grade strontium nitrate and sodium sulphate. Capacities of the plants are: 225 tons of $SrSO_4$ concentrate a day from the mill, 90 tons a day of $SrCO_3$, and up to 100 tons a day of sodium sulphate. There is capacity at the Point Edward plant to produce small quantities of strontium nitrate, used in pyrotechnics and tracer ammunition. Operating problems and cost overruns were associated with the new plant and newly developed process, however, technological difficulties have been largely resolved. Research into new and expanded uses of strontium carbonate continues and a slow but steady growth in consumption is anticipated.

Current producers of strontium carbonate in the United States obtain their celestite from Mexico.

Prices

United States prices according to Chemical Marketing Reporter, December 1974.

Strontium carbonate	($ per pound)
technical grade, bags	
carlot, truckload, works	.13–21
Strontium nitrate	($ per 100 pounds)
bags, carlot, works	15.00

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
92839-5	Strontium nitrate effective July 1, 1974 to June 30, 1984	free	free	free

United States

Item No.		On and After January 1 1973
Strontium Metal		
632.46	Unwrought, waste and scrap	5%
632.68	Alloys of strontium	7.5%
473.19	Strontium chromate pigments	5%
Strontium Compounds		
421.70	Carbonate	free
421.72	Carbonate (precipitated)	6%
421.74	Nitrate	6%
421.76	Oxide	6%
421.82	(mineral celestite)	free
421.84	Sulphate	5%
421.86	Other	5%

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Bentonite

F. E. HANES

Bentonite is a clay composed mainly of the mineral montmorillonite, a hydrated aluminum silicate with weakly attached cations of sodium and calcium. Bentonite has different properties depending on the predominance of sodium or calcium. In general, the properties of clays are complex; difficulty in determining reasons for their behaviour under certain conditions is complicated by their extremely fine particle size and, in the case of bentonite, become additionally more complicated because of the cation exchange and swelling capacity of the clays. The sodium bentonites have a great physical avidity for water. This characteristic provides sodium bentonite with unique swelling properties and, when utilized, it will swell from 15 to 20 times its original dry volume. Sodium bentonite also possesses a high dry-bonding strength, especially at high temperatures, and this feature is important in the manufacture of some ceramic products.

Montmorillonite clays have high ion-exchange properties and, by adsorption, absorption and chemical activity, bentonite can collect many types of inorganic and organic compounds, sometimes selectively. In general, the non-swelling or calcium bentonites exhibit the more pronounced adsorptive characteristics. While naturally-occurring clays may exhibit adsorptive or bleaching properties, their efficiencies are commonly improved by acid leaching or, as the process is generally termed activation.

Another clay, "fuller's earth," is also largely a montmorillonite clay and is very similar to non-swelling bentonite. These clays have natural bleaching and absorbent properties and were originally used by fullers to remove dirt and oil from wood. The terminology is confusing, and bentonite and fuller's earth may or may not be separated in world trade and production figures by country.

Bentonite originates from deposits of volcanic ash that have been altered by induration and weathering. The deposits occur in relatively flat-lying beds of various chemical compositions and impurities; the latter consisting of quartz, chlorite, biotite, feldspar and jarosite. Natural clay may be creamy white, grey, blue, green or brown; and, in places, beds of a distinctly different colour are adjacent. Fresh, moist surfaces are waxy in appearance; on drying, the colour lightens, and the clay has a distinctive cracked or crumbly texture.

Production and occurrences in Canada

Canadian bentonite occurrences are confined to Cretaceous and Tertiary rocks at many localities in Manitoba, Saskatchewan, Alberta and British Columbia. Although clay beds occur in rocks older than Cretaceous, none in Canada has been identified as bentonite.

Indusmin Limited, who, for the past 2 to 3 years had been diamond drilling and evaluating a 4-million-ton deposit of bentonite in the Truax area, Saskatchewan, has abandoned the property. Test samples sent to the University in Saskatchewan and the Canada Centre for Mineral and Energy Technology, Ottawa, were found to lack qualities to meet the "dry" and "green" strengths required by the iron ore industry.

Three companies mine and process bentonite in Canada. Statistics on total production are not available for publication.

In Alberta, Dresser Minerals Division of Dresser Industries, Inc. recovers swelling bentonite from the Edmonton Formation of Upper Cretaceous age. The deposits are in the Battle River Valley, nine miles south of Rosalind, the site of the company's processing plant. Baroid of Canada, Ltd. mines a similar bentonite from the same formation, about fourteen miles northwest of the company's processing plant and rail siding at Onoway.

Bentonite is mined selectively from relatively shallow paddocks or pits in the dry, summer months. Some natural drying may be done by spreading and harrowing material before trucking it to plants for further processing. Both companies dry, pulverize and bag the bentonite. Swelling bentonite from Alberta is used mainly as a foundry clay. Other uses are as a drilling-mud additive, as feed pelletizing material, as a fire-retardant additive to water and as a sealer for farm reservoirs.

In Manitoba, Pembina Mountain Clays Ltd. mines non-swelling bentonite from the Upper Cretaceous Vermilion River Formation, 19 miles northwest of Morden, which is, in turn, 80 miles southwest of Winnipeg. Some bentonite is dried and pulverized in a plant at Morden, but the bulk of production is railed from Morden to the activation plant at Winnipeg, where it is leached, washed, filtered, dried, pulverized and bagged. The main use is for decolourizing and purifying mineral and vegetable oils, animal fats and tallows.

Uses, consumption and trade

Bentonite has many uses, but generally constitutes only a small part of the final product.

Select swelling bentonite has found widespread and rapidly growing uses as a binder in the pelletizing of iron mineral concentrates. About 18 pounds is used in every long ton of concentrate to provide the pellet with sufficient "green" strength to withstand handling during the drying and firing stages. The amount of bentonite required varies with the mineralogy and particle size of the concentrate.

Approximately 75 per cent of the total consumption of bentonite in 1973 was used in pelletizing iron-ore concentrates. Iron ore companies in Canada in 1974 reported a similar volume consumption of bentonite compared with 1973.

Special muds used in oil- and gas-well drilling contain about 10 per cent swelling bentonite, which is used principally to prevent the loss of drilling fluid into permeable zones by coating the wall of the drillhole with a gel. It also serves as a lubricant, and helps to keep the drill cuttings in suspension.

Swelling bentonite serves as a binder in moulding sands used by iron and steel foundries. Non-swelling bentonite is also used as a binder in some low-temperature foundries.

Swelling bentonite is used as a binder in the

Table 1. Canada, bentonite imports and consumption, 1973-74

	1973		1974^p	
	(short tons)	($)	(short tons)	($)
Imports				
Bentonite				
United States	204,891	3,084,000	245,904	3,535,000
Greece	21,280	23,000	44,587	594,000
Total	226,171	3,318,000	290,491	3,947,000
Activated clays and earths				
Greece	152,908	1,492,000	69,409	1,058,000
United States	24,040	2,385,000	20,404	2,491,000
France	2,122	815,000	152	71,000
Other countries	10	4,000	23	11,000
Total	179,080	4,696,000	89,988	3,631,000
Fuller's earth				
United States	13,569	201,000	9,486	289,000

	1971^r	1972^r	1973^p
	(short tons)	(short tons)	(short tons)
Consumption[1] (available data)			
Pelletizing iron ore	223,741	209,274	263,408
Well drilling	1,416	11,022	13,571
Foundries	40,794	42,625	46,058
Chemicals	536	25	326
Fertilizer stock and poultry feed	828	732	622
Paint and varnish	472	286	585
Pulp and paper	93	179	2,430
Other products[2]	10,663	12,579	11,046
Total	278,543	276,722	338,046

Source: Statistics Canada.
[1] Does not include activated clays and earths. Breakdown by Mineral Development Sector. [2] Explosives, frits and enamels, refractory brick and cements, ceramic products, petroleum refining and refining vegetable oils and other miscellaneous minor uses.
^{p} Preliminary; ^{r} Revised.

pelletizing of base-metal concentrates and stock feeds. It is used in small quantities as a plasticizer in abrasive and ceramic mixes; as a filler in paints, paper, rubber, pesticides, comestics, medicinal products, and cleaning and polishing compounds; in the grouting of subsurface water-bearing zones; and in the sealing of dams and reservoirs. Bentonite slurry is effective in fighting forest fires and in retaining the walls of excavations prior to the placement of concrete or other structural materials. Swelling bentonites used in these various industries make up a major share of the total (bentonite, activated clays and earth, and fuller's earth) applications for high montmorillonite-type clay materials. They represented more than 96 per cent of the total product in the 1973 consumption values.

Some non-swelling bentonite is used in pelletizing stock feed, as a carrier for pesticides, and as a cleaning powder for animals.

Activated bentonite is used in decolouring mineral and vegetable oils, animal fats, waxes, beverages and syrups. It is also used as a catalyst in the refining of fluid hydrocarbons.

Consumption of bentonite in Canada increased greatly in the last decade, see Table 2, largely because of increased consumption as a binder in iron concentrate pelletizing as more of these plants have been constructed. Consumption of bentonite in well drilling in the oil and gas industry is subject to considerable fluctuation. Iron and steel foundries require bentonite as a binder for moulding sands; approximately 40 to 45 thousand tons are used annually in Canada. Relatively minor quantities of activated clays and fuller's earth are imported mainly from the United States, and some activated bentonite from Manitoba is exported to the United States.

Bentonite production in the United States is centred on extensive deposits in Wyoming where the name was derived from the Cretaceous Fort Benton Formation. These Cretaceous deposits are the world's outstanding swelling bentonite occurrences, and the specifications and standards for bentonite used in industry are based on these high-quality clays. Although there are numerous occurrences of bentonite in many countries it is mined in only a few. Because of the high standards of Wyoming bentonite this material is transported over such distances that transportation costs commonly exceed the value of the product at the mine, in some cases by several times. Canada is the main importer from the United States, but some bentonite is shipped to Australia and western Europe. Non-swelling bentonite, fuller's earth, and bleaching clays are produced in numerous states, the major ones being Florida, Georgia, Mississippi and Texas.

Table 2. Canada, bentonite imports[1] and consumption[2], 1965-74

	Imports		Consumption[r]
	(short tons)	($)	(short tons)
1965	192,170	2,310,566	136,257
1966	204,038	2,606,000	169,692
1967	235,451	3,346,000	189,155
1968	323,093	4,041,000	222,011
1969	311,327	4,638,000	265,765
1970	386,984	5,590,000	289,692
1971	370,146	5,357,000	278,543
1972	349,883	5,912,000	276,722
1973	418,820	8,215,000	338,046
1974[p]	389,965	7,867,000	..

Sources: Statistics Canada and Mineral Development Sector.
[1] Includes bentonite, fuller's earth and activated clays and earths. [2] Includes only bentonite and fuller's earth.
[r] Revised; [p] Preliminary; .. Not available.

Outlook

The bulk of Canada's bentonite consumption is used in pelletizing iron ore concentrates. At present, the most suitable material for this purpose is imported from the United States. The slowdown in import growth since 1970 is attributed to more stabilized consumption patterns resulting from the completion of new pellet plants. The 6-million-ton-a-year iron ore pellet plant that came into production in 1973 at Sept-Îles, Quebec, increased consumption in 1974 compared with 1973 and should attain maximum consumption in two to three years. Sidbec-Dosco Limited at Port Cartier, P.Q. has a projected 6-million-ton-a-year plant development at its Fire Lake property. The mine and concentrator located at Gagnon, P.Q. should reach maximum capacity output by 1978. It is anticipated that such new developments will increase bentonite consumption by more than 40 per cent in the next three years. No changes in production and consumption in industries other than in ore pelletizing are foreseen.

Prices

United States bentonite prices quoted in Oil, Paint and Drug Reporter, December 23, 1974.

	($)
Bentonite, domestic, 200 mesh, bags, car lots, fob mines, per ton	15.50 – 16.00
Bentonite, imported Italian white, high gel, bags, 5-ton lot ex-warehouse, per lb	.1688

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
29500-1	Clays, not further manufactured than ground	free	free	free
92803-2	Activated clay	10%	15%	25%
20600-1	Fuller's earth, in bulk	free	free	free

United States

Item No.		On and After Jan. 1, 1972
		(¢ per long ton)
521.61	Bentonite	40
521.51	Fuller's earth not beneficiated	25
521.54	Wholly or partly beneficiated	50
		(¢ per lb)
521.87	Clays, artificially activated with acid or other material	0.05 +6% ad val

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Bismuth

G.R. PEELING

Bismuth is obtained in Canada in the processing of some lead–zinc, lead–zinc–copper and copper ores. The more important sources during 1974 were the lead–zinc–copper ores mined in New Brunswick and the lead–zinc ores mined in southeastern British Columbia. Smaller amounts were recovered from ores mined in Ontario and Quebec. Bismuth is also recovered from the flue dusts at the copper smelter of Gaspé Copper Mines Limited in Quebec.

Bismuth production in Canada, based on bismuth recovered from domestic ores and concentrates, plus the bismuth content of bullion and concentrates exported totalled 244,726 pounds valued at $2,006,263. The figures are substantially higher than those for 1973. The increase is partly attributable to incomplete statistics from 1973 and to increased production in British Columbia and New Brunswick.

In 1974, world production of bismuth as estimated by the United States Bureau of Mines, excluding United States production was about 8.9 million pounds, a decrease of 3.7 per cent from the 9.2 million pounds produced in 1973. Japan was the leading producer with an output of 1.8 million pounds followed by Peru, Bolivia and Mexico. The United States which is a substantial producer from its own and imported ores, does not publish production statistics but usually ranks among the top six producing countries (a range of 0.5–1.8 million pounds). About half of its production is derived from imported materials with Canada supplying about 35 per cent of the imports.

The strong demand evident in 1973 continued through the first half of 1974 but declined rapidly in the second half as the world economy slid into a recession. This demand slump late in the year lead to increased inventories and forced a downward adjustment in prices.

In the United States, consumption was down 21 per cent from 1973 with pharmaceuticals showing the largest drop, 25 per cent. Imports declined 29 per cent with strong demand in Europe and substitution being important causal factors. The General Services Administration sold 57 pounds from the government stockpile leaving 2,100,004 pounds at year-end. The stockpile objective is 95,900 pounds but Congressional approval is needed before any of the 2,004,104 pounds of excess can be released. Production in the United States is expected to increase in 1975 as The Anaconda Company's Victoria Mine in Nevada reaches full production. This is a copper mine from which will be produced a concentrate containing an estimated 0.07 per cent bismuth. If the mine operates at capacity, an additional 400,000 pounds of bismuth would be available to the U.S. market annually.

Production of bismuth in 1974 in Japan declined about 10.4 per cent from the 1973 level. Japan derives most of its metal production from foreign material and particularly copper concentrates imported from Australia, but with the opening of the Tennant Creek copper smelter of Peko-Wallsend Ltd., this source was reduced in 1974 and will cease in 1975. The long term outlook for Japan is one of decreasing production unless bismuth rich materials are imported from elsewhere.

In Australia, Peko-Wallsend Ltd., with potential to be the world's largest producer of bismuth from its new copper smelter and bismuth recovery plant near Tennant Creek, Northern Territory experienced start-up problems and delivery problems caused by flooding in 1974 in Central Australia. The plant has a capacity to recover about 1,300 tons of bismuth annually as crude bullion. The copper mining and smelting operations were closed and put on a care and maintenance basis early in January 1975 because of low copper prices and high operating costs. It is expected to re-open in 1977 if copper prices have sufficiently recovered.

Peko-Wallsend's major bismuth source is the Juno mine, with the Warrego, Peko, Orlando and Gecko mines supplying lesser amounts. Reserves for the five mines were approximately 7.3 million tons at the end of 1974. The Juno mine has the richest bismuth ore but only has reserves for about one more year of production. A joint company was formed by Peko-Wallsend and Mining & Chemical Products Ltd., United Kingdom, to market bismuth produced by Peko's Australian operations. The marketing arrangement does not apply to Australia, New Zealand, Japan and the People's Republic of China.

Bolivia, traditionally a major supplier of bismuth, produced 1.45 million pounds in 1974. The bismuth smelter at Telamayu, owned by Corporacion Minera de Bolivia (Comibol), produced crude bismuth metal which is sent to Europe for refining. Comibol contracted with Sidech S.A. of Belgium to construct a refinery at Telamayu to raise the bismuth content of its product from 20 per cent to 99.9 per cent bismuth. The expected completion date is May 1975. Until the refinery is complete, the entire output at Telamayu will continue to be treated by Sidech's plant in Belgium. The country's major bismuth deposits are located at the Tasna mines, Baracoles in the North Group, and Esmoraca.

Outlook

The outlook for 1975 is bleak; stocks are likely to increase, prices weaken, and demand remain slack at least for the first half of the year. Bismuth demand is unlikely to pick up until the major industrial countries experience an economic turn-around. In particular, bismuth production will not pick up until there is an improvement in the copper and lead demand and some forecasts suggest that a turnaround may not take place until 1976. Production in Japan and Australia will certainly be lower in 1975 than in 1974; nonetheless new bismuth sources in Australia and the United States and increased production from Canada will ensure adequate quantities until at least 1980.

Domestic Sources

New Brunswick. The Smelting Division of Brunswick Mining and Smelting Corporation Limited produces bismuth metal at its plant at Belledune, about 25 miles northwest of Bathurst, New Brunswick. In 1974, production amounted to 53,317 pounds of bismuth contained in a semirefined bismuth–lead alloy compared with 30,620 pounds of refined bismuth grading 99.9 per cent or better in 1973. The Kroll-Betterton process is used to treat the desilverized lead bullion and produce a bismuth–lead–calcium–magnesium dross. The dross is then pyrometallurgically refined with chlorine to produce bismuth metal or alloy.

Nigadoo River Mines Limited reopened its lead–zinc–copper–silver mine near Bathurst in January 1974. Substantial amounts of bismuth contained in the lead concentrate produced were recovered by the custom smelter receiving the concentrates.

Brunswick Tin Mines Limited, a subsidiary of the Sullivan Mining Group Ltd., continued metallurgical testing on ores from its Mount Pleasant property, about 40 miles north of St-Andrews in Charlotte County, New Brunswick. Ore reserves are estimated at 12.6 million tons in the North Zone and 30 million tons in the Fire Tower Zone grading 0.2 per cent tungsten, 0.08 per cent bismuth, 0.08 per cent molybdenum, about 5 per cent flourite, 1.0 oz. a ton indium and minor amounts of copper, lead, zinc and tin. Bulk samples for metallurgical testing were sent to the Department of Energy, Mines and Resources in 1974. The tests should be completed by the fall of 1975. Preliminary results are encouraging for the recovery of bismuth through a process involving gravity separation, flotation and leaching. If the property is

Table 1. Canada, bismuth production and consumption, 1973-74

	1973		1974[r]	
	(lb)	($)	(lb)	($)
Production, all forms[1]				
Ontario	4,077	20,059	16,169	132,553
New Brunswick	62,622	308,100	153,530	1,258,639
British Columbia	2,851	14,027	74,320	609,275
Quebec	1,134	5,579	707	5,796
Total	70,684[3]	347,765	244,726	2,006,263
Consumption, refined metal (available data)				
Fusible alloys and solders	4,821		4,836	
Other uses[2]	52,031		59,711	
Total	56,852		64,547	

Source: Statistics Canada.
[1] Refined bismuth metal from Canadian ores, plus recoverable bismuth content of bullion and concentrates exported. [2] Includes bismuth metal used in manufacture of pharmaceuticals and fine chemicals, other alloys and malleable iron. [3] Statistical coverage in 1973 was incomplete.
[r] Revised.

Table 2. Canada, bismuth production, exports and consumption, 1965-74

	Production all forms[1]	Exports[2]	Consumption[3]
		(pounds)	
1965	428,759	..	48,300
1966	525,659	..	56,400
1967	668,476	..	47,900
1968	648,232	..	59,300
1969	579,059	..	33,800
1970	590,340	..	24,548
1971	271,196	..	35,876
1972	275,029	..	37,892
1973[4]	70,684[4]	..	56,852
1974[r]	244,726	..	64,547

Source: Statistics Canada.
[1] Refined bismuth metal from Canadian ores, plus recoverable bismuth content of bullion and concentrates exported. [2] Refined and semirefined bismuth metal. [3] Refined bismuth metal reported by consumers. [4] Incomplete statistical coverage.
[r] Revised; .. Not available.

brought into production at a proposed milling rate of 1,500 tons a day, annual bismuth production would be in the order of 400,000 to 500,000 pounds.

British Columbia. Cominco Ltd., remained the only producer of bismuth metal in British Columbia, deriving most of its output from lead concentrates produced at its Sullivan lead-zinc mine at Kimberley. Other sources included lead concentrates from other company mines and custom shippers both domestic and foreign. Lead bullion produced from the smelting of these concentrates contains about 0.05 per cent bismuth. Bismuth is recovered as 99.99 + per cent metal from the treatment of residues resulting from the electrolytic refining of the lead bullion. Bismuth for use in research and in the electronics industry is further processed at the company's nearby high-purity plant to give it a purity of up to 99.9999 per cent. Production in 1974 totalled 220,000 pounds compared with 124,000 pounds in 1973.

Uses

A major use of bismuth is in pharmaceuticals, cosmetics and industrial and laboratory chemicals including catalytic compounds. Various bismuth compounds, salts and mixtures are used in pharmaceuticals for indigestion remedies, antacids, burn and wound dressings. Insoluble salts of bismuth are given to patients before X-ray examination of the digestive tract. Cosmetics containing bismuth oxychloride, which imparts a "pearlescent" glow to eye shadow, lipstick, nail pol-

Table 3. Estimated world production of bismuth, 1972-74

	1972	1973	1974[e]
		(pounds)	
Japan (metal)	1,974,000	2,010,000[e]	1,800,000
Peru	1,492,000	1,658,000	1,700,000
Bolivia	1,393,000	1,400,000[e]	1,450,000
Mexico	1,387,000	1,400,000	1,400,000
Australia	796,000	815,000	1,200,000
People's Republic of China (in ore)	550,000	550,000	..
Republic of Korea (metal)	212,000	210,000[e]	200,000
France (metal)	148,000	155,000[e]	155,000
Romania (in ores)	180,000[e]	180,000[e]	..
U.S.S.R. (metal)	120,000[e]	120,000[e]	120,000
Canada	275,000	157,000[e]	245,000
Other countries	292,000	566,000	625,000
Total[1]	8,819,000	9,221,000	8,895,000

Sources: Statistics Canada for Canada; for remaining countries, U.S. Bureau of Mines, *Minerals Yearbook* Preprint 1973 and U.S. Commodity Data Summaries, January 1975.
[1] Total for listed figures only. It excludes United States production, which is not available for publication; as well as that of some other smaller producing countries.
[p] Preliminary; [e] Estimated; .. Not available.

ish and powders, comprise one of the larger end-use markets of bismuth, but consumption in this market depends on changing fashion trends and is declining.

Another important outlet for the metal is fusible or low-melting-point alloys for fire-protection devices, electrical fuses, fusible plugs and solders. Many of these alloys contain 50 per cent or more bismuth with the chief additive metals being cadmium, lead and tin. In safety applications, the dependability of the melting temperatures of the various bismuth alloy compositions is of utmost importance. Pure bismuth metal expands 3.3 per cent on changing from a molten to a solid state. Nonshrinking low-melting point bismuth alloys are used in the holding of jet engine airfoil blades during the machining of the root sections. Type metal contains bismuth because of the expanding property of bismuth alloys. Bismuth–tin alloys are sprayed on patterns to make moulds in the plastic industry.

The metal is also used as an important additive to improve the machinability of aluminum alloys, malleable irons and steel alloys and, with indium, forms a low-melting alloy used in the ophthalmic industry for holding lenses. The United States Atomic Energy Commission uses bismuth in many nuclear research applications because of the metal's low thermal neutron absorption rate.

Table 4. United States consumption of bismuth by principal uses.

	1973	1974^p
	(pounds)	
Fusible alloys	932,630	748,604
Other alloys	15,206	21,417
Pharmaceuticals[1]	1,117,644	838,134
Experimental uses	21	305
Metallurgical additives	830,928	668,932
Other uses	9,790	6,586
Total	2,906,219	2,283,978

Source: *Mineral Industry Surveys*, United States Department of the Interior, Bureau of Mines, "Bismuth in the First Quarter 1975."

[1] Includes industrial and laboratory chemicals.

^{p} Preliminary; ^{e} Estimated.

Prices

The Canadian price for bismuth, as quoted by Cominco Ltd., for bars 99.99 per cent pure, in lots of one ton or more was $6.50 a pound until February 5 when it was increased to $7.00 a pound. On April 8 the price was increased to $9.00 and it was increased again on June 18 to $12.00 a pound. This price was in effect for the rest of the year. The United States' prices, in ton lots, as published in *Metals Week*, was U.S. $6.50 in January and rose steadily to a level of $9.00 a pound on April 4. A split price of $9.00 to $12.00 was in effect for part of June and all of July until all producers aligned at $9.00 on August 1. This price held for the rest of the year. Dealer prices in the United States were more volatile, opening the year around $7.00 a pound, increasing to a high of $20.50 in May and then declining to the $6.00 level in December.

Prices

Canada

Canadian bismuth prices in Canadian currency, as quoted by Cominco Ltd. in 1974:

Bismuth metal–99.99% pure, per lb.	
Lots of 1 ton or more	
January 1–February 5	$6.50
February 6–April 7	7.00
April 8–June 17	9.00
June 18	12.00
Lots less than 1 ton	
January 1–February 5	$6.75
February 6–	7.25

Not recorded after February 6.

United States

United States bismuth prices in U.S. currency, as quoted in Metals Week in 1974:

Bismuth Metal, per lb.	
Ton lots	
January 1–January 31	6.50
February 1–February 6	6.50–7.00
February 7–February 11	7.00–7.25
February 12–April 3	7.00–9.00
April 4–June 16	9.00
June 17–July 31	9.00–12.00
August 1–December 31	9.00

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
33100-1	Bismuth ores and concentrates	free	free	free
35106-1	Bismuth metal, not including alloys, in lumps, powders, ingots or blocks	free	free	25%

United States

Item No.		
601.66	Bismuth ores and concentrates	free
632.10	Bismuth metal, unwrought; waste and scrap, bismuth alloys	free
632.64	Containing by weight not less than 30% lead	free
		1972
632.66	Other	9
633.00	Bismuth metal, wrought	

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Cadmium

G.S. BARRY

Cadmium occurs in nature predominantly as a sulphide, greenockite, associated with zinc sulphide ores, especially sphalerite, the common zinc ore mineral. This association with zinc minerals continues during processing and cadmium is recovered as a byproduct of zinc refining. Canadian zinc ores contain up to 0.07 per cent cadmium and zinc concentrates contain up to 0.7 per cent cadmium. Most of the world's cadmium production is from zinc concentrates that grade 0.1 to 0.3 per cent cadmium.

Canadian mine production in 1974, as reported by Statistics Canada, was 3,917,000 pounds, a small decrease from 1973. This amount represents the metallic cadmium recovered at domestic smelters from Canadian ores, plus the recoverable cadmium content of ores and concentrates exported.

Cadmium is recovered at electrolytic zinc plants as a precipitate or oxide sponge produced during the purification of the zinc electrolyte. In Canadian plants, the metal is then recovered either by the electrolytic process, where cadmium is redissolved in sulphuric acid and plated out in electrolytic cells, or by a purification process in which residues are releached and reprecipitated and the resulting sponge is briquetted, melted in an electric furnace, dezinced and cast. At zinc primary distillation plants, cadmium is reduced and vapourized with zinc in a retort or furnace. The vapour is condensed and cadmium (B.P.*776°C) is separated from zinc (B.P. 905°C) by fractional redistillation.

Metallic cadmium is recovered as a byproduct at the electrolytic zinc plants of Cominco Ltd. at Trail, British Columbia; Hudson Bay Mining and Smelting Co., Limited at Flin Flon, Manitoba; Canadian Electrolytic Zinc Limited (CEZ) at Valleyfield, Quebec; and at Ecstall Mining Limited's new plant near Timmins. In 1974, metallic cadmium produced in Canada totalled 2,541,270 pounds, compared with 3,085,219 pounds in 1973.

For the second consecutive year Japan was the world's leading producer of cadmium metal with a smelter output of 3,399 tons from primary and secondary sources; the former world leader, the United States, recorded a production of 3,301 tons. West Germany, Canada and Belgium are the next-largest producers. Normally, Canada produces more than the two other countries, but prolonged strikes in 1974 accounted for the lower output.

Canadian exports of refined cadmium totalled 1,987,149 pounds, compared with the all-time record of 3,085,219 pounds in 1973. The United States and Britain remained Canada's largest customers, receiving almost 99 per cent of Canada's exports.

The available data indicates that Canadian consumption continues to decline moderately. It is estimated to have been 105,548 pounds in 1974, down from 120,958 pounds in 1973. Apparent consumption in the United States was 12,100,000 pounds, a decrease of 3.5 per cent over that of 1973. Cadmium consumption can only be estimated roughly, since there is no way to check consumers' inventory changes, and these are known to fluctuate widely.

World demand was strong in the first half of 1974 while production continued to lag below demand. Declining cadmium production was compensated for by an increased flow of cadmium from producer and consumer stocks and U.S. Government stockpile releases. The latter disposal increased substantially from 397 tons in 1973 to 1,007 tons in 1974. However, demand decreased so rapidly in the last quarter of the year that by the end of 1974 producer's stocks of metal increased to 2.8 million pounds, substantially above stock levels at the beginning of the year (1.8 million pounds).

In North America, the producer price for cadmium remained unchanged from March 15, 1973 to March 31, 1974 at $3.75 per pound, with users paying $3.90 to $4.25 per pound to distributors and secondary dealers. Effective May 1, National Zinc Company Inc. raised its price for cadmium to $4.30 per pound, and on May 8 three other cadmium producers raised prices to $4.25 per pound. Cadmium was quoted unchanged in the range of $4.25 to $4.30 per pound until December 19, 1974, when all U.S. producers quoted at a single price of $4.25 per pound. This price remained unchanged at the end of the year. Dealers' prices remained within range of producers' prices to September, but experienced wide price fluctuations between $2.15 and $4.00 per pound in the last quarter of 1974.

Canadian production

Canadian mines listed in Table 4, and some minor

* Boiling point.

producers not included in the list, produced approximately 8.3 million pounds of cadmium contained in concentrates. Between 70 and 90 per cent of this amount was recovered domestically and in smelters around the world. The stated amount of about 8.3 million tons is almost double that reported by Statistics Canada. This difference stems from the fact that many mining companies are not paid for their cadmium in concentrates and thus did not report it. Additional information is given in the following review by provinces:

Newfoundland: The Buchans unit of American Smelting and Refining Company (ASARCO) remains the only producer in Newfoundland. Production returned to normal levels after major losses in 1973 on account of a strike.

Table 1. Cadmium production, exports and consumption 1973-74

	1973		1974p	
	(pounds)	($)	(pounds)	($)
Production				
All forms[1]				
Ontario	2,764,697	10,063,497	2,770,000	10,984,000
British Columbia	810,779	2,951,236	488,000	1,934,000
Quebec	270,518	984,686	277,000	1,097,000
Newfoundland	52,498	191,093	130,000	515,000
Manitoba	205,204	746,943	124,000	490,000
New Brunswick	—	—	54,000	215,000
Northwest Territories	16,800	61,152	40,000	158,000
Saskatchewan	63,538	231,278	34,000	134,000
Yukon	12,560	45,718	—	—
Total	4,196,594	15,275,603	3,917,000	15,527,000
Refined[2]	3,085,219		2,541,270	
Exports				
Cadmium metal				
United States	2,004,985	6,491,000	1,416,158	5,197,000
United Kingdom	1,222,900	3,418,000	546,480	2,187,000
Italy	—	—	22,000	83,000
India	—	—	2,500	10,000
Japan	4	...	11	...
Netherlands	30,865	101,000	—	—
Republic of South Africa	2,224	7,000	—	—
Venezuela	440	2,000	—	—
Other countries	103	1,000	—	—
Total	3,261,521	10,020,000	1,987,149	7,477,000
Consumption (Cadmium Metal)[3]				
Plating	87,651		75,837	
Solders	8,258		2,420	
Other products[4]	25,049		27,791	
Total	120,958		105,548	

Source: Statistics Canada.
[1] Production of refined cadmium from domestic ores, plus recoverable cadmium content of ores and concentrates exported. [2] Refined metal from all sources and cadmium sponge. [3] Available data reported by consumers. [4] Mainly chemicals, pigments, and alloys, other than solder.
p Preliminary; — Nil; ... Less than one thousand dollars.

New Brunswick: Brunswick Mining and Smelting Corporation Limited, which operates two mines near Bathurst, no longer produces cadmium at its smelter at Belledune. All its zinc concentrates are now exported for treatment at foreign smelters. The three mines in New Brunswick accounted for a total of 883,783 pounds of contained cadmium, of which a large portion will be recovered abroad but not paid for.

Table 2. Canada, cadmium production, exports and consumption, 1928-74

	Production		Exports	
	All Forms[1]	Refined[2]	Cadmium Metal	Consumption[3]
	(pounds)			
1928	491,894	..	..	..
1929	773,976	..	..	..
1930	456,582	..	..	..
1931	323,139	..	..	..
1932	65,425	..	..	..
1933	246,041	..	..	..
1934	293,611	..	..	..
1935	580,530	..	470,000	..
1936	785,916	..	724,000	..
1937	745,207	..	566,000	..
1938	699,138	700,000	466,000	..
1939	939,691	940,000	1,050,000	..
1940	908,127	908,000	798,000	154,000
1941	1,251,291	1,252,000	910,000	298,000
1942	1,148,963	1,148,000	800,000	414,000
1943	786,611	786,000	572,215	336,000
1944	526,970	527,000	383,324	216,000
1945	646,064	638,000	350,744	174,000
1946	802,648	802,000	573,368	192,000
1947	718,534	718,000	622,891	150,000
1948	766,090	766,090	596,098	185,000
1949	846,541	846,541	633,607	222,000
1950	848,406	834,218	676,005	231,000
1951	1,326,920	1,266,000	824,850	290,000
1952	948,587	819,822	620,344	232,500
1953	1,118,285	977,226	969,563	239,250
1954	1,086,780	1,058,624	776,391	197,690
1955	1,919,081	1,714,965	1,562,337	220,890
1956	2,339,421	1,932,887	1,922,685	206,420
1957	2,368,130	2,018,000	1,941,680	177,000
1958	1,756,050	1,634,000	1,263,617	170,000
1959	2,160,363	2,528,000	1,979,638	226,000
1960	2,357,497	2,238,000	2,056,333	190,000
1961	1,357,874	2,234,000	1,901,962	171,000
1962	2,604,973	2,435,000	2,340,289	232,000
1963	2,475,485	2,354,000	1,939,110	209,000
1964	2,772,984	2,220,000	1,623,679	178,000

Table 2. (concl'd)

	Production		Exports	
	All Forms[1]	Refined[2]	Cadmium Metal	Consumption[3]
1965	1,755,925	1,790,488	1,364,645	172,000
1966	3,236,862	2,217,322	2,012,323	171,000
1967	4,836,317	2,002,892	1,676,676	155,000
1968	5,014,965	2,113,949	1,802,780	125,000
1969	5,213,054	2,123,955	1,686,573	132,136
1970	4,307,953	1,844,706	1,549,035	124,959
1971	4,063,805	1,568,787	1,438,789	117,395
1972	4,267,987	2,251,094	2,261,621	123,395
1973	4,196,594	3,085,219	3,261,521	120,958
1974p	3,917,000	2,541,270	1,987,149	105,548

Source: Statistics Canada.
[1] Production of refined cadmium from domestic ores, plus cadmium content of ores and concentrates exported. [2] Refined cadmium from all sources, including that obtained from imported lead and zinc concentrates; includes cadmium in sponge. [3] As reported by consumers.
p Preliminary; .. Not available.

Table 3. World smelter production of cadmium

	1973	1974
	(short tons)	
Japan	3,494	3,399
United States	3,714	3,301
U.S.S.R.	3,086	3,086
West Germany	1,346	1,476
Canada	1,543	1,271
Belgium	1,410	1,150
Australia	747	837
France	668	709
Italy	438	408
Poland	386	386
Other countries	2,396	2,144
Total	19,228	18,167

Sources: World Bureau of Metal Statistics; for Canada, Statistics Canada.
Note: Data are for production of cadmium as unwrought metal from domestic and imported materials. Secondary metal is included where known, but the total in aggregate is less than one per cent of the world total. 1974 figures from United States Bureau of Mines, Commodity Data Summaries, January 1975.

Quebec. Canadian Electrolytic Zinc Limited (CEZ) produces refined cadmium at its Valleyfield plant. The bulk of zinc concentrates comes from the Mattagami, Orchan and Mattabi mines and Geco Mines Limited of Quebec and Ontario. Most zinc concentrates are low in cadmium, containing 0.11 to 0.16 per cent, except those from Geco which contain 0.38 per cent. Production at the CEZ plant in 1974 was 772,000 pounds, compared with 598,000 pounds in 1973. Most of the cadmium is sold as refined metal but small quantities are sold as sponge cadmium.

Ontario. Ecstall Mining Limited at Timmins, the largest producer of cadmium in Canada, produced 3,151,000 pounds in zinc concentrates, of which 782,200 pounds was recovered as cadmium metal at its zinc plant. The cadmium section of the plant began operation in the fall of 1972. Other zinc-copper mines in Ontario produce zinc concentrates carrying low-to-moderate cadmium values, except the Geco mine at Manitouwadge mentioned above. The South Bay mine of Selco Mining Corporation Limited also has higher-than-average cadmium values, at 0.25 per cent in concentrates. These are shipped for processing in France.

Manitoba and Saskatchewan. The electrolytic zinc plant of Hudson Bay Mining and Smelting Co., Limited at Flin Flon, Manitoba treats zinc concentrates produced in these two provinces and some imported from the Northwest Territories. Production at the plant was 298,736 pounds of cadmium in 1974 compared to 306,570 pounds in 1973.

British Columbia. Metallic cadmium amounting to 899,000 pounds was recovered at the metallurgical works of Cominco Ltd. at Trail. This is less than half of normal production as losses were incurred due to a four-month strike. Cominco also treats ores and concentrates from its subsidiary, Pine Point Mines Limited, N.W.T. and, on a custom basis, from various small mining operations in British Columbia and other provinces. Some of the purchased concentrates from British Columbia have a very high value in cadmium. A number of mines also ship concentrates to Japan where cadmium is recovered.

Yukon Territory. Cyprus Anvil Mining Corporation is a large producer and exporter of zinc concentrates. Although these are low in cadmium, a few hundred thousand pounds of cadmium are still recovered abroad from them.

Northwest Territories. Pine Point Mines Limited is a large — and the only — mine producing zinc concentrates containing approximately 0.10 to 0.12 per cent cadmium. About two thirds of these are smelted at Trail and the rest is exported. Due to the strike at Trail, a higher-than-normal proportion of zinc concentrates was exported during 1974.

Uses

Cadmium is a soft, ductile, silvery-white electropositive metal with a valence of two. It is used mainly for electroplating other metals or alloys; principally iron and, to a lesser extent, copper, to protect them against oxidation. A cadmium coating, like a zinc coating, protects those metals lower in the electromotive series by physical enclosure and by sacrificial corrosion. Cadmium is usually preferred to zinc as a coating because it is more ductile, is slightly more resistant to common atmospheric corrosion, can be applied more uniformly in recesses of intricately-shaped parts, and can be electrodeposited with less electric current per unit of area covered. It is also preferred for its more pleasing aesthetic appearance. Because it is more costly and much less plentiful than zinc, it is not as widely used. Improvement in zinc electroplating techniques in recent years have tended to reduce the consumption of cadmium in plating. Toxicity and environmental pollution are other factors that recently contributed to lower consumption.

Cadmium-plated parts are used in the manufacture of automobiles, household appliances, aircraft, radios, television sets and electrical equipment. Plating accounts for about half the total consumption of cadmium.

The second-largest use is in the manufacture of pigments. Cadmium sulphides give yellow-to-orange colours and cadmium sulphoselenides give pink-to-red and maroon. Cadmium stearates act as stabilizers in the production of polyvinyl chloride plastics, and cadmium phosphors are used for tubes in both black-and-white and colour television sets. The use of cadmium compounds in recent years has expanded at a rate of 5 to 10 per cent annually and is now the largest potential growth area. Expansion in this use, which now accounts for about 35 per cent of cadmium consumption, has more than made up for reduced consumption in plating.

Cadmium is a valuable alloying metal and has applications in cadmium-silver solders and in cadmium-tin-lead-bismuth fusible or low-melting-point alloys for automatic sprinkler systems, fire-detection apparatus, and valve seats for high-pressure gas containers. Low-cadmium copper (about 1 per cent cadmium) is used in the manufacture of trolley and telephone wires because of the improved tensile strength imparted by cadmium. Low-cadmium copper is also now employed in automobile radiator finstock, replacing the low-silver copper formerly used. Another growing application is in the production of nickel-cadmium storage batteries. These batteries are

(text continued on page 81)

Table 4. Companies reporting cadmium production, 1974 (and 1973)

Company and Location	Mill Capacity	Grade of Zinc Concentrates: Cadmium	Zinc	Lead	Copper	Silver	Zinc Concentrate Produced	Cadmium Contained in Zinc Concentrates	Remarks
	tons ore/ day	%	%	%	%	oz/ton	tons	pounds	
Newfoundland									
American Smelting and Refining Company (Buchans Unit) Buchans	1,250 (1,250)	0.22 (0.21)	55.30 (55.81)	3.72 (3.97)	0.74 (0.79)	4.44 (4.91)	42,325 (20,561)	183,000 (87,000)	Normal production after strike losses in 1973.
New Brunswick									
Brunswick Mining and Smelting Corporation Limited, Bathurst, No.6 mine and No.12	10,000 (9,850)	0.12 (0.11)	52.23 (53.28)	2.69 (2.16)	0.33 (0.27)	2.77 (2.69)	255,965 (330,811)	614,316 (727,784)	Production drop due to labour problems.
Heath Steele Mines Limited, Newcastle	3,100 (3,100)	0.11 (0.11)	48.07 (48.99)	1.86 (1.49)	0.60 (0.39)	2.85 (2.42)	73,229 (78,094)	161,104 (171,807)	Expansion in progress.
Nigadoo River Mines Limited, Robertville	1,000 (—)	0.62 (—)	44.72 (—)	1.78 (—)	1.26 (—)	4.92 (—)	8,739 (—)	108,363 (—)	Production was resumed in December 1973 after two years of suspension.
Quebec									
Joutel Copper Mines Limited, Joutel	700 (700)	0.13 (0.13)	51.67 (52.74)	0.08 (. .)	. . (. .)	. . (. .)	10,039 (25,030)	26,101 (70,083)	Mine will be closed in 1975.
Manitou Barvue Mines Limited, Val d'Or	1,600 (1,600)	0.18 (0.18)	56.3 (57.96)	. . (. .)	. . (. .)	6.21 (. .)	6,695 (5,982)	24,102 (21,960)	Concentrates shipped to the U.S.A.
Mattagami Lake Mines Limited, Matagami	3,850 (3,850)	0.14 (0.13)	52.7 (52.2)	— (—)	0.40 (0.35)	1.18 (1.21)	183,559 (178,104)	513,965 (463,070)	Three quarters of production shipped to CEZ at Valleyfield where cadmium is recovered.

Table 4. (cont'd)

Company and Location	Mill Capacity	Grade of Zinc Concentrates: Cadmium	Zinc	Lead	Copper	Silver	Zinc Concentrate Produced	Cadmium Contained in Zinc Concentrates	Remarks
	tons ore/ day	%	%	%	%	oz/ton	tons	pounds	
Quebec (concl'd)									
Orchan Mines Limited, Matagami, Orchan and Garon mines	1,900 (1,900)	0.11 (0.11)	52.38 (53.38)	0.35 (0.41)	0.72 (. .)	. . (. .)	27,155 (40,936)	59,741 (90,059)	Production was lower, mainly because of labour problems.
Sullivan Mining Group Ltd., Stratford Centre Cupra, D'Estrie Weedon and Clinton mines	1,500 (1,500)	0.28 (0.28)	56.68 (56.56)	0.43 (0.49)	1.20 (1.02)	1.28 (1.19)	13,739 (12,232)	76,938 (71,333)	The Cupra Division operates a concentrator for all three mines. The Weedon mine closed in 1973. The Clinton mine started production in 1974.
Ontario									
Ecstall Mining Limited, Timmins	10,000 (10,000)	0.27 (0.25)	52.14 (52.69)	. . (. .)	0.47 (0.42)	2.30 (4.70)	580,534 (589,894)	3,151,000 (2,960,475)	Higher production due to improvement of grade. Average of "a" and "c" types of zinc concentrates.
Mattabi Mines Limited, Sturgeon Lake	3,000 (3,000)	0.13 (0.13)	54.43 (55.38)	. . (. .)	. . (. .)	. . (. .)	164,896 (202,513)	428,730 (526,534)	Only 5% was processed domestically at CEZ, Valleyfield (1974).
Noranda Mines Limited, Geco Division, Manitouwadge	5,000 (5,000)	0.38 (0.38)	53.50 (53.89)	— (—)	0.67 (0.68)	1.53 (1.67)	132,400 (100,890)	1,006,240 (766,764)	Almost all the zinc concentrates are shipped to CEZ at Valleyfield.
Selco Mining Corporation Limited, South Bay Division, Uchi Lake	500 (500)	0.24 (0.25)	54.22 (52.0)	. . (. .)	0.36 (. .)	1.31 (. .)	38,318 (41,878)	186,000 (199,000)	Reserves increased. Possibility of more ore at depth. Data for fiscal year ending March 31, 1975.
Willroy Mines Limited, Manitouwadge Division	1,700 (1,700)	0.18 (0.18)	52.66 (52.45)	. . (. .)	. . (. .)	. . (. .)	19,826 (17,295)	72,116 (61,457)	Zinc concentrates exported to U.S.A.

Table 4. (cont'd)

Company and Location	Mill Capacity	Grade of Zinc Concentrates: Cadmium	Zinc	Lead	Copper	Silver	Zinc Concentrate Produced	Cadmium Contained in Zinc Concentrates	Remarks
	tons ore/ day	%	%	%	%	oz/ton	tons	pounds	
Manitoba and Saskatchewan									
Hudson Bay Mining and Smelting Co., Limited, Flin Flon (Flin Flon, Schist Lake, Chisel L., Stall Lake, Osborne Lake, Anderson Lake, Dickstone, White Lake Ghost Lake mines)	8,500 (8,500)	. . (. .)	48.6 (48.84)	0.9 (0.58)	0.70 (0.62)	1.34 (1.39)	69,550 (90,796)	154,836 (270,901)	In addition to cadmium recovered from its own concentrates, the Flin Flon smelter processes custom concentrates.
British Columbia									
Bradina Joint Venture, Owen Lake	500 (500)	— (0.28)	— (48.18)	— (7.48)	— (1.01)	— (20.34)	— (8,277)	— (48,282)	Mine closed in August 1973.
Cominco Ltd., Sullivan mine, Kimberley	10,000 (10,000)	0.13 (. .)	48.24 (48.30)	6.12 (6.30)	— (—)	2.49 (2.58)	114,154 (198,454)	296,800 (. .)	All concentrates processed at Trail.
Kam-Kotia-Burkam Joint Venture, Silmonac Mine, Sandon	150 (150)	0.40 (0.43)	51.11 (51.97)	. . (1.05)	— (—)	79.00 (59.86)	747 (1,133)	5,941 (9,744)	
Reeves MacDonald Mines Limited, Remac Annex mine	1,000 (1,000)	0.50 (0.57)	51.98 (52.01)	1.82 (2.69)	— (—)	3.67 (5.18)	12,526 (14,129)	125,260 (172,514)	Mining ceased in February 1975, production of broken ore continued until May, 1975.
Teck Corporation Limited, Beaverdell mine Beaverdell	110 (110)	0.41 (0.30)	39.90 (47.54)	1.65 (2.30)	— (—)	58.41 (65.61)	287 (318)	2,353 (1,910)	Mine has approximately two years' reserves.

Table 4. (concl'd)

Company and Location	Mill Capacity	Grade of Zinc Concentrates: Cadmium	Zinc	Lead	Copper	Silver	Zinc Concentrate Produced	Cadmium Contained in Zinc Concentrates	Remarks
	tons ore/day	%	%	%	%	oz/ton	tons	pounds	
British Columbia (concl'd)									
Western Mines Limited, Lynx and Myra Falls, Buttle Lake, V.I.	1,000 (1,000)	0.23 (0.24)	51.14 (53.34)	. . (0.98)	. . (1.11)	. . (6.00)	37,346 (44,736)	174,993 (211,262)	Mine instituted cutbacks that may be carried into 1975.
Yukon Territory									
United Keno Hill Mines Limited, Elsa, Husky, No Cash mines, Elsa	550 (550)	0.70 (0.74)	53.0 (55.70)	. . (1.14)	— (—)	. . (32.65)	527 (1,404)	7,330 (17,944)	Production for the year was normal, but average grade of zinc mined declined.
Northwest Territories									
Pine Point Mines Limited, Pine Point	11,000 (11,000)	. . (. .)	56.66 (55.59)	1.70 (1.60)	— (—)	. . (. .)	357,457 (390,892)	. . (. .)	Zinc concentrates grade approximately 0.10 to 0.12% cadmium. Total contained cadmium in 1974 was approximately 800,000 pounds.

. . Not available.

considerably more expensive than the standard lead-acid battery, have a longer life and higher peak power output, are smaller, and are superior in low-temperature operation. They are especially suitable for use in airplanes, satellites and missiles, and ground equipment for polar regions, as well as in portable items such as battery-operated shavers, toothbrushes, drills and hand saws. Uses of cadmium in alloys account for about 15 per cent of cadmium consumption.

Prices

Most electrolytic zinc plants recover between 45 and 75 per cent of the cadmium in zinc concentrates. Usually, settlement to the mine is based on a standard deduction of approximately 3 pounds of cadmium per ton of concentrate (i.e. 0.15 per cent) and payment for 60 per cent of the remaining assayed content.

Canadian producers' cadmium prices throughout 1974, as quoted in The Northern Miner, for sticks, bars, balls, etc. 99.8 per cent pure.

Effective Date	Lots of 2,000 lb and over	Lots under 2,000 lb
	($ per lb)	($ per lb)
January 1	3.75	3.95

(Not reported after February 14)

United States producers' prices throughout 1973, as quoted in the Engineering Mining Journal.

Effective Date	($ per lb)
January 1	3.75
May 7	4.25 – 4.30

Outlook

Cadmium is a byproduct of zinc mining and refining, and the ups-and-downs of cadmium supply, demand and prices are closely related to general economic activity and zinc production. The cadmium market is a relatively minor market and small changes can make a big difference in prices. Strong demand characterized the beginning of 1974, but by the end of the year demand was extremely weak. For 1975 the forecast is for a decrease in demand of 40 to 50 per cent, with no sustained recovery before 1977. For the longer-term, it is possible that potential supply will continue to outpace demand. Producer prices will be either lowered drastically or merchant metal will be offered at considerable discount to producer prices.

According to the U.S. Bureau of Mines, the increased development of nickel-cadmium batteries will eventually produce a larger circulating load of secondary cadmium, but only a small percentage of total demand can come from this source. The toxic effects of cadmium in air, acid solutions and water-borne silt may restrict its use in plating establishments or as compounds in pigments or stabilizers if stricter antipollution standards are put into effect. Scavenging systems for industrial waste waters are available but small consumers may find the increased cost unacceptable. In industralized nations, smelters producing cadmium byproducts will be enjoined to recover as high a percentage of cadmium input as is economically feasible in order to prevent its dispersal into the environment.

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
32900-1	Cadmium in ores and concentrates	free	free	free
31502-1	Cadmium metal, not including alloys in lumps, powders, ingots or blocks	free	free	25%

United States

Item No.		
601.66	Cadmium in ores and concentrates	free
632.14	Cadmium metal, unwrought waste and scrap (duty on waste and scrap suspended on or before June 30, 1973)	free
633.00	Cadmium metal, wrought	9%
632.84	Cadmium alloys, unwrought	9%

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Calcium

M.J. GAUVIN

Calcium, a member of the alkaline earth family, is silvery white in colour, extremely soft and ductile and has a low tensile strength. The metal tarnishes rapidly under atmospheric conditions and is a powerful reducing agent. It is the fifth most abundant element in the earth's crust, but does not occur naturally in its elemental form. Although calcium occurs chiefly in limestone, dolomite and sea water, high-calcium limestone deposits are the principal sources of calcium metal.

Metallic calcium may be recovered by electrolytic or thermal methods. Extraction was previously carried out by the fused salt electrolysis of calcium chloride, but today it is only done by aluminothermic reduction of lime by a non-continuous process. There are only three producers of metallic calcium in the noncommunist world: Chromasco Limited in Canada; Planet-Wattohm S.A., a subsidiary of Compagnie de Mokta, in France; and Charles Pfizer and Co. Inc. at Canaan, Conn. in the United States. All three use a thermal reduction method. Canada continued to be a leading international producer and supplier of calcium metal in 1974. Production and consumption of calcium amount to approximately 1,000 tons a year in the noncommunist world.

Canadian industry

Chromasco Limited produces calcium metal at its metallurgical plant at Haley, near Renfrew, Ontario. It utilizes the same vacuum retort method, known as the "Pidgeon process," used to produce its principal product, magnesium. Other products from the Haley operation, in addition to magnesium and calcium metals, include magnesium and calcium alloys and barium, strontium and thorium metals. To make calcium, high-purity quicklime (CaO) and commercially pure aluminum are briquetted and then charged into horizontal electric retorts made of chrome-nickel steel. Under vacuum and at a temperature of about 1170°C, the aluminum reduces the quicklime to form a calcium vapour. This calcium vapour crystallizes at about 680°-740°C in the water-cooled condenser section of the retort, which projects outside the furnace wall. The initial product, known as "crowns," grades about 98 per cent calcium. Higher purities are obtained by subsequent refining operations.

Chromasco makes three main grades of calcium: Grade 1 – chemical standard, 99.9 per cent calcium with minor amounts of other elements; Grade 2 – nuclear quality, 99.9 per cent calcium, including a magnesium content up to a maximum of 0.5 per cent; Grade 4 – commercial grade (crowns), 98 per cent calcium, 0.5 to 1.5 per cent magnesium, 1 per cent nitrogen maximum, 0.35 per cent aluminum maximum.

Canadian production of calcium in 1974 was a record 1,018,000 pounds, 56 per cent more than the 651,921 pounds produced in 1973 and 8 per cent above the previous record 942,682 pounds produced in 1969. Most of our production is exported, 747,500 pounds being sold in foreign markets in 1974, compared with 378,300 pounds in 1973. Exports to the

Table 1. Canada, calcium production and exports, 1973-74

	1973		1974^p	
	(pounds)	($)	(pounds)	($)
Production (metal)[1]	651,921	489,813	1,018,000	897,000
Exports (metal)				
United States	131,200	91,000	550,700	465,000
Mexico	117,700	81,000	121,100	99,000
West Germany	95,600	70,000	61,700	64,000
United Kingdom	4,000	8,000	10,000	19,000
Other countries	29,800	43,000	4,000	4,000
Total	378,300	293,000	747,500	651,000

Source: Statistics Canada.
[1] Shipments of calcium metal and calcium metal used in production of calcium alloys.
^{p} Preliminary.

Table 2. Canada, calcium production and exports, 1965-74

	Production[1]	Exports
	(pounds)	
1965	159,434	148,300
1966	249,179	242,800
1967	543,692	513,000
1968	468,511	353,700
1969	942,682	724,600
1970	443,557	174,100
1971	355,247	152,900
1972	469,378	253,100
1973	651,921	378,300
1974^p	1,018,000	747,500

Source: Statistics Canada.
[1] Producers' shipments of calcium metal and calcium metal used in production of calcium alloys.
^{p} Preliminary.

United States totalled 550,700 pounds compared with 131,200 pounds in 1973.

Uses

Metallic calcium is a powerful reducing agent. Accordingly, one of its major applications is in metallurgical processes for removing oxygen and halogens from various metals which resist reduction by normal reductants such as carbon, hydrogen and natural gas. Among such metals are columbium, tantalum, titanium, thorium, uranium, vanadium and zirconium. As a purifier, calcium removes residual sulphur, phosphorus and oxygen from steel. The major usage of calcium is to remove bismuth, antimony and arsenic from lead. Metallic calcium is also used in producing organocalcium compounds for special lubricants, corrosion inhibitors and detergents. In certain types of storage batteries, a lead alloy containing only 0.1 per cent calcium exhibits properties superior to an alloy containing 3 per cent antimony generally used. Substitution in this field could be an important factor in any future growth in consumption of calcium. Alloys of calcium and silicon, and of calcium, silicon and magnesium are widely used in the steel industry to control grain size, inhibit carbide formation, improve ductility and reduce internal flaws.

Outlook

A shortage of raw materials is almost impossible to perceive since limestone and other calcium minerals are readily available and inexpensive. Consumption of calcium metal is limited and, unless its use is greatly accelerated, existing producers will be able to supply the market adequately in the foreseeable future. The longer-term outlook for the metal could improve somewhat if the growth rate for one of the metal's major uses, i.e., in hydraulic cements, should increase. The growth rate might also rise if the so-called "maintenance-free" automotive batteries prove to be successful from a commercial viewpoint on a large-scale basis. These permanently (hermetically) sealed batteries use calcium-lead alloy instead of antimonial-lead alloy in the battery grids. These new-type batteries require virtually no maintenance during their normal battery life. It has been reported that some of them have been used, without the addition of water or electrolyte, in automobiles that have travelled a total of up to 60,000 miles.

Prices

The price of calcium metal crowns increased in August 1974 from 95 cents to $1.24 a pound. This price was maintained for the remainder of the year. The price of calcium silicon alloy was 22.75 cents a pound on January 1, 1974 and was increased in May to 36 cents with a further increase to 57 cents a pound in July 1974. According to *Metals Week*, December 27, 1974, United States prices were as follows:

	(¢ per lb)
Calcium metal, ton lots, full crowns	95
Calcium alloy, fob shipping point, freight equalized to nearest main producer, carload lots:	
calcium silicon, 32% calcium	57

Tariffs

Canada

Item No.		Most Favoured Nation
		(% ad val.)
92805-1	Calcium metal	15

United States

Item No.		On and after January 1 1971	1972
		(% ad val.)	
632.16	Calcium metal, unwrought	9	7.5
633.00	Calcium metal, wrought	10.5	9

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Cement

D.H. STONEHOUSE

Portland cement is produced by burning, usually in a rotary kiln, an accurately proportioned, finely ground mixture of limestone, silica, alumina and iron oxide. Kiln discharge, in the shape of rough spheres, is a fused, chemically complex mixture of calcium silicates and aluminates termed clinker, which is mixed with gypsum, 4 to 5 per cent by weight, and ground to a fine powder to form portland cement. By close control of the raw mix, of the burning conditions and of the use of additives in the clinker grinding procedure finished cements displaying various desirable properties can be produced.

There are three basic types of portland cement produced and used in Canada – Normal Portland, High Early Strength Portland and Sulphate-Resisting Portland – all of which are covered in specifications under CSA Standard A5 – 1971 (Canadian Standards Association). Moderate portland cement and low heat of hydration portland cement, designed for mass concrete use such as in dam construction, are manufactured by several companies in Canada and are also covered in CSA Standard A5 – 1971. Masonry cements produced in Canada should conform to the requirements of CSA Standard A8 – 1970. Masonry cement (generic name) includes such proprietary names as Mortar Cement, Mortar Mix (unsanded), Mason's Cement, Brick Cement and Masonry Cement. The latter, produced by portland cement manufacturers, is a mixture of portland cement, finely ground high-calcium limestone (35% to 65% by weight) and a plasticizer. The other products do not necessarily consist of portland cement and limestone, and may include a mixture of portland cement and hydrated lime and/or other plasticizers.

Cement has little use alone but, when combined with water, sand, gravel, crushed stone or other aggregates in proper proportions, acts as a binder, cementing the materials together as concrete. Concrete has become a widely used and readily adaptable building material which can be poured on site in large engineering construction projects such as dams or can be used in the form of delicate precast panels or heavy, prestressed columns and beams in building construction.

Specifications

Portland cement used in Canada should conform to the specifications of CSA Standard A5 – 1971 published by the Canadian Standards Association. This standard covers the five main types of portland cement as follows: Normal, Moderate, High Early Strength, Low Heat of Hydration, and Sulphate-Resisting Portland cements. Masonry cement produced in Canada should conform to the CSA Standard A8 – 1970.

The cement types manufactured in Canada and not covered by the CSA standards generally meet the appropriate specifications of the American Society of Testing and Materials (ASTM).

Cembureau, The European Cement Association, has published Cement Standards of the World — Portland Cement and its Derivatives, in which standards are compared. Cembureau's *World Cement Directory* lists production capacities by company and by country.

Summary

Cement is one of a number of industrial mineral commodities produced in Canada in direct support of the construction industry. Others are clays, lime, sand and gravel, stone, asbestos and gypsum. The construction industry is the largest single employer in Canada and is one that is immediately affected by changes in the country's economic climate. In a supply role to a volatile industry, the cement industry, in turn, must be capable of adjusting and remaining competitive.

A growing export market for cement in northeastern and southeastern United States has resulted in the Canadian cement industry being influenced, at least regionally, by construction activity and intentions in that country. The current deficiency in productive capacity in northeastern and midwestern United States was brought on by plant closures forced by the application of environmental legislation, and by the lack of appeal the industry has had to attract capital investment for either the erection of new plants or for the modernization of existing plants. During 1974, a depressed construction industry in the United States gave temporary and partial relief from the cement shortage situation which has seen imported cement accepted from as far away as Norway. However, it is unlikely that any new or expanded capacity through the next two or three years will do anything but parallel demand.

In Canada, construction is categorized broadly as building construction and engineering construction, and the values of each type give some basis for comparison. Historically, building construction has represented about 60 per cent of the total value of construction and one element within this general category — residential construction — has normally ac-

Table 1. Canada, cement production and trade, 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Production[1]				
By province				
Ontario	4,197,754	85,634,181	4,438,000	90,535,000
Quebec	3,491,777	65,331,147	3,332,000	62,342,000
Alberta	1,033,413	26,259,024	1,016,000	25,810,000
British Columbia	950,772	24,935,624	965,000	24,700,000
Manitoba	647,755	17,015,644	686,000	18,066,000
Saskatchewan	215,224	6,857,036	255,000	8,135,000
Nova Scotia	..	5,576,914	..	5,912,000
New Brunswick	..	5,203,050	..	5,672,000
Newfoundland	..	3,748,371	..	3,539,000
Total	11,125,738	240,560,991	11,308,000	244,711,000
By type				
Portland	10,725,212	..	10,900,912	..
Masonry[2]	400,526	..	407,088	..
Total	11,125,738	240,560,991	11,308,000	244,711,000
Exports				
Portland cement				
United States	1,408,385	24,396,000	1,264,446	23,573,000
Other countries	1,203	42,000	1,440	69,000
Total	1,409,588	24,438,000	1,265,886	23,642,000
Cement and concrete basic products				
United States	..	20,893,000	..	11,726,000
Other countries	..	184,000	..	191,000
Total	..	21,077,000	..	11,917,000
Imports				
Portland cement, white				
United States	22,897	1,049,000	26,463	1,215,000
Japan	2,558	89,000	434	18,000
Belgium and Luxembourg	3,684	126,000	—	—
West Germany	35	2,000	—	—
Total	29,174	1,266,000	26,897	1,233,000
Cement, nes[3]				
United States	95,153	2,574,000	249,297	7,254,000
United Kingdom	3,216	176,000	607	49,000
West Germany	335	31,000	146	23,000
France	—	—	64	6,000
Denmark	778	55,000	—	—
Total	99,482	2,836,000	250,114	7,332,000
Total cement imports	128,656	4,102,000	277,011	8,565,000

Table 1 (concl'd)

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Refractory cement and mortars				
United States	..	2,918,000	..	3,713,000
United Kingdom	..	32,000	..	305,000
Ireland	..	850,000	..	195,000
Denmark	..	20,000	..	25,000
Austria	..	4,000	..	14,000
Other countries	..	18,000	..	31,000
Total	..	3,842,000	..	4,283,000
Cement and concrete basic products, nes				
United States	..	569,000	..	1,302,000
West Germany	..	19,000	..	39,000
United Kingdom	..	4,000	..	27,000
Mexico	..	32,000	..	5,000
France	..	34,000	..	2,000
Japan	—	—	..	2,000
Total	..	658,000	..	1,377,000
Cement clinker				
United States	5,043	125,000	12,284	296,000

Source: Statistics Canada.
[1] Producers' shipments, plus quantities used by producers. [2] Includes small amounts of other cements. [3] Includes grey portland, masonry, acid proof, aluminous and other specialty types of cement.
p Preliminary; nes Not elsewhere specified; .. Not available; — Nil.

counted for 30 per cent of total value or one half of the value of building construction. In terms of current dollars, construction has been credited with an average of 17 per cent of our gross national expenditure over the past ten years. Capital and repair expenditure on construction in 1974 was $24.2 billion, up 20 per cent over the 1973 figure of $20 billion. Forecasts indicate that in 1975 such investment will total $27 billion, an increase of 13 per cent. The fact that the rate of increase in construction expenditures is expected to be lower than in each of the two preceding years is attributed to an expected 3 per cent decline in residential construction with 210,000 starts anticipated, compared with 222,123 starts in 1974. Non-residential construction is projected to increase by 23 per cent in 1975. Engineering construction will continue strong, and total construction in place should be no less in 1975 than in 1974 but the value of construction will reflect inflation of as much as 10 per cent. Problems associated with the supply of construction materials, of particular importance during the past two years, will prove of lesser concern to the industry in 1975 than those related to both the supply and cost of labour. Labour disruptions reached record proportions in 1974 with the loss of 2.4 million man days. Residential building price indexes rose over 8.0 per cent in 1974, including 6.5 per cent for material and 10.6 per cent for labour. A 14 per cent increase in the non-residential sector was made up of increases of 18.5 per cent for material and 10.3 per cent for labour.

A typical feature of the cement manufacturing industry is its diversification and vertical integration into related construction materials industries. Many cement companies also supply ready-mix concrete, stone aggregates, and preformed concrete products such as slabs, bricks and prestressed concrete units.

Markets for cement tend to be regional because transportation costs represent much of the laid-down price to the consumer and only rarely, as in the case of special cements or in periods of regional shortage, shipments are made beyond normal distribution boundaries. Production, therefore, is determined by the regional construction activity and by interpretation of construction intentions.

Cement production capacity at the end of 1974 was about 15.9 million tons a year, excluding the capacity of three plants which only grind clinker and including some listed capacity which could be reactivated or maintained only at considerable expense. Capacity increases during 1974 were limited to new grinding mills at Lake Ontario Cement Limited's Picton, Ontario plant. A new kiln installation at the St. Constant plant of Canada Cement Lafarge Ltd., scheduled for completion during 1974, was delayed by labour disruptions; it was expected to be operative early in 1975. The industry's projected net increase in capacity totals 2,692,000 tons a year of which 1,880,000 tons a year is scheduled for addition in 1975. See Table 8. Theoretical capacity utilization in 1974 was just over 71 per cent.

Table 2. Canada, cement production, trade and consumption, 1965-74^p

	Production[1]	Exports[2]	Imports[2]	Apparent Consumption[3]
	(short tons)			
1965	8,427,702	334,887	37,619	8,130,434
1966	8,930,552	407,395	50,615	8,573,772
1967	7,994,954	328,018	44,118	7,711,054
1968	8,165,805	366,506	51,500	7,850,799
1969	8,250,032	634,208	53,396	7,669,220
1970	7,945,915	566,521	97,191	7,476,585
1971	9,075,915	887,846	55,874	8,243,943
1972	10,038,617	1,299,329^r	43,372^r	8,782,660^r
1973	11,125,738	1,409,588	128,656	9,844,806
1974^p	11,308,000	1,265,886	277,011	10,319,125

Source: Statistics Canada.
[1] Producers' shipments plus quantities used by producers. [2] Does not include cement clinker. [3] Production plus imports less exports.
^{p} Preliminary; ^{r} Revised.

Canadian industry and developments

Atlantic region. There are three cement manufacturing plants in the Atlantic provinces serving the markets in the immediate area by road, rail and water transportation routes. The plants represent 5.6 per cent of Canadian cement production capacity in a region having 9.5 per cent of the total population of Canada.

A plant located at Corner Brook, Newfoundland, established in 1951, is operated by North Star Cement Limited. Limestone and shale, raw materials for the dry process being used, are quarried in the immediate area, and gypsum is purchased from The Flintkote Company of Canada Limited, which quarries gypsum at Flat Bay, about 60 miles south of Corner Brook. Shipments of portland cement are made by rail and by sea, mostly to provincial markets. Production depends directly on construction activity.

During 1974 Lehigh Portland Cement Company, Allentown, Pennsylvania, in joint agreement with British Newfoundland Exploration Limited (Brinex) assessed the raw materials available in the Port au Port district of Newfoundland with the objective of establishing a 1-million-ton-a-year portland cement facility in the region. Obviously, a buoyant export market for portland cement or for clinker would be needed in order to support a plant of such capability. Early in 1975 Lehigh terminated its association with the project while Brinex continued to investigate the feasibility of an industrial mineral complex based on high calcium limestone.

Nova Scotia's only cement manufacturing facility, a single-kiln, dry-process plant incorporating the most modern analytical and control devices, was established in 1965 by Canada Cement Company, Limited (now Canada Cement Lafarge Ltd.) at Brookfield. Limestone at the plant site is chemically very close to a natural cement rock; but variations in lime, alumina and iron content necessitate the addition of iron oxide, coal ash and high-calcium limestone, all of which are available nearby. Gypsum is purchased from the Milford quarry of National Gypsum (Canada) Ltd., about 25 miles south of Brookfield. Portland cement is marketed in bulk or package under the brand name "Maritime" cement. During 1974, Nova Scotia cement production showed an increase of about 5 per cent over 1973. Canada Cement recently announced plans to double the capacity of its Brookfield plant.

Canada Cement Lafarge Ltd. also operates a cement manufacturing plant at Havelock, New Brunswick. This plant, built in 1951 and expanded in 1966 by the addition of a second kiln, now has a capacity of 450,000 tons a year. The company increased plant capacity with the addition of heavier grinding equipment and with the addition of larger storage facilities. Shipments in 1974 were up about 12 per cent over 1973.

Quebec. In the Province of Quebec, five companies operate a total of seven cement manufacturing plants. Regionally, the companies producing cement in Quebec compete for the construction markets in the Montreal and Quebec City areas as well as for markets in more remote regions where major heavy construction projects are under way — the James Bay project, the Manicouagan project, and the iron ore development north of Port-Cartier. Preparations for the 1976 Olympics will add to construction activity in Montreal, and construction of the Ste-Scholastique airport project continues. Major export markets developed in the United States over the past few years for both cement and cement clinker accepted less product in 1974 because of the downturn in construction in that country. Cement production in Quebec decreased by about 3 per cent in 1974.

The Montreal East plant of Canada Cement Lafarge Ltd. at Pointe-aux-Trembles has been operated as part of the Canada Cement complex since it was acquired in 1909. Material from the adjacent quarry approximates a natural raw mix which requires only minor amounts of sand, iron oxide and high-calcium limestone for corrective purposes. Situated a mile from docking facilities on the St. Lawrence River, the plant has access to water transportation, and ships to distribution warehouses in the Atlantic provinces and in areas bordering the Great Lakes as well as to local consumers. The plant capacity, 1.4 million tons a year, is second only to that of St. Lawrence Cement Company's Clarkson, Ontario plant, which has a capacity of 1.75 million tons a year. The Montreal plant is scheduled to undergo major rehabilitation by 1976 with the replacement of seven kilns by two more modern ones with preheater units and with conversion to the dry process. Effective capacity at completion of the project will be 500,000 tons a year.

Canada Cement Lafarge's plant at St. Constant, south of Montreal was to have increased capacity by 500,000 tons a year during 1974. Construction difficulties delayed completion of the additional kiln and ancillary equipment until early 1975. The plant is modern, technically efficient and could conceivably replace some of the capacity of Canada Cement Lafarge's older Montreal East plant. The company's Hull operation is on the site where cement was first produced in Canada. From this location, areas of the Ottawa Valley are served. The Quebec government has indicated it will expropriate this property over the next ten years.

Miron Company Ltd., with the second largest cement-producing capacity in the Montreal area, operates a dry-process plant at St-Michel. The company also supplies concrete and other building materials to the construction industry and maintains a contracting division. During 1973, Genstar Limited of Montreal negotiated to acquire the majority of Miron shares. Genstar through its cement division, operates Inland Cement Industries Limited in Winnipeg, Regina and Edmonton, and Ocean Cement Limited in Bamberton, B.C.

St. Lawrence Cement Company has a plant at Villeneuve, near Quebec City, capable of manufacturing about 790,000 tons of cement a year. Limestone and shale are available at the site, iron oxide and gypsum are brought in by truck and rail. Finished products include normal portland cement, medium heat of hydration cement, high early strength cement, low heat of hydration cement and masonry cement. Shipments are made in bulk or in bags by truck and by rail.

Independent Cement Inc. began construction of its cement-manufacturing plant at Joliette, Quebec in 1965, and it went on stream in the fall of 1966 with a two-kiln operation capable of producing about 435,000 tons a year. A third kiln, adding about 220,000 tons a year to plant capacity, started up in 1970. In 1972, a fourth kiln of similar design was installed. This company has pursued an aggressive sales campaign and has captured a major share of the Montreal area markets.

Ciment Quebec Inc. was established in 1952 at St-Basile, 40 miles west of Quebec City, as a single-kiln operation. Two additional kilns were installed to boost production capacity to about 380,000 tons a year.

Ontario. Four companies operate a total of six cement-manufacturing plants in the Ontario region, serving industrial and urban growth areas in southern Ontario, and shipping to points in Quebec and northern Ontario as well as exporting to the United States. One other company operates a clinker grinding plant.

The industrialized and population-intense region surrounding Lake Ontario and Lake Erie continues to grow and, in so doing, provides markets for cement in many engineering, commercial, industrial and residential building projects, all of which have shown continued growth. The Ontario cement producers represent 37.2 per cent of total production capacity in a region occupied by about 36 per cent of the total Canadian population. The industry operated at about 76 per cent of capacity in 1974. Steady growth is indicated by heavy investment in additional capacity during 1974 as well as by announced intentions by producers to increase their capacities during the next few years.

Lake Ontario Cement Limited is one of Canada's largest cement exporters. The plant is located at Picton where favourable raw materials are situated adjacent to deep water, permitting comparatively inexpensive bulk shipments to be made to Great Lakes and St. Lawrence Seaway ports. Shipments, also made by truck and by rail to domestic markets, were at an all-time high in 1974. The company is undergoing a plant expansion to meet the expected growth in demand for cement and concrete products. Late in the year the company announced it contracted to supply clinker to a Martin Marietta Corp. cement plant in Michigan beginning in 1976.

The Belleville plant of Canada Cement Lafarge Ltd., one of the original operations grouped to form the Canada Cement Company in 1909, was phased out of operation at the end of October, 1973, subsequent to the company's new 1.1-million-ton-a-year plant at Bath commencing start-up procedures in mid-September.

Canada Cement Lafarge operates a plant at Woodstock, Ontario capable of producing about 600,000 tons a year from a two-kiln, wet process. The plant was constructed in 1956 to serve the developing area of southwestern Ontario. Clay overburden from the limestone quarry is of a quality that can be utilized in manufacturing masonry cement, high early strength cement and normal portland cement.

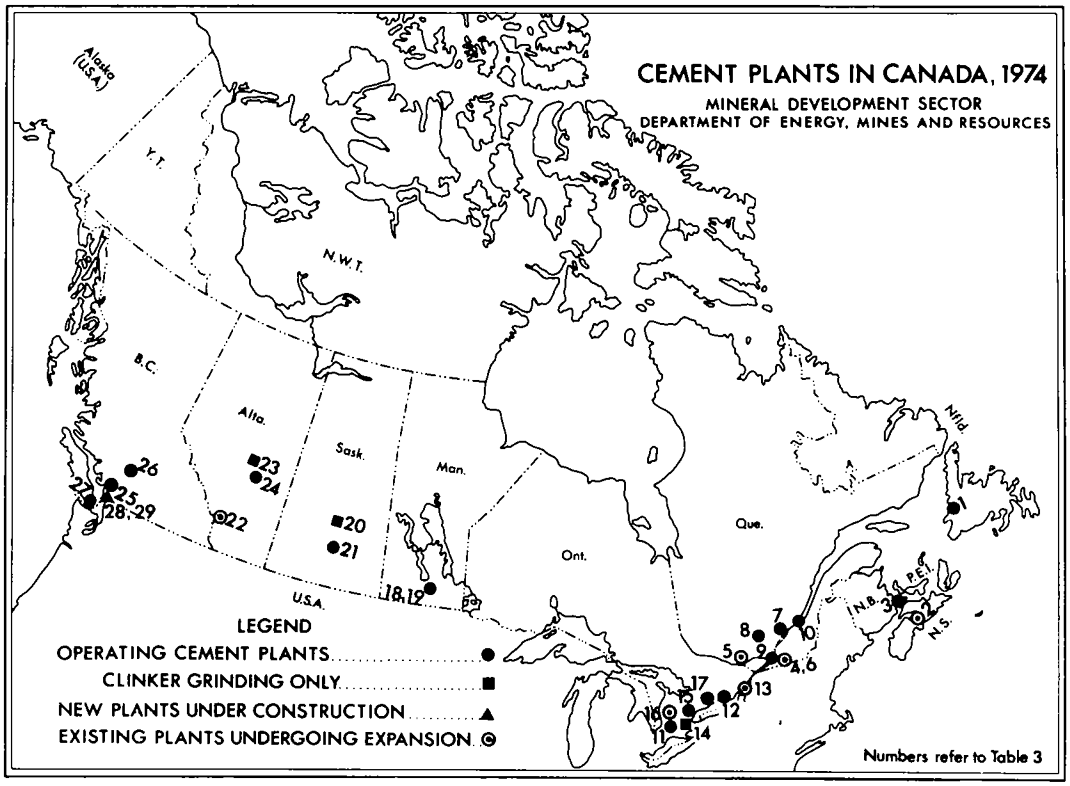
St. Lawrence Cement Company constructed its Clarkson, Ontario plant in 1957 and, with the expansion to 1.75 million tons a year in 1968, it became Canada's largest producing plant. The plant now combines a wet and dry process.

Limestone for the plant is conveyed by boat from Ogden Point, 100 miles east of Toronto on the north shore of Lake Ontario. A mile-long, overhead, covered

Table 3. Cement plants – approximate annual capacities, end of 1974

Company	Plant Location	Process	Capacity
Atlantic region			
1. North Star Cement Limited	Corner Brook, Newfoundland	dry	175,000
2. Canada Cement Lafarge Ltd.	Brookfield, N.S.	dry	262,000[1]
3. Canada Cement Lafarge Ltd.	Havelock, N.B.	dry	450,000
Total Atlantic region			887,000
Quebec			
4. Canada Cement Lafarge Ltd.	Montreal	wet	1,400,000[2]
5. Canada Cement Lafarge Ltd.	Hull	wet	210,000
6. Canada Cement Lafarge Ltd.	St-Constant	dry	525,000[3]
7. Ciment Quebec Inc.	St-Basile	wet	380,000
8. Independent Cement Inc.	Joliette	dry	875,000
9. Miron Company Ltd.	St-Michel	dry	1,050,000
10. St. Lawrence Cement Company	Villeneuve	wet	787,500
Total Quebec region			5,227,500
Ontario			
11. Canada Cement Lafarge Ltd.	Woodstock	wet	595,000
12. Canada Cement Lafarge Ltd.	Bath	dry	1,100,000
13. Lake Ontario Cement Limited	Picton	dry	1,025,000[4]
14. Medusa Products Company of Canada, Limited	Paris	grinding only	
15. St. Lawrence Cement Company	Clarkson	wet/dry	1,750,000
16. St. Marys Cement Limited	St. Marys	wet	743,000[5]
17. St. Marys Cement Limited	Bowmanville	wet	700,000
Total Ontario region			5,913,000
Manitoba			
18. Canada Cement Lafarge Ltd.	Fort Whyte	wet	630,000
19. Inland Cement Industries Limited	Winnipeg	wet	350,000
Saskatchewan			
20. Canada Cement Lafarge Ltd.	Floral	grinding only	
21. Inland Cement Industries Limited	Regina	dry	227,500
Alberta			
22. Canada Cement Lafarge Ltd.	Exshaw	wet	543,000[4]
23. Canada Cement Lafarge Ltd.	Edmonton	grinding only	
24. Inland Cement Industries Limited	Edmonton	wet	577,500
Total Prairie region			2,328,000
British Columbia			
25. Canada Cement Lafarge Ltd.	Lulu Island	wet	612,500
26. Canada Cement Lafarge Ltd.	Kamloops	dry	210,000
27. Ocean Construction Supplies Limited	Bamberton	wet	700,000
28. Ocean Construction Supplies Limited		dry	750,000[6]
Haida Cement Company, Limited	New Westminster	dry	330,000[6]
Total British Columbia region			1,522,500
Total capacity (58 kilns)			15,878,000

Source: Published data and company communication.
[1] Capacity to be doubled. [2] Undergoing rehabilitation, scheduled for completion 1976. [3] Capacity increase scheduled for 1974 delayed to 1975. [4] Capacity increase scheduled for 1975. [5] Capacity increase scheduled for 1976. [6] Not included in totals, under construction, or planned.



conveyor is used to transport stone from the lake carriers to the plant. Gypsum is trucked from producers in southwestern Ontario. The market area for finished cement product is mainly the Toronto-Hamilton strip and southern Ontario served by rail and truck deliveries. Large quantities of clinker are exported to United States points. The company sold its assets in Wyandotte Chemical Corporation, Michigan in compliance with the U.S. Federal Trade Commission divesture order issued in early 1973.

St. Marys Cement Limited operates two plants in Ontario. The original plant at St. Marys was constructed in 1912 to serve the Toronto area. It has been expanded and modernized over the years and with the installation of a sixth kiln by 1976 will have the capacity to produce over 1.4 million tons a year. A new and highly automated plant, built at Bowmanville during 1967 and 1968, was expanded during 1973 with the addition of a second kiln to increase capacity to 700,000 tons a year. The plant is favourably situated to ship product via truck and rail to the major marketing area of metropolitan Toronto.

Medusa Products Company of Canada, Limited, Paris, Ontario grinds a white clinker imported from the Medusa plant at York, Pennsylvania. The white cement is sold mainly in Ontario.

Prairie region. Two companies, Canada Cement Lafarge Ltd. and Inland Cement Industries Limited, operate a total of five clinker-producing plants in the Prairie region along with two clinker-grinding plants. The region accounts for 14.7 per cent of Canadian cement-producing capacity exclusive of the grinding plants and during 1974 produced well over 80 per cent of that capacity.

Canada Cement Lafarge Ltd. operates a plant at Fort Whyte, near Winnipeg, Manitoba. The original facility has been enlarged and rebuilt several times and is today a highly efficient plant capable of producing 630,000 tons of cement a year. High-calcium limestone is obtained from the company's quarry at Steep Rock on the shore of Lake Manitoba, gypsum from Silver Plains, silica from Beausejour and clay from Fort Whyte. Products include portland cement, sulphate-resisting cement, oil well cement and masonry cement for a market area extending from the United States

Table 4. Canada, cement plants, kilns, production and capacity, 1970-74

	Plants	Kilns	Approximate Annual Capacity	Production	Capacity Utilization
			(tons)	(tons)	(%)
1974	24	58	15,878,000	11,308,000	71
1973	24	58	15,728,000	10,884,000	69
1972	24	59	14,948,000	9,962,455	67
1971	24	58	14,729,000	9,326,312	63
1970	24	58	14,729,000	7,945,915	54

Source: Data supplied by companies to Mineral Development Sector.

Table 5. Canada, destination of domestic cement shipments[1], 1974

	(short tons)
Ontario	4,042,344
Quebec	2,828,201
Rest of Canada	3,451,978
Canada total	10,322,523
Exports	983,425
Total shipments	11,305,948

Source: Statistics Canada.
[1] Special compilation. Direct sales from producing plants.

border to the most northerly populated areas and eastward halfway across northern Ontario.

At Exshaw, Alberta, a cement plant has been operated by the Canada Cement group since 1910. Major improvements under way and planned for the Exshaw plant will result in a net increase in production capacity of about 40 per cent to 700,000 tons a year. A new quarry site will be developed and will require the relocation of several roads and structures in Exshaw. Finished cement is shipped by rail and truck to consumers in eastern British Columbia, Alberta and western Saskatchewan. Large quantities of clinker are shipped to the company's grinding, storage and distributing plant at Edmonton, Alberta. A facility at Floral, near Saskatoon, Saskatchewan was built in 1964 as a distribution terminal and in 1966 was expanded to include clinker-grinding equipment. When the demand for cement warrants, the Floral establishment can be expanded further to become a fully integrated cement manufacturing and distributing plant. Clinker for the Floral plant currently is obtained from Fort Whyte.

Inland Cement Industries Limited, a Genstar Limited subsidiary, operates three cement-manufacturing plants—one in Winnipeg, Manitoba, one in Regina, Saskatchewan and one in Edmonton, Alberta. The Winnipeg plant came on stream in 1965 to increase the company's total production capacity to over 1 million tons a year. A limestone quarry at Mafeking, Manitoba, near the Manitoba-Saskatchewan border, supplies limestone to the Regina plant while the Winnipeg plant is supplied from Steep Rock. The Edmonton plant is supplied from Cadomin, Alberta, by a 5,000-ton-unit train which is part of a total, automated, materials-handling system. Other raw materials are obtained close to the plant sites. A market area stretching east to the Lakehead and west to central British Columbia is served by Inland's facilities.

Houg Cement, Limited, Edmonton was scheduled to produce cement from marl early in 1974 near Clyde some 40 miles northeast of Edmonton. Details are limited, but a $5 million expenditure for a 60,000-ton-a-year plant has been reported. Local markets would consist principally of ready-mix operations.

Table 6. Canada, mineral raw materials[1] used by the cement industry

Commodity	1972	1973p
	(short tons)	
Shale	671,491	588,114
Limestone	13,978,794	15,868,345
Gypsum	494,476	503,204
Sand	246,370	196,042
Clay	1,032,047	1,058,537
Iron oxide	91,410	114,996

Source: Statistics Canada.
[1] Includes purchased materials and material produced from own operations.
p Provisional.

Pacific region. Construction activity in British Columbia has been maintained at a high level despite labour problems and escalating costs. Confidence in increased construction demands for cement is reflected in Genstar's proposal to construct a new 750,000-ton-a-year plant somewhere in the Vancouver area at a cost of $60 million. In 1973, Haida Cement Company Limited announced its intention to build a 330,000-ton-a-year plant in New Westminster. At the end of 1974 the status of the proposed plant was not known — construction had not begun.

Early in 1973, seven companies operating in the cement-concrete industry in British Columbia were charged in provincial court under the Combines Investigation Act for illegally lessening and preventing competition in the supply and sale of cement and

Table 7. Capacity changes during 1974, cement plants

Company	Location	Net Increase	Approximate Cost	Remarks
		(tons a year)	($ million)	
Ontario				
Lake Ontario Cement Limited	Picton	150,000	6	New cement grinding capability (2 roller mills)

Source: Mineral Development Sector.

ready-mix concrete. The case continued into 1974 and culminated with the conviction of all seven companies and with the imposition of heavy fines.

Canada Cement Lafarge Ltd. produces cement at Richmond on Lulu Island near Vancouver, British Columbia, using limestone barged down the Strait of Georgia from a quarry at Vananda on Texada Island. The plant was built in 1958, and later the capacity was doubled to the present 612,000 tons a year. A new plant with a capacity of over 210,000 tons a year began production in 1970 at Kamloops, British Columbia.

Ocean Cement & Supplies Ltd. quarries limestone at Bamberton on Vancouver Island for cement manufacture and for use as an aggregate. The cement plant has a capacity of about 700,000 tons a year and, quite likely, will be used as a terminal or to produce specialty cements with completion of the new facility on the mainland. Inland Cement Industries Limited and Ocean Cement & Supplies Ltd. are now operated as a cement division of Genstar.

Markets and trade

Cement markets are regional in scope and are centred in developing or growing urban areas where construction activity is concentrated, or in areas where mining or heavy engineering construction projects are being performed. The normal market area influenced by a given cement-producing plant is dependent on the amount of transportation cost that the selling price can absorb. A potential large volume of sales could warrant a secondary distribution terminal; water transportation to a distribution system could extend a plant's market area even farther. Because raw materials for cement manufacture are available in nearly all areas, most countries can supply their own cement requirements if the market volume warrants a plant. Few countries rely entirely on imports for their cement needs. However, some countries rely heavily on export markets for their cement production in order to operate facilities economically.

Specialty cements, such as white cement, are transported greater distances than ordinary grey portland cement, when the transportation costs do not represent as high a proportion of the landed price and when quantities are generally much smaller than for portland cement. Cement shortages in countries experiencing a buoyant surge in construction have lead to exceptions to the norm and have resulted in cement being shipped unusual distances, e.g., Norway shipped cement to United States during 1973 and Saudi Arabia was seeking 1 million tons from Canada during 1974.

Cement from plants in the United States and Canada is traded between the two countries where competition and tariffs permit. The 1973 situation in which record amounts of both cement and clinker were exported to the United States market was an anomally created by the combined effects of a cement shortage in parts of the United States and an extremely buoyant construction industry. A sliding economy had an immediate and strong effect on United States construction activity during 1974 and the cement industry in turn was forced to adjust to reduced demand for its product. Exports of portland cement from Canada to the United States were reduced by about 10 per cent in 1974. Canadian market areas are reflected in the distribution of shipments from Canadian producers, see Table 5. A depressed cement market in Canada followed that in the United States, with a most pronounced drop in production and shipments noted in early 1975.

Although cement is used mainly in the construction industry, significant amounts are used in the mining industry to consolidate backfill, where mining methods dictate. Amounts so used grew from about 5,000 tons in 1960 to a reported 231,000 tons in 1970, the increase being related to the mechanization of backfilling techniques and to research conducted with support from National Research Council's Industrial Research Assistance Program. In 1974 the amount so used was recorded as 191,503 tons in 17 operations.

The use of a gypsum-free portland cement in a new patented process for the production of cold-bonded iron ore pellets offers an interesting market possibility.

Outlook

Construction in Canada will continue to show an annual increase in value, and cement producers will have to compete with all producers of other building

Table 8. Planned capacity increases, cement plants

Company	Plant Location	Net Increase	Expected Date of Completion	Approximate Cost	Remarks
		(tons/year)		($ million)	
Atlantic					
Canada Cement Lafarge Ltd.	Brookfield	262,000		25	Capacity to be doubled.
Quebec					
Canada Cement Lafarge Ltd.	St. Constant	500,000	1975	25	Originally scheduled for completion during 1974.
	Montreal East	(900,000)	1976	13	General rehabilitation, 2 kilns to replace 7, wet process to dry process, effective capacity 500,000.
	Hull		1976	2	New finish grinding mills.
Ontario					
Lake Ontario Cement Limited	Picton	850,000	1975	15	New kiln (fourth).
St. Marys Cement Limited	St. Marys	700,000	1976	30	New kiln (sixth) and new mill.
Alberta					
Canada Cement Lafarge Ltd.	Exshaw	200,000	1975	30	New kiln (sixth), plant modernization and new quarry development.
British Columbia					
Ocean Construction Supplies Limited		750,000		60	New plant planned for undisclosed location on mainland.
Haida Cement Company Limited	New Westminster	330,000	1975	25	New plant planned.
		2,692,000		225	

Source: Mineral Development Sector.

materials to obtain a share of the construction dollar. Not only is practical research in the use of cement-concrete needed, but effective advertising and public relations must be used to encourage acceptance of modular construction at a time when reasonably priced, attractive and convenient housing units are in short supply. In general, modest gains are expected in the near-term with activity across the country expected to range from promising to cautious. The availability of other construction materials has played a major role in determining the amount of cement required for construction. Projects have been delayed because of

Table 9. Canada, house construction by province

	Starts			Completions			Under Construction		
	1973	1974	% diff.	1973	1974	% diff.	1973	1974	% diff.
Newfoundland	4,831	4,911	+ 2	4,478	4,446	− 1	3,737	4,173	+12
Prince Edward Island	2,122	1,334	−37	1,789	1,664	− 7	1,192	860	−28
Nova Scotia	7,734	6,008	−22	5,534	6,604	+19	7,117	6,349	−11
New Brunswick	7,235	5,861	−19	7,036	6,812	− 3	4,534	3,550	−22
Total (Atlantic Provinces)	21,922	18,114	−17	18,837	19,526	+ 4	16,580	14,932	−10
Quebec	59,550	51,642	−13	55,260	55,596	+ 6	39,280	31,487	−20
Ontario	110,536	85,503	−23	98,262	104,360	+ 6	98,566	78,517	−20
Manitoba	11,531	8,752	−24	10,727	12,164	+13	9,088	5,668	−38
Saskatchewan	6,386	7,684	+20	5,421	6,487	+20	3,876	5,001	+29
Alberta	20,977	19,008	− 9	23,470	21,570	− 8	12,734	9,940	−22
Total (Prairie Provinces)	38,894	35,444	− 9	39,618	40,221	+ 2	25,698	20,609	−20
British Columbia	37,627	31,420	−16	34,604	34,540		27,112	22,861	−16
Total Canada	268,529	222,123	−17	246,581	257,243	+ 4	207,236	168,406	−19

Source: Statistics Canada.

shortages of steel, rebar, gypsum products, etc., and shortages of certain materials could create problems again. Of particular concern in this regard will be sources of energy. Work stoppages have seriously delayed many construction projects. In general, labour relations in the construction industry have shown improvement with a mature and rational approach to labour-management problems which, hopefully, will continue and thereby do much to reduce the cyclical aspects of the industry. The shortage of skilled labour could reach problem proportions for the construction industry, if not generally, certainly in some regions as more and larger projects are undertaken.

The cement industry in Canada is capable of meeting the immediate demands on it and is in a position to expand in anticipation of even greater demand.

New plants are being built and existing ones are being expanded utilizing modern equipment and techniques of manufacture. New plant locations are situated with respect to both resource material and markets. The expense of adapting older facilities to meet newly imposed environmental control regulations can contribute to a decision in favour of a new plant — such decisions have forced a number of plant closures in the United States. Continued diversification and vertical integration by cement producers will eventually result in the write-off of some comparatively inefficient production capacity as the emphasis on a cement-concrete industry increases. Although individual companies continue to conduct research relative to cement production, much experimentation concerning the use of cement and concrete is done through the Portland Cement Association (PCA), an industry-supported, nonprofit organization whose purpose is to improve and extend the uses of cement and concrete through scientific research and engineering fieldwork. The Association is active in all parts of Canada, and can offer detailed information on concrete use, design and construction from its regional offices.

Reference should be made to a new cold processing method of cement manufacture in which no heat treatment is required other than in the production of quicklime. U.S. Patent No. 3,066,031 granted to C.J. Schifferle and assigned to J.J. Coney "stipulates that finely ground silicon dioxide and aluminium oxide mixed with calcium oxide can produce a cement of good quality when these components are subjected to a process of compounding".

Total value of construction expenditure in 1975 is estimated by the Canadian Construction Association at about $27 billion, an increase of approximately 13 per cent over 1974. Because of inflationary factors real growth is expected to be small. There will undoubtedly be regional weaknesses but housing construction will recover towards mid-1975 and will carry with it other associated projects. Engineering construction will continue reasonably strong with many long range carry over projects.

World review

Because of the direct relationship of cement, concrete, and construction, the production and, more particularly, the consumption of cement can be

Table 10. Canada, production of concrete products

	1973	1974p
Concrete bricks (number)	176,206,297	173,928,837
Concrete blocks (except chimney blocks)		
Gravel (number)	214,326,843	202,602,080
Other (number)	42,502,255	42,169,817
Concrete drain pipe, sewer pipe, water pipe and culvert tile (short tons)	1,555,674	2,095,362
Other precast products (short tons)	. .	139,524
Concrete, ready-mix (cubic yards)	17,351,556	17,830,645

Source: Statistics Canada.
p Preliminary; . . Not available.

Table 11. Canada, construction spending by provinces, 1973-75

	1973[1]	1974[2]	1975[3]
	(millions of dollars)		
Newfoundland	497.8	594.8	605.7
Prince Edward Island	115.3	109.8	108.7
Nova Scotia	620.8	694.0	745.5
New Brunswick	517.3	728.2	835.1
Quebec	4372.8	5519.0	6339.0
Ontario	7135.0	8402.4	9369.3
Manitoba	888.7	985.0	1021.2
Saskatchewan	699.8	918.2	1075.6
Alberta	2333.8	2749.4	3265.1
British Columbia	2678.8	3115.0	3513.4
Yukon and Northwest Territories	309.4	397.2	369.1
Canada	20,169.5	24,213.0	27,247.7

Source: Statistics Canada.
[1]Final. [2] Preliminary. [3] Forecast.

monitored as an indication of a country's rate of development.

World production was estimated to be just over 770 million tons, down from 780 million in 1973. Even greater additions to production capacities than those witnessed during the past few years will be needed to meet demand in many developing countries. The following items are indicative of trends in the regions noted, but in no way represent a total coverage.

Asia. In Japan, a supply-demand imbalance developed during 1974 within the cement-concrete-construction complex as consumption levelled at about 6 million tons a month, while productive capacity grew to around 108 million tons a year. Production cutbacks were evident as, following relaxation of the Government price freeze on cement on September 20, prices were permitted to increase an average of 17.4 per cent.

A flash calcining process developed by Ishikawajima-Harima Heavy Industries Co. Ltd. of Japan is to be distributed by Fuller Co. (GATX). The system includes a suspension preheater, a flash furnace, a rotary kiln and a recuperative clinker cooler. Raw meal is calcined in the flash furnace at 1,600°F, removing 90 per cent of the CO_2 and allowing greater capacity put through with no increase in kiln size.

Ssangyong Cement (Singapore) PTE Ltd., jointly owned by Ssangyong Cement Ind. Co. Ltd. of Seoul, Korea, the Development Bank of Singapore and Afro-Asia Shipping Co. PTE Ltd., is to install a 4,000 hp finish mill along with storage and packaging equipment. The $3 million contract is with Fuller Co. (GATX). In Korea Ssangyong plans to double its capacity.

Table 12. World production of cement, 1963-73

	1963	1973p	Increase
	(thousand short tons)		(%)
U.S.S.R.	67,260	120,703	79
United States	69,260	87,498	26
Japan	33,012	86,007	161
West Germany	32,206	45,040	40
Italy	24,348	39,961	64
People's Republic of China	11,023	33,880	207
France	19,989	33,863	69
Spain	8,541	24,511	187
United Kingdom	15,498	22,037	42
Poland	8,459	17,143	103
India	10,312	16,535	60
Brazil	5,714	14,709	157
East Germany	6,016	12,125	102
Canada	7,014	11,126	59
Other countries	97,990	215,448	120
Total	416,642	780,586	

Sources: Statistics Canada, U.S. Bureau of Mines *Minerals Yearbook, 1965* for 1963 *and 1973* for 1973.
p Preliminary.

Cement productive capacity in Thailand is to be increased to 6.8 million tons a year from the current 4.3 million tons. Siam Cement Co. will increase capacities at two of its four plants, while Jalaprathan Cement Co. Ltd. will enlarge both of its plants. A new company, Thai Sathapana Co. Ltd., will build a new 1,000-ton-a-day plant.

In 1973, India's cement producing capacity was 19.75 million metric tons a year. The Government of India's fifth 5-year plan calls for production of 25 million tons a year by 1978. This equates to 85 per cent utilization of installed capacity of 29 million tons by that time. Capacity increases are scheduled for the government-owned Cement Corp. of India for the State sector and for the private sector. Official domestic cost allowances and pricing structure set the price of cement at $U.S. 32.51 a metric ton effective September 1, 1973. India continues its program of accelerating cement exports.

The Government of Iraq plans a four kiln cement plant with a total capacity of 2.2 million tons a year at a cost of $225 million for 1978. The turnkey contract is with F.L. Smidth & Co.

The Bodoosh cement plant in northern Iraq will boost capacity by 1,500 tons a day with the incorporation of the Polysius A.G. dry process system. Original equipment consisted of two wet process kilns of 600 tons a day capacity.

Saudi Cement Corp. of Dammam, Saudi Arabia plans the expansion of its Hoffuf plant by 1 million metric tons a year at a cost of $80 million. The turnkey contract is with Polysius A.G. of West Germany. Two 1,500-metric-ton-a-day kilns will be added, along with the modernization of three existing kilns.

Table 13. Apparent consumption of cement by the leading producers, 1973

	Production^{p}	Apparent Consumption	lb/ capita
	(thousand short tons)		
U.S.S.R.	120,703	117,591	942
United States	87,498	85,806	816
Japan	86,007	8,537	1,577
West Germany	45,040	43,773	1,411
Italy	39,961	39,339	1,433
People's Republic of China	33,880	21,109	53
France	33,868	32,950	1,263
Spain	24,511	23,801	1,365
United Kingdom	22,037	22,067	787
Poland	17,143	18,744	1,125
India	16,535	16,402	57
Brazil	14,709	14,892	293
East Germany	12,125	10,303	1,213
Canada	11,126	9,977	904
Other countries	215,448		
Total	780,586		

Sources: Statistics Canada, U.S. Bureau of Mines *Minerals Yearbook, 1973* Cembureau Statistical Review, 1973.
^{p} Preliminary.

Europe. The Halkis Cement Co. S.A. of Athens, Greece is adding an extensive materials handling system to facilitate shipment of up to 2.7 million tons a year. Ship loading and unloading equipment is being installed by GEC — Elliott Mechanical Handling Ltd. of U.K. The Greek Government lifted the export ban on cement in November, 1973 that had been proclaimed in May 1973 in order to satisfy domestic cement requirements.

With completion of a current expansion program, Chalkis Cement Co., S.A. of Greece will have four plants with individual capacities of 1 million tons a year. Titan Cement Co. produced 2.8 million tons in 1973 and expanded its Patras harbour facilities to accommodate 20,000 ton ships. A new 700,000-tons-a-year plant at Drepanon. Patras was put on stream in 1973 and a new 1-million-tons-a-year plant is underway.

Yugoslavia, at present a net importer of cement, is planning an 850,000-tons-a-year plant. The $70 million plant will be built by Salonit Anhovo Industrija Gradbenega Materiala.

Table 14. Cement production per capita, leading countries, 1963 and 1973

	1963	1973	Increase
	(pounds)		(%)
Bahamas	. .	11,063	. .
Qatar	. .	6,222	. .
Luxembourg	1,381	2,017	46
Switzerland	1,368	1,974	44
Austria	1,018	1,833	80
Belgium	1,117	1,591	42
Japan	688	1,588	131
Greece	596	1,587	166
Cyprus	359	1,556	333
Norway	864	1,503	74

Sources: Calculated from production figures in U.S. Bureau of Mines *Minerals Yearbook 1965 and 1973,* and population statistics in United Nations Monthly Bulletin of Statistics, 1965 and 1975.
. . Not available.

Oceania. The Philippine Government stopped all exports of cement effective December 13, 1973, except for some long-range sales commitments, because of the petroleum shortage. Cement manufacture consumed 16 per cent of the countries bunker fuel oil while 20 to 25 per cent of its cement production was exported.

South America. In Colombia, Cementos Boyaca, S.A. plans to expand from 360,000 to 520,000 tons a year capacity at a cost of over $7 million. Holderbank of Switzerland controls 49 per cent of this firm, with 51 per cent being Colombian owned.

Venezolana de Cementos has built a 1.8-million-tons-a-year plant at Pertigalete in Anzoatequi state.

Table 15. Apparent consumption of cement, 1973 – leading consumers

	Consumption	Consumption per capita
	(000 short tons)	(lb)
U.S.S.R.	117,591	942
United States	85,806	816
West Germany	43,773	1,411
Italy	39,339	1,433
France	32,950	1,263
Spain	23,801	1,365
United Kingdom	22,067	787
People's Republic of China	21,109	53
Poland	18,744	1,125
India	16,402	57
Brazil	14,892	293
Mexico	10,505	388
East Germany	10,303	1,213
Czechoslovakia	10,036	1,376
Canada	9,977	904

Source: Cembureau Statistical Review, 1973.

Venezuela produces about 3 million tons a year and consumes about 90 per cent of this amount, giveing impetus to further expansion plans for Pertigalete and to plan for a new 750,000-tons-a-year plant at Maracaibo.

North America. To meet the projected demands of industrial expansion in the late 1950s, many cement companies added to their production capacities with the result that the North American industry developed a total capacity in excess of that required to meet the demand. The cement industry had to "sell" its product by providing services and technical assistance to consumers and by researching new and competitive construction uses for concrete. Vertical integration, diversification and mergers, although always a part of

Table 16. Per capita apparent consumption of cement, 1973 – leading countries

	Apparent Consumption lb/capita
Nigeria	4,240
Qatar	3,821
Guam	2,646
Andorra	2,426
Kuwait	2,128
Luxembourg	2,073
Switzerland	2,015
Libyan Arab Republic	1,910
Austria	1,713
Bermuda	1,654
Japan — Ryukyu Islands	1,577
Cyprus	1,557
New Caledonia	1,526
Greece	1,493
Rhodesia	1,484

Source: Cembureau Statistical Review, 1973.
Note: Canada ranks forty-first.

Table 17. Cement, world production and capacity

Country	Annual Capacity^{e} 1974	1973	1974^{e}
	(thousands short tons)		
United States (incl. Puerto Rico)	95,000	87,498	86,000
Canada (shipments)	18,000	11,126	11,308
Other North America (except Cuba)	19,000	15,202	15,000
Total North America	132,000	113,826	112,308
South America	38,000	33,257	34,000
Europe(free)	270,000	224,021	220,000
Asia (free)	180,000	158,134	155,000
Africa	30,000	23,648	24,000
Oceania	8,000	7,050	7,000
Communist countries (except Yugoslavia)	255,000	220,650	220,000
World total	913,000	780,586	772,308

Source: U.S. Bureau of Mines, Commodity Data Summaries, January, 1975.
^{e} Estimated.
Note: Canada's estimated capacity is high, see Table 3. Estimate has been left to relate to others.

the cement industry, have become more common on the North American scene.

About 15 per cent of world cement production comes from North America, with the United States contributing nearly 80 per cent of the total, and Canada and Mexico following in that order. Numerous plant changes and additions have been announced throughout the industry in North America. Virtually all plants are undergoing some modernization and improvement of dust-collecting facilities because of new or anticipated pollution control standards and a few plants in the United States have cited this as a reason for closure. Canada's cement capacity, together with that planned to come on stream during the next two years, permits export of clinker and cement without harm to domestic markets. A realistic, practical production capacity, as opposed to a listed capacity, would probably indicate surprisingly little excess production capability in Canada's cement industry. This would be especially obvious in certain regions of the country, and at the height of activity during a construction year.

In the United States, low prices, high costs, low profit margins, under capacity complicated by a downturn in construction activity and intentions are of major concern to the cement industry. The energy situation will undoubtedly have an influence on these items either directly or indirectly, as will environment regulations. Three new plants were opened in 1974 in the United States, with a combined capacity of 1.315 million tons a year. Ten major expansions added 3.8 million tons. For 1975 three new plants are to come on stream and with 12 major expansions will increase capacity by a total of 4.365 million tons. Current plans are to bring an additional 6.215 tons capacity on stream by 1977.

Table 18. Canada, value of construction by province, 1973-74

	1973			1974[1]		
	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total
	(thousands of dollars)					
Newfoundland	211,809	259,604	471,413	261,512	252,253	513,765
Nova Scotia	311,965	311,647	623,612	375,659	333,593	709,252
New Brunswick	296,644	197,519	494,163	335,088	285,578	620,666
Prince Edward Island	73,821	34,658	108,479	80,781	37,821	118,602
Quebec	2,739,374	1,618,592	4,357,966	3,185,605	1,878,016	5,063,621
Ontario	4,990,204	2,247,318	7,237,522	5,674,807	2,605,517	8,280,324
Manitoba	502,857	385,636	888,493	552,967	416,951	969,918
Saskatchewan	354,402	351,432	705,834	414,445	364,874	779,319
Alberta	999,512	1,273,228	2,272,740	1,085,137	1,570,307	2,655,444
British Columbia, Yukon, Northwest Territories	1,648,909	1,329,151	2,978,060	1,844,843	1,597,592	3,442,435
Canada	12,129,497	8,008,785	20,138,282	13,810,844	9,342,502	23,153,346

Source: Statistics Canada.
[1] Intentions.

Table 19. Value of construction in Canada, 1972-74

	1972	1973	1974[1]	Change 1973-1974
			(millions of dollars)	(%)
Building construction				
Residential	5,870.6	7,133.0	7,863.6	+ 10.2
Industrial	926.7	1,075.8	1,275.3	+ 18.5
Commercial	1,706.2	2,089.1	2,598.1	+ 24.4
Institutional	1,249.3	1,151.5	1,240.1	+ 7.7
Other building	574.7	680.1	833.7	+ 22.6
Total	10,327.5	12,129.5	13,810.8	+ 13.9

Table 19 (concl'd)

Engineering construction				
Marine	145.6	149.9	181.9	+ 21.4
Highways, aerodromes	1,670.8	1,872.1	2,110.2	+ 12.7
Waterworks, sewage systems	714.3	831.5	1,002.6	+ 20.6
Dams, irrigation	77.9	87.0	110.6	+ 27.1
Electric power	1,235.2	1,609.3	1,834.8	+14.0
Railway, telephones	666.1	795.0	939.7	+18.2
Gas and oil facilities	1,385.7	1,531.2	1,833.0	+ 19.7
Other engineering	1,065.8	1,132.8	1,329.7	+ 17.4
Total	6,961.4	8,008.8	9,342.5	+ 16.7
Total construction	17,288.9	20,138.3	23,153.3	+ 15.0

Source: Statistics Canada.
[1] Intentions.

Tariffs

Canada Item No.		British Preferential (¢)	Most Favoured Nation (¢)	General (¢)
29000-1	Portland and other hydraulic cement, nop; cement clinker per 100 lb	free	free	6
29005-1	White, nonstaining portland cement, per 100 lb	4	4	8

United States Item No.		On and After Jan. 1, 1972 (¢ per 100 lb incl. weight of container)
511.11	White nonstaining portland cement	1
511.14	Other cement and cement clinker	free
		(%)
511.21	Hydraulic cement concrete	free
511.25	Other concrete mixed	7.5

Sources: For Canada, the Customs Tariff and Amendments, Department of Nationl Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Chromium

R.F. JOHNSON

Canada has no economically mineable deposits of chrome ore (chromite). Following the closure of Union Carbide Canada Limited's ferrochrome plant in 1974, the only commercial products made in Canada that contain chromium are chromium and chromium-magnesite refractories. Demand for chromium products was high in 1974.

Chromite was in short supply during 1974 as a number of disruptions, both natural and political, created marketing difficulties. The political situation in southern Africa was the major cause of most of the difficulties. As a result, chromite prices rose sharply during the year. Ferrochromium was also in short supply.

Demand for chromite and ferrochromium is expected to fall in 1975 after consumers rebuild inventories. Prices should remain stable during 1975. Demand is expected to rise in the first half of 1976.

Canada

There are two principal areas of chromite mineralization in Canada: the Bird River area in Manitoba and the Eastern Townships in Quebec. The Bird River deposits are a continuous band of chromite mineralization, similar in type to the important chrome deposits in Rhodesia and the Republic of South Africa. However, most of the mineralization is low grade, 10-20 per cent chromic oxide (Cr_2O_3) and has a low iron-to-chromium ratio. This is undesirable in that the ores are difficult to beneficiate to a marketable product. The Ontario Research Foundation has developed a process for upgrading the Bird River chromite to a marketable product and partially as a result of this, the Manitoba Department of Mines, Resources and Environmental Management is currently conducting a re-evaluation of the Bird River deposits. Deposits in the Eastern Townships are discontinuous or podiform deposits. These deposits were exploited earlier in the century and during the Second World War. While these deposits are generally satisfactory in grade and composition, the tonnages are too small to be considered economical. The large number of claim owners in this area discourages major efforts to determine if there are larger deposits at depth.

Union Carbide Canada Limited, which was Canada's only producer of ferrochromium, closed its Welland, Ontario ferroalloy plant in late 1974. The seven furnaces situated at Welland are small and outdated; and the cost of installing pollution control equipment would make the operations uneconomic. The plant was to be replaced by a large ferromanganese furnace but, since Union Carbide was unable to obtain a long-term contract for electrical power from Ontario Hydro, the ferromanganese furnace was subsequently located at Beauharnois in Quebec. Union Carbide will be able to continue sales into 1975 until accumulated stocks are depleted.

Canadian consumption of ferrochromium was 28,380 tons in 1973, compared with 24, 975 tons in 1972. In 1973 the principal consumers were: Atlas Steels Division of Rio Algom Mines Limited; Canron Limited; Colt Industries (Canada) Ltd.; The Steel Company of Canada, Limited and The Algoma Steel Corporation, Limited. In recent years, the ratio of high-carbon ferrochrome to low-carbon ferrochrome consumed has been about 2:1. Atlas Steels, Canada's largest producer of stainless steel, announced that its present melt shop at Welland, will be replaced by a new one in 1977 that will increase ingot capacity to 320,000 tons a year from the current 250,000 tons a year. This will lead to an increase in stainless steel production and an increase in ferrochromium consumption.

Canadian consumption of chrome ore in 1973 was 38,030 tons compared with 62,713 tons the previous year. The decrease in consumption is largely because of the closure of Union Carbide's ferroalloy plant at Welland. The two major consumers in 1973 were Canadian Refractories Division of Dresser Industries Canada, Ltd., and General Refractories Company of Canada Limited. Both companies manufacture refractories.

At present, there is only one important consumer of chromium metal in Canada — Deloro Stellite Division of Canadian Oxygen Limited, Belleville, Ontario. The International Nickel Company of Canada, Limited (Inco) plans to build a rolling mill at Sudbury, Ontario. The capacity is estimated to be in the order of 20 million pounds of strip a year made from nickel-copper alloy powders. A number of nickel alloys contain chromium, and it is possible that chromium metal consumption in Canada will increase significantly on completion of the plant in 1977.

Canadian imports of ferrochrome will rise as Union Carbide's stocks become depleted. Demand is expected to rise to about 50,000 tons a year by 1980 and the bulk of the imports will probably come from Republic of South Africa. If Inco's new rolling mill does utilize chromium powders, the probable source of the imports will be the United States.

Table 1. Canada, chromium trade and consumption, 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Imports				
Chromium in ores and concentrates				
United States	9,476	845,000	24,319	1,907,000
Philippines	11,778	816,000	3,757	301,000
Republic of South Africa	2,580	80,000	2,669	125,000
Other countries[1]	3,763	352,000	975	98,000
Total	27,597	2,093,000	31,720	2,431,000
Ferrochromium				
Republic of South Africa	25,142	5,451,000	29,380	7,733,000
United States	7,406	2,325,000	5,596	2,795,000
Brazil	2,862	499,000	4,842	1,426,000
Other countries[2]	2,870	911,000	1,400	913,000
Total	38,280	9,186,000	41,218	12,867,000
Chromium sulphates, including basic				
United States	837	228,000	962	332,000
United Kingdom	225	47,000	106	31,000
People's Republic of China	–	–	2	1,000
Japan	111	24,000	–	–
Total	1,173	299,000	1,070	364,000
Chromium oxides and hydroxides				
United States	622	457,000	1,000	969,000
France	636	415,000	389	314,000
United Kingdom	207	149,000	110	86,000
Other countries[3]	154	116,000	60	63,000
Total	1,619	1,137,000	1,559	1,432,000
Chrome dyestuffs				
United States	22	65,000	31	77,000
Switzerland	28	44,000	2	13,000
Other countries[4]	28	111,000	16	94,000
Total	78	220,000	49	184,000

Source: Statistics Canada.
[1] Cyprus.
[2] Includes United Kingdom, Greece, Sweden, Yugoslavia.
[3] Includes West Germany, People's Republic of China, Netherlands, Belgium and Luxembourg and Japan.
[4] Includes West Germany, Netherlands, Japan and United Kingdom.
p Preliminary; – Nil.

World production, trade and developments

World production of chromite (chrome ore) contained an estimated 2.77 million metric tons of Cr_2O_3 in 1973. The world trade in chrome ores and concentrates was estimated at 4.3 million metric tons (gross weight) in 1973.

Several developments in 1974 caused prices to rise sharply. The major developments arose from difficulties in southern Africa and may presage future areas of concern for both producers and consumers.

Shipping difficulties in southern Africa aggravated an already tight-supply situation in 1974. Overcrowding at the ports of Lourenco Marques and Beira in Mozambique caused disruptions in chrome ore deliveries in June, July and August. Lourenco Marques and Beira are the principal exporting ports for the mineral industries of the Transvaal (Republic of South Africa) and Rhodesia. A shortage of stocking facilities at the ports and slow-loading times together with strikes resulted in a large backlog of shipments. Other products, such as vanadium pentoxide and ferroalloys, were shipped preferentially because of their higher unit values in comparison with chrome ore. The backlog while partially eliminated before year-end is expected to continue through 1975.

Early in 1974, a discrepancy was apparent between official import figures of chrome ore by Japan from the

Table 2. Canada, chromium trade and consumption, 1965-74

	Imports		Exports	Consumption[2]	
	Chromite[1]	Ferro-chromium[2]	Ferro-chromium[2]	Chromite	Ferro-chromium
	(short tons)		(short tons)	(short tons)	
1965	35,408	15,336	205	69,105	12,903
1966	20,880	12,536	35	64,550	17,200
1967	34,485	21,740	–	70,549	19,557
1968	22,401	15,045	1	77,075	45,696
1969	41,924	25,123	..	68,484	25,035
1970	30,445	22,943	..	61,963	31,257
1971	32,716	39,906	..	61,313	22,861
1972	24,728	15,204	..	62,712	24,975
1973	27,597	38,280	..	38,030	28,380
1974^p	31,720	41,218	..	66,658	..

Source: Statistics Canada.
[1] Chromium content. [2] Gross weight.
^{p} Preliminary; – Nil; .. Not available.

Republic of South Africa and official export figures of chrome ore by Republic of South Africa to Japan. The difference, about 200,000 tons, originated in Rhodesia despite Japanese support of trade sanctions against Rhodesia. As a result, realignment of supplies by Japan put a strain on world supplies.

The political uncertainty in Rhodesia came into prominence in 1974. All parties seem to be willing to negotiate a political settlement on black majority rule in Rhodesia; however, prospects for a quick settlement appear dim. Because of Rhodesia's racial policy, the move to reimpose the chrome embargo on Rhodesian ore by the United States gained strength during the year and indications are that an embargo will be placed on Rhodesian chromite in 1975. This would place considerable stress on supplies from other sources of metallurgical grade chromite (U.S.S.R. and Turkey) as the United States will have to find alternative sources for the ore and ferrochrome currently imported from Rhodesia.

The gaining of independence by Mozambique from Portugal will cause further chromite supply problems in the future as Mozambique may close the Rhodesian consulates in Lourenco Marques and Beira. In the past, the Rhodesian consuls in Mozambique have been important middlemen in arranging the sales of chrome ore to countries supporting the UN sanctions and the disruption will have a disruptive effect, at least in the short-term. Also, Mozambique, which is dependent for much of its foreign exchange earnings on the transshipments of South African and Rhodesian goods, may require some certification of origin of chromite and chrome products shipped from Republic of South Africa.

One of the proposals placed before the recent Commonwealth Conference was to compensate Mozambique for foreign exchange losses if the embargo against shipping Rhodesian goods is rigorously enforced. A similar proposal will likely be put to the United Nations.

If the United States reimposes the embargo against Rhodesian goods, Cuba is a possible alternate source. The Organization of American States is nearing agreement on a formula that will lead to the lifting of the trade embargo against Cuba in 1975. Cuban production is about 35,000 tons a year and should triple to about 100,000 tons a year by 1978. In 1974, Cuba reportedly made sales to Europe of ore averaging 44 per cent Cr_2O_3.

In Malagasy, a cave-in at the Bemanevika open-pit mine of Compagnie Minière d'Andriamena (Comina) resulted in suspension of open-pit operations slightly ahead of schedule, but ore had been stockpiled in anticipation of the changeover to underground operations in 1975. The new mine will have about two thirds of the capacity of the open-pit mine with a consequent production loss of about 20,000 tons a year. European and Japanese interests are currently engaged in detailed exploration of a potential ore zone in central Malagasy.

A new project, which will produce some 120,000 tons a year of chrome concentrate, is scheduled to begin production in the Limoeria area of Brazil in 1976. Serjana, a Brazilian-Japanese company, will develop the deposit with shipments initially going to Japan. Production at the Pedrinhas mine of Ferbasa, Brazil's only producer of chrome ore, fell sharply below expectations following start-up problems with the new concentrator and a cave-in at the mine site.

India expects its ferrochrome consumption to double to about 45,000 tons a year by 1980, and a recommendation has been put forward to reduce

Table 3. Estimated production of chromic oxide (Cr_2O_3) in chrome ores and concentrates, 1973

Country	Production (000,000 tons Cr_2O_3)
Malagasy	0.07
Republic of South Africa	0.69
Rhodesia	0.20
India	0.11
Philippines	0.21
Albania	0.19
U.S.S.R.	0.87
Finland	0.06
Greece	0.01
Cyprus	0.01
Turkey	0.21
Iran	0.07
Brazil	0.02
Other	0.05
Total	2.77

Source: Various publications; estimates of Cr_2O_3 by the Mineral Development Sector.

exports of higher grade ores. The bulk of Indian ore is exported to Japan.

The outbreak of civil war in Cyprus caused a suspension of mining activity in the fall of 1974. Shipments of chromite were not restored by the end of the year.

In 1970, Etibank, Turkey's state-owned mining company, signed a contract with Japan Metals and Chemical Corporation (JMC) to deliver one million tons of chrome ore over a ten-year period. As part of the contract, JMC supplied Etibank with two electric furnaces capable of producing high-carbon ferrochrome at the rate of 25,000 tons a year. Only a small part of this contract has been accepted but, with the opening of the Suez Canal in June 1975 and the reduction of Japanese chrome imports from Rhodesia, increasing amounts of this contract will be taken in the next several years. Etibank will start up its Kef chromite project near Diyarbakir in eastern Turkey at the end of 1975. The project will produce about 135,000 tons of chrome concentrates a year; half of which is to be exported and half of which will go to a new ferrochrome plant near Elazig scheduled to begin production in 1976. Technical assistance in the construction of the ferrochrome plant, which will produce about 55,000 tons a year, is being supplied by the Japanese company, Mitsubishi Corporation.

The Republic of South Africa will increase its ferrochrome capacity by 400,000 tons a year by 1978. Announcements were made during the year that two new ferrochrome plants would begin production in 1977 and that facilities at two existing plants would be expanded. The two new plants are Tubatse Ferrochrome — a company formed by Union Carbide Corporation and General Mining and Finance Corporation, and a new company formed by Johannesburg Consolidated Investment Company (JCI) and Showa Denko Kahan Kaisha. Both plants will begin production in 1977, each with a rated annual capacity of 130,000 tons. Once production from Tubatse commences, Union Carbide will change over its Marietta Ohio plant from ferrochrome to ferromanganese production and supply the United States market with production from Tubatse. Showa Denko will take 35,000 tons a year from the production of the Showa Denko — JCI plant for marketing in Japan. The facilities will be expanded at Amcor Ltd., and Feralloys Limited, a subsidiary of The Associated Manganese Mines of South Africa Limited. Amcor will begin production of 60,000 tons a year of ferrochrome with the production being under long-term contract to two Japanese consumers. Negotiations for installation of a second furnace are underway with Japanese consumers. Feralloys expansion is scheduled for completion in 1976.

The U.S.S.R. is asking for bids on a ferroalloy complex that is scheduled to produce 350,000 tons a year of charge chrome from 850,000 tons of chromite. Several ferroalloy producers have been approached for technical assistance on the project. Financial assistance is being sought from subsidy programs such as the one sponsored by the U.S. Export-Import Bank. The U.S.S.R. would probably like to repay part of the cost of the financial and/or technical assistance with ferroalloys. The projected completion date for the complex is 1980.

In September 1974, Tasmanian Electro-Metallurgical Company Ltd., a subsidiary of The Broken Hill Proprietary Company Limited of Australia, began production of ferrochrome at its Bell Bay, Tasmania plant. The company expects to consume about 100,000 tons a year of chrome ores and concentrates. The initial supply contract has been signed with Iran.

Grades of ore

The only commercially important ore of chromium (Cr) is chromite. Chromite ores contain varying amounts of iron (Fe), magnesium (Mg) and aluminum (Al). The general formula of chromite is $(Fe,Mg)O(Cr,Fe,Al)_2O_3$. There are three principal grades of ore, namely metallurgical, refractory and chemical.

Use and technology

Metallurgical grade chromite is used primarily in the production of ferroalloys. Some metallurgical grade chromite is used in the production of chromium metal. The principal ferroalloys produced are high-carbon (HC) ferrochromium, low-carbon (LC) ferrochromium and ferrochromium-silicon.

As a constituent of iron castings, steels and superalloys, chromium increases resistance to oxidation and corrosion and increases the ability to withstand stress at high temperatures. In addition, chromium helps to refine the grain structure in iron castings.

Table 4. Estimated trade in chrome ore and concentrates, 1973

Exporting Region	Importing Region Japan	United States	Western[1] Europe (estimated)	Eastern Europe and China (estimated)	Total
			(000 metric tons)		
Republic of South Africa	420	275	510	–	1,205
Rhodesia	200[e]	39	. . .	–	239
Philippines	115	173	100	–	388
U.S.S.R.	95	220	560	325	1,200
Turkey	45	119	215	–	379
India	221	–	–	–	221
Iran	12	–	65	–	77
Albania	7	–	195	120	322
Cyprus	–	–	40	–	40
Malagasy	–	–	120	–	120
Brazil	36	–	–	–	36
Finland	–	–	30	–	30
Greece	–	–	17	–	17
Sudan	12	–	13	–	25
Total	1,163	826	1,865	445	4,299

Sources: Mineral Industry Surveys: Chromium, December 1973 and December 1974. Commodity Trade Statistics, United Nations, 1973.
[1] Includes Yugoslavia.
[e] Estimated; – Nil; . . . . if any, included in the Republic of South Africa.

The principal use of chromium ferroalloys is in the production of stainless and heat-resisting steels. Most applications of stainless and heat-resisting steels are in corrosive environments, e.g., petrochemical processing; high-temperature environments, e.g., turbines and furnace parts; and consumer goods areas e.g., cutlery and decorative trim. Chromium is added to alloy and tools steels to increase hardenability and to improve some mechanical properties such as yield strength. Superalloys containing chromium have a high degree of resistance to oxidation and corrosion at elevated temperatures and are used in jet engines, gas turbines and chemical processing. Chromium containing castings are usually used for high-temperature applications.

The development of the argon-oxygen decarburization (AOD) step in the manufacture of stainless and heat-resisting steels has prompted major changes in chromium usage. The AOD process, which was developed by Union Carbide Corporation and Joslyn Stainless Steels, Division of Joslyn Mfg. & Supply Co., is essentially a refining step after the charge has been melted down. Argon, an inert gas, is used along with oxygen so that carbon instead of chromium will be preferentially oxidized. Among other benefits, this serves to increase the recovery of chromium in the steels.

The ability to use charge chrome, which requires less energy to produce than the other chromium ferroalloys, and the reduction in the total amount of ferroalloys required should lead to a quick adoption of technologies similar to the AOD step. The overall advantages obtained are lower cost of chromium

Table 5. Specifications and grades of chromite

Grade	Chromic Oxide (Cr_2O_3) content	Cr:Fe ratio	Other requirements
Metallurgical	>46%	>3:1	<5% silica (SiO_2)
Refractory	35-40%	>3:1	<6% silica, alumina (Al_2O_3) and chromic oxide content should be 57-63% <12% iron (FeO)
Chemical	>44%	>1.5:1	<15% alumina <5% silica <20% iron

Source: Mineral Development Sector.

Table 6. Composition and power consumption rates for chromium ferroalloys

Ferroalloy	Chromium	Carbon	Silicon	Power Consumption Rates
	(%)	(%)	(%)	(kwh/ton)
Charge chrome	52-58	6-8	..	4,050[1]
HC Ferrochromium	66-77	4-6	1-2	4,500[2]
LC Ferrochromium	65-70	<0.06	<1.5	8,000[2]
Ferrochromium-silicon	33-36	<0.05	45-48	8,600[2]

[1] From *Metal Bulletin Monthly*, February 1974.
[2] From *Metal Bulletin*, June 7, 1974.
.. Not available.

additions and in major stainless steel producing countries where electricity is expensive or in short supply, some savings in energy consumption for the production of ferroalloys. Another process, similar to AOD refining, is the Creusot-Loire-Uddleholm (CLU) process which is being developed commercially by some European steelmakers.

In effect, this means that the growth rate of chromium usage will be less than that of stainless steel because of the more efficient use of chromium additions.

The refractory industry uses chromium in the form of chromite principally in the manufacture of refractory bricks. Some chromite is employed for refractory purposes in mortars and in ramming, castable and gunning mixes, or directly for furnace repair.

Refractories composed of both chromite and magnesite are used principally in applications where basic slags and dust are encountered. The principal areas of use are in the ferrous and nonferrous metal industries. In the ferrous industry, chrome-magnesite brick is used in the basic open hearth and basic electric furnaces. The declining importance of the basic open hearth in steelmaking has led to a decline in the amount of chromite used as a refractory in the steel industry. The continuing decline in open-hearth production will be partially compensated for by the increase in electric furnace production and a slower decline or, possibly, a stabilization of chromite refractory consumption in the steel industry should result in the next few years. In the nonferrous industry, chrome-magnesite brick finds its principal use in converters. If oxygen-blowing in converters becomes economically feasible, the higher operating temperatures generated may necessitate a change to a higher magnesite content brick and thereby decrease chromite refractory usage.

The glass industry uses some chrome-magnesite brick in the reheating chambers of glass furnaces, and the kraft paper industry uses a dense chromite brick in recovery furnaces to resist chemical attack by spent liquors.

Chromite mortars and gunning mixes are used in the bonding and coating of basic bricks or in areas where separation of various types of bricks by a chemically neutral substance is desirable. Castables and ramming mixes find their chief use in the open-hearth furnace.

Chromium chemicals have a wide variety of uses in a number of industries. Most chromium chemicals are derived from sodium dichromate, which is manufactured directly from chemical-grade chromite. The principal uses of chromium compounds are: in pigments, as mordants and dyes in the textile industry; as a tanning agent for all types of leathers; and in chrome electroplating, anodizing and dipping of various products. Among other uses, chromium compounds are used as oxidants and catalysts in the manufacture of various products such as saccharin; in the bleaching

Table 7. Comparison of chromium consumption in an 18-8 stainless steel between AOD and pre-AOD steelmaking methods

	Pre-AOD		AOD	
	Gross Weight	Chromium Content[e]	Gross Weight	Chromium Content[e]
	(1 lb of alloy/ton of steel)			
Addition agent				
HC Ferrochromium[1]	114	79	209	115
LC Ferrochromium	73	46	9	6
Ferrochromium silicon	149	51	29	10
Total	336	176	247	131

Source: *Metals Week*, February 25, 1974.
[1] Average grade: pre-AOD 69-70 per cent Cr and AOD 52-58 per cent Cr (charge chrome).
[e] Estimated.

and purification of oils, fats and chemicals; and as an agent to promote the water insolubility of various products such as glues, inks and gels.

Prices

Chromite prices experienced two significant upturns during 1974 and early 1975. The first, in the March-April period, was a result of the disclosure of the extent of Japanese chromite imports from Rhodesia. The Japanese sought to obtain supplies of metallurgical grade chromite from other sources to compensate for this loss (about 200,000 tons) and this caused the prices of Russian and Turkish ore, particularly, to rise. The second, in the December 1974 – January 1975 period, followed the November elections in the United States. A more liberal Congress was elected and passage of a bill to reimpose the embargo on Rhodesian chromite seemed likely. Chromite prices rose rapidly in the expectation that the United States would then have to replace the metallurgical-grade chromite previously imported from Rhodesia with chromite from alternate sources, principally Turkey and the U.S.S.R.

Transvaal chromite experienced a price increase in the July – September period as a result of the shipping difficulties in the ports of Mozambique. Turkish chromite increased in the June – October period, probably as a result of the strained relations between Turkey and the United States arising out of the Cyprus situation.

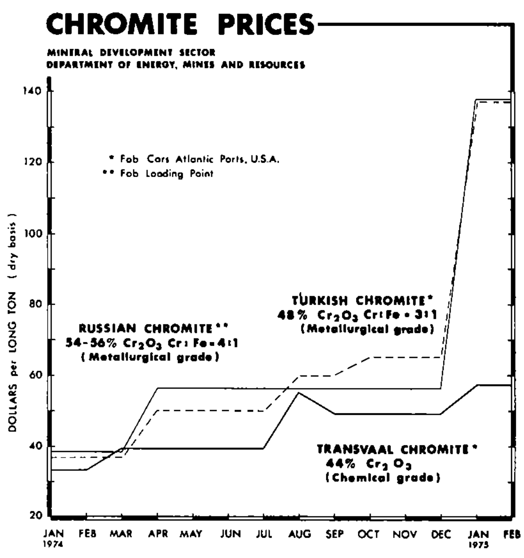
Ferrochrome prices generally moved in response to changes in the chromite price. The disruptions in chromite supply, particularly the reduced shipments of chromite through Mozambique in July and August, forced some ferrochrome producers in Europe to declare a force majeure on shipments. This situation was eased slightly by a 25 per cent cutback in stainless steel production in Japan in September. This cutback in stainless steel production coincided with the cave-in at the Pedrinhas mine in Brazil that would have, by itself, probably caused an increase in chromite prices. This enabled Japan to export an estimated 50,000 tons of ferrochrome by year-end and this served to moderate price increases.

Outlook

Chromite demand will continue to decline in the second half of 1975 because of the depressed state of the world steel industry; however, prices will ease only slightly because of the continuing concern over chromite supplies. Some of the contracts signed between producers and consumers in late 1974 and early 1975 were, because of the advantageous situation for producers, for a six-month duration. A producer in the Philippines, Acoje Mining Limited, recently withdrew its request for an increase of $27 a ton for metallurgical-grade chromite because of consumer resistance in Japan. Orissa Mining Limited of India received bids at about double the previous year's price on an offer of 160,000 tons of ore for delivery over 13 months. Traditionally, this ore has gone to the Japanese market; however, this time the top bidders were trading firms. The final award has not been decided, but the price will be between $90 and $120 a ton fob India. With the opening of the Suez Canal, some Indian ore will be diverted to Europe and, as a result, chrome prices for Japanese consumers will rise since they will no longer have the essentially captive sources that they had when the Suez Canal was closed.

Demand should recover in 1976 as steel production recovers. Ore prices should rise in late 1976 and 1977 as the ferrochrome projects in the Republic of South Africa come on stream and remove significant tonnages previously destined for other markets. Prices should remain high through 1980. If a political settlement in Rhodesia is reached, prices should ease as Rhodesian production could at least be expected to reach pre-sanction levels, i.e., about 650,000 tons a year of chromite.

The move by ore-producing countries to export ferrochrome rather than chromite will cause significant changes in the world ferrochrome industry. One result will be that there will probably be little or no increase in the amount of ore available for world trade between 1973 and 1980. The U.S.S.R.'s plan to construct a ferrochrome plant by 1980 will further aggravate the chromite supply difficulties of the industrialized nations if there is not a concomitant increase in ore production. In addition, there is a good possibility that Brazil will be involved in a ferrochrome project by 1980 that will further aggravate the chromite supply situation for traditional ferrochrome producers. Because of the limited sources of chromite, this situation will have to be accepted by the consuming nations.



Data Source: Engineering and Mining Journal

Prices

Chrome prices published by *Metals Week.*

	December 28 1973	December 13 1974
	(U.S.$)	
Chrome ore per long ton, dry basis, fob cars Atlantic ports		
Transvaal 44% Cr_2O_3, no ratio	33-34	47-52
Turkish 48% Cr_2O_3, 3:1 ratio	37	65
Russian 54-56% Cr_2O_3, 4:1 ratio (per metric ton)	37-39	53-58
Chromium metal		
Electrolytic, 99.8% fob shipping point, per lb	1.50	2.45
	(U.S. ¢)	
Ferrochrome per lb Cr content, fob shipping point		
High carbon 67-70% Cr, 5-6%C	23.7	54.0
Imported charge chrome	21.0-22.5	65.0-75.0
Low carbon 67-73% Cr, 0.025% C	36.5	–

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
		(%)	(%)	(%)
32900-1	Chrome ore	free	free	free
34700-1	Chromium metal, in lumps, powder, ingots, blocks or bars and scrap alloy metal containing chromium for use in alloying purposes	free	free	free
37506-1	Ferrochrome	free	5	5
92821-1	Chromium oxides and hydroxides from July 15, 1971 to Feb. 28, 1976 with the exception of the following:	10	15	25
	Chromic oxides	free	free	free
	Chromium trioxide	free	free	free
92838-8	Chromium potassium sulphate	free	free	10
92838-9	Chromium sulphate, basic	free	free	10

United States

Item No.		1974
		(%)
601.15	Chrome ore	free
632.18	Chromium metal, unwrought (duty on waste and scrap suspended)	5
632.84	Chromium alloys, unwrought	9
	Ferrochromium	
607.30	Not containing over 3% by weight of carbon	4
607.31	Containing over 3% by weight of carbon	0.625¢ per lb on chromium content
531.21	Chrome refractories	12.5
473.10	Chrome colours	5
420.90	Chromate and dichromate	0.87¢ per lb.

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Clays and Clay Products

D.H. STONEHOUSE

Clays are earthy, fine grained rocks composed mainly of minerals of secondary origin — the clay minerals — among which the most predominant are the hydrous aluminum silicates. The clay minerals, formed by the chemical weathering or alteration of aluminous minerals such as feldspar and mica, are generally classified into three major groups based on detailed chemistry and crystalline structure — the kaolinite group, the montmorillonite group and the illite group. Clay deposits suitable for the manufacture of ceramic products may include nonclay minerals such as quartz, calcite, dolomite, feldspar, gypsum, mica, iron-bearing minerals and organic matter. The nonclay minerals may, or may not be deleterious, depending upon individual amounts present and on the particular application for which the clay is intended.

The commercial value of clays, and of shales that are similar in composition to clays, depends mainly on their physical properties — plasticity, strength, shrinkage, vitrification range and refractoriness, fired colour, porosity and absorption — as well as on the proximity of any given deposit to growth centres in which clay products will be consumed.

Canadian sources of the principal types of clays

Common clays and shales. These materials are usually higher in alkalis, alkaline materials and iron-bearing minerals and much lower in alumina than the high-quality kaolins, fire clays, ball clays and stoneware clays. Common clays and shales are found in all parts of Canada, but deposits having excellent drying and firing properties are generally scarce and new deposits are continually being sought.

The clay minerals in common clays and shales are chiefly illitic or chloritic. The presence of iron usually results in a salmon or red fired colour. Their fusion points are low, usually well below pyrometric cone equivalent number 15 (PCE 15 — the pyrometric cones are a convenient method of relating temperature and time by a single value), which is defined by a temperature of approximately 1,430°C and is considered to be the lower limit of the softening point for fire clays.

Suitable common clays and shales are utilized in the manufacture of heavy clay products such as common brick, facing brick, structural tile, partition tile, conduit tile, quarry tile and drain tile. Some Canadian common clays are mixed with stoneware clay for the manufacture of facing brick, sewer pipe, flue lining and related products. The raw materials utilized in the heavy clay industry usually contain up to 35 per cent quartz. If the quartz, together with other nonplastic materials, exceeds this percentage, the plasticity of the clay is reduced and the quality of the ware is lowered. If calcite or dolomite is present in sufficient quantities the clay will fire buff and the fire strength and density will be adversely affected.

Most of the common surface clays in Canada are the result of continental glaciation and subsequent stream transport. Such Pleistocene deposits are of interest to the ceramic industry and include stoneless marine and lake sediments, reworked glacial till, interglacial clays and floodplain clays. These deposits are characterized by low melting temperatures.

The common shales provide the best source of raw material for making brick. In particular those found in Cambrian, Ordovician and Carboniferous rocks in eastern Canada, and Jurassic, Cretaceous and Tertiary rocks in western Canada are utilized by the ceramic industry. In many instances these shales are more refractory than the Pleistocene clays.

China clay (kaolin). China clay is a high-quality white, or nearly white, clay formed from the decomposition of the mineral feldspar, a major constituent of granite. The natural decomposition process, known as kaolinization, results in a hydrated aluminum silicate ($Al_2O_3 \cdot 2SiO_2 . 2H_2O$) with the approximate percentage composition as follows: 40 per cent Al_2O_3, 46 per cent SiO_2 and 14 per cent H_2O.

None of the crude kaolins known to exist in Canada have been developed, primarily because of beneficiation problems and the small size of some deposits. Most occurrences contain a high proportion of quartz particles of varied sizes — while mica, feldspar, magnetite, pyrite and colloidal iron have been noted as well. In the crude material the percentage of kaolinite frequently is small, making removal of impurities from Canadian kaolins difficult.

China clay is used primarily as a filler and coater in the paper industry, a raw material in ceramic products and a filler in rubber and other products. The following properties are required in clays used by the paper industry: low-viscosity characteristics when in clay-water systems; intense whiteness; high coating retention; and freedom from abrasive grit. In the ceramic industry china clay is used as a refractory raw material. In prepared whiteware bodies such as wall tile, sanitaryware, dinnerware, pottery and electrical porcelain, quantities of nepheline syenite, silica, feldspar and talc are used as well.

Lower-quality kaolins in North America might be mined, and more expensive processing might be justified as higher-quality deposits become depleted. If this situation arises, the development of a few Canadian deposits could become more attractive, particularly if new processing techniques and equipment become available.

In southern Saskatchewan, deposits of sandy kaolin occur near Wood Mountain, Fir Mountain, Knollys, Flintoft and other localities. Despite considerable work, no satisfactory method of producing a good commercial kaolin from these deposits has been developed.

A deposit of refractory clay which is very plastic to very sandy, and is similar to a secondary china clay, occurs along the Fraser River near Prince George, British Columbia. This material has been investigated

(text continued on page 113)

Table 1. Canada, production of clay and clay products from domestic sources, 1972-74

	1972[r]	1973	1974[p]
		($000)	
Production[1] from domestic sources, by provinces			
Newfoundland	257	260	275
Nova Scotia	1,684	2,101	2,725
New Brunswick	668	840	1,131
Quebec	8,300	9,725	12,393
Ontario	30,484	34,601	37,810
Manitoba	667	1,257	753
Saskatchewan	1,758	2,014	2,188
Alberta	4,438	4,782	5,688
British Columbia	4,301	5,590	5,527
Total Canada	52,557	61,170	68,490
Production[1] from domestic sources, by products			
Clay-fireclay and other clay	637	775	868
Firebricks and fireclay blocks and shapes	1,219	1,338	1,498
Brick-soft mud process	2,190	603	675
stiff mud process	27,624	32,096	35,937
dry press	7,131	9,387	10,510
fancy and ornamental sewer brick and paving brick	753	791	886
Structural hollow blocks	237	225	252
Drain tile	4,114	3,838	4,297
Sewer pipe	4,028	4,529	5,071
Flue linings	1,579	2,668	2,988
Pottery (glazed and unglazed including earthenware, sanitary-ware, stoneware, flower pots, etc)	3,045	4,920	5,508
Total	52,557	61,170	68,490

Source: Statistics Canada.
[1] Producers' shipments. Distribution for 1974 estimated by Statistics Section, Mineral Development Sector.
[p] Preliminary; [r] Revised.

Table 2. Canada, imports and exports of clay, clay products and refractories, 1973-74

	1973		1974p	
	(short tons)	($000)	(short tons)	($000)
Imports				
Clays				
Bentonite	226,671	3,318	290,491	3,947
Drilling mud	13,777	3,309	22,090	3,876
China clay, ground or unground	204,429	6,417	199,805	7,418
Fire clay, ground or unground	35,128	1,005	49,281	1,594
Clays, ground or unground	94,424	1,407	111,912	2,371
Clays and earth, activated	179,080	4,696	89,988	3,631
Subtotal clays	753,509	20,152	763,567	22,837
Clay products	(M)		(M)	
Building brick, glazed	2,664	221	2,770	254
nes	24,130	1,882	39,304	2,727
Building blocks	..	242	..	565
Clay bricks, blocks and titles nes	..	508	..	1,082
Earthenware tile	(sq. ft.)		(sq. ft.)	
under 2 1/2" x 2 1/2"	15,557,393	4,850	26,323,664	9,443
over 2 1/2" x 2 1/2"	34,989,628	8,254	45,466,223	13,033
Subtotal, brick blocks, tile	..	15,957	..	27,104
Tableware, ceramic	..	37,114	..	44,395
Porcelain, insulating, fitting	..	5,459	..	7,432
Pottery settings and firing supplies	..	343	..	500
Subtotal, porcelain pottery	..	42,916	..	52,327
	(short tons)		(short tons)	
Refractories				
Firebrick				
Alumina	37,587	6,750	58,211	11,472
Chrome	3,491	629	2,123	578
Magnesite	17,503	4,943	21,713	6,971
Silica	3,638	770	16,312	3,720
nes	181,367	15,287	222,311	23,026
Refractory cements and mortars	..	3,842	..	4,283
Acid-proof brick	..	254	..	341
Crude refractory material	8,735	740	7,582	647
Grog (refractory scrap)	12,104	577	21,491	1,013
Refractories, nes	..	2,675	..	4,246
Subtotal refractories	..	36,467	..	56,297
Total clays, clay products and refractories	..	115,492	..	158,565
By main countries				
United States	..	58,006	..	81,421
United Kingdom	..	27,834	..	32,071
Japan	..	13,614	..	19,212

Table 2 (concl'd)

	1973		1974^p	
	(short tons)	($000)	(short tons)	($000)
Imports (concl'd)				
Italy	..	3,365	..	7,318
West Germany	..	3,292	..	5,281
Netherlands	..	182	..	2,598
Greece	..	1,726	..	1,664
Spain	..	601	..	1,580
France	..	1,686	..	1,272
Austria	..	634	..	780
Others	..	4,552	..	5,368
Total	..	115,492	..	158,565
Exports				
Clays, ground and unground	5,629	327	2,557	118
Clay products	(M)		(M)	
Building brick clay	14,678	1,493	11,780	1,600
Clay bricks, blocks, tiles nes	..	852	..	530
Subtotal, bricks, blocks, tiles	..	2,345	..	2,130
High-tension insulators and fittings	..	1,488	..	1,909
Tableware	..	5,368	..	5,188
Subtotal porcelain tableware	..	6,856	..	7,097
Refractories				
Firebrick and similar shapes	68,835	11,056	57,119	9,898
Crude refractory materials	1,162,896	1,476	1,185,607	1,769
Refractory nes	..	1,643	..	1,914
Subtotal refractories	..	14,175	..	13,581
Total clays, clay products and refractories	..	23,703	..	22,926
By main countries				
United States	..	17,699	..	15,460
Australia	..	199	..	923
Dominican Republic	..	711	..	791
Chili	..	782	..	572
South Africa	..	363	..	475
France	..	241	..	413
Poland	..	92	..	400
United Kingdom	..	440	..	391
Mexico	..	260	..	336
Tanzania	..	—	..	250
Peurto Rico	..	316	..	217
Venezuela	..	24	..	200
Others	..	2,576	..	2,498
Total	..	23,703	..	22,926

Source: Statistics Canada.
^p Preliminary; .. Not available; nes Not elsewhere specified; (M) = 1,000; — Nil.

as a source of kaolin, as a fire clay and as a raw material for facing brick.

Various kaolinitic-rock deposits have been investigated in Manitoba. The reported deposits are principally in the northwest at Cross Lake and Pine River, on Deer Island (Punk Island) and Black Island in Lake Winnipeg, and at Arborg. Kaolinitic clays occur near Kergwenan and are being used for the manufacture of brick and tile.

Various companies have shown considerable interest in Quebec's kaolin-bearing deposits although the deposits, in general, contain an excessive amount of quartz and iron minerals. Kaolin-bearing rock occurs at St-Remi-d'Amherst, Papineau County; Brebeuf, Terrebonne County; Point Comfort, on Thirty-one Mile Lake, Gatineau County; and Château-Richer, Montmorency County.

Extensive deposits of kaolin-sand mixtures occur in northern Ontario along the Missinaibi and Mattagami rivers. Algocen Mines Limited has found substantial quantities of kaolin-silica mixtures along the Missinaibi River north of Hearst. Results to date indicate that the kaolin has good refractory characteristics and meets specifications for filler-grade material. Potential uses for the silica, which comprises 80 per cent of the deposit, include glass manufacture, abrasive flour and ceramic application. Distance from markets and the difficult terrain and climate of the area have hindered development.

Ball clay. Ball clays are a very fine grained, sedimentary kaolinitic type of clay with unfired colours ranging from white or various shades of grey depending on the amount of carbonaceous material present.

Ball clays obtained in Canada are mineralogically similar to high-grade, plastic fire clay. They are composed principally of fine-particle kaolinite and quartz, with less alumina and more silica than kaolins. Ball clays are extremely refractory products. In whitewares they impart a high green strength as well as plasticity to the bodies. Although white firing clays are most suitable, fired products which are cream coloured do not interfere with the quality of the whiteware products.

Ball clays are known to occur in the Whitemud Formation of southern Saskatchewan. Good-quality deposits are present at Willows, Readlyn, Big Muddy Valley, Blue Hills, Willow Bunch, Flintoft and in other areas. Clay from the Willows area has been used for many years in the potteries at Medicine Hat and Vancouver; however, the lack of proper quality control, the distance from large markets and lack of reserves have been the principal disadvantages affecting the widespread use of this material. Some ball clays from the Flintoft area are used for white-to-buff facing brick and for household pottery and crocks.

Fire clay. Fire clays contain high percentages of alumina and silica. They may be sedimentary or residual in origin, plastic or nonplastic and are composed mainly of kaolinite. The classification of fire clays may be related to the composition, physical characteristics, refractoriness, use, or association with other minerals. Descriptive terminology includes plastic fire clay, nonplastic fire clay, high-alumina fire clay, siliceous fire clay, flint clay, coal measure fire clay, or high-heat duty fire clay. Fire clays are plastic when pulverized and wetted, rigid when subsequently dried and of sufficient purity and refractoriness for use in commercial refractory products.

Canadian fire clays are used principally for the manufacture of medium- and high-duty firebrick and refractory specialties. High-duty refractories require raw materials having a PCE of about 31.5 to 32.5 (approximately 1,699° to 1,724°C). Intermediate-duty refractories require raw materials having a PCE of about 29 (approximately 1,659°C) or higher. Clays having a PCE of less than 29 but greater than 15 (approximately 1,430°C) may be suitable for low-duty refractories or ladle brick as well as for other clay products. No known Canadian fire clays are sufficiently refractory for the manufacture of super-duty refractories without the addition of some very refractory material such as alumina.

Various grades of good-quality fire clay occur in the Whitemud Formation in southern Saskatchewan.

Good-quality fire clays occur on Sumas Mountain in British Columbia. Some fire clay from the Sumas deposit is exported to the United States, and a small quantity is used at plants in Vancouver.

Fire clay and kaolin occur in the James Bay watershed of northern Ontario along the Missinaibi, Abitibi, Moose and Mattagami rivers. Considerable exploration has been carried out in some parts of these areas in recent years.

At Shubenacadie, Nova Scotia, some seams of clay are sufficiently refractory for medium-duty refractories. Research has indicated that these deposits may be suitable for production of ladle brick. Clay from Musquodoboit, Nova Scotia has been used by a few foundries in the Atlantic provinces, and the properties and extent of this clay were investigated by the Nova Scotia Department of Mines.

Ontario and Quebec have no producing domestic sources of clay. These provinces import most of their requirements from the United States.

Stoneware clay. Stoneware clays are similar to low-grade plastic clays and are characterized by good plasticity, a vitrification range between PCE 4 and 10, a long firing range and a fired colour from buff to grey. They range from commercially inferior material through semirefractory to firebrick clays. They should have low fire shrinkage, enough plasticity and toughness for shaping, no lime- or iron-bearing concretions and very little coarse sand.

Table 3. Canada, shipments of clay products produced from imported clay[1] 1971-73

	1971		1972		1973^p	
	(000 ft^2)	($000)	(000 ft^2)	($000)	(000 ft^2)	($000)
Glazed floor and wall tile	15,023	5,820	17,641	6,958	..	..
Electrical porcelains	..	18,592	..	17,273	..	15,630
Pottery, art and decorative ware	..	1,576	..	644	..	3,183
Pottery, other	..	1,725	..	2,753	..	893

Source: Statistics Canada.
[1] Does not include refractories; .. Not available.

Table 4. Canada, shipments of refractories, 1971-73

	1971		1972		1973^p	
	(short tons)	($000)	(short tons)	($000)	(short tons)	($000)
Firebrick and similar shapes[1]	145,504	21,875	135,796	21,833	130,767	24,460
Cement, mortars, castables	95,196	13,909	88,031	13,435	62,618	9,912

Source: Statistics Canada.
[1] Includes fire clay blocks and shapes, fire brick, etc., made from domestic clays, and rigid fire brick, stove linings and other shapes made from imported clays, chrome ore, magnesite etc. Silica brick not included.
^{p} Preliminary.

Table 5. Canada, clay and clay products production and trade, 1965-74

	Production					
	Domestic Clays[1]	Imported Clays[2]	Total	Refractory Shipments[3]	Imports[4]	Exports[4]
	(millions of dollars)					
1965	42.8	31.4	74.2	27.4	59.4	10.3
1966	43.0	35.9	78.9	28.6	71.7	12.6
1967	44.3	35.5	79.8	30.7	70.7	13.7
1968	48.7	39.6	88.3	33.2	65.4	11.8
1969	49.5	34.5	84.0	35.5	76.3	14.0
1970	51.8	33.6	85.4	42.3	81.2	15.6
1971	50.2	35.1	85.3	39.8	84.5	15.5
1972	52.6^r	39.4	92.0	39.7	98.5	15.9
1973	61.2	49.1	111.1	34.4	115.5	23.7
1974^p	68.5	..	..	..	158.6	22.9

Source: Statistics Canada.
[1] Production (shipments) of clay and clay products from domestic material. [2] Production (shipments) of clay products from imported clays. [3] Includes fire brick and similar shapes, all types, refractory cements, mortars, castables, plastics, etc., plus all other products shipped. [4] Includes refractories.
^{p} Preliminary; .. Not available; ^{r} Revised.

Stoneware clays are used extensively in the manufacture of sewer pipe, flue liners, facing brick, pottery, stoneware crocks and jugs, and chemical stoneware.

The principal source of stoneware clay in Canada is the Whitemud Formation in southern Saskatchewan and southeastern Alberta. The Eastend area in Saskatchewan was formerly the source of much of the clay used at Medicine Hat. Stoneware clay pits are presently located in the Alberta Cypress Hills, southeast of Medicine Hat, and at Avonlea, Saskatchewan. Stoneware clays occur on Sumas Mountain, near Abbotsford, British Columbia. These clays are used in the manufacture of sewer pipe, flue lining, facing brick and tile.

In Nova Scotia, stoneware clays occur at Shubenacadie and Musquodoboit. The Shubenacadie clays are used principally for the manufacture of buff facing brick. Other similar deposits occur at Swan River, Manitoba, where some buff brick has been manufactured, Kergwenan, Manitoba and in British Columbia at Chimney Creek Bridge, Williams Lake, Quesnel and near the Alaska Highway at Coal River.

Quebec and Ontario import stoneware clay from the United States for manufacture of facing brick and sewer pipe.

Canadian industry and developments

Clays and clay products produced from domestic sources were valued at $68.5 million in 1974, up 12 per cent over the revised figure for 1973. *Operators List 6, Ceramic Plants in Canada, (1975)* published by the Department of Energy, Mines and Resources, indicates the industry consisted of 181 operating plants at the end of 1974.

The brick and tile manufacturing industry accounts for approximately one third of the ceramic plants in Canada. These plants manufacture clay products which include common brick, facing brick, structural tile, quarry tile and drain tile, primarily from local common clays and shales. In recent years, requirements for brick as a structural material in low- to medium-rise buildings have been emphasized. The use of an oversize "through the wall" (TTW) brick, which provides wall thickness, now provides a significant market for brick manufacturers.

Seven plants manufacture sewer pipe from domestic common clay, shale or stoneware clay along with some imported shale and fire clay. Of the porcelain and pottery producers, sanitaryware plants, electrical procelain plants, wall tile plants, dinnerware plants and the art potteries are the principal consumers of ceramic-grade china clay and ball clays. These raw materials are imported mainly from the United States and Britain. Some of the art potteries and one of the dinnerware plants imported unfinished ware and completed the manufacturing process by glazing or decorating.

Most of the refractory manufacturing plants utilize imported clay including ball clay, fire clay and kaolin, as the principal ingredients in many of their products. The nine abrasives plants utilized both domestic and imported raw materials. The distribution was approximately half and half, except for silicon carbide, which was supplied entirely from domestic sources, and petroleum coke, which was imported. Domestic and foreign sources of raw materials were used by Canadian glass plants. Those in Quebec and Ontario accounted for most of the imported silica sand used. Porcelain enamel was produced and utilized at 24 plants.

Table 6. Distribution of ceramics plants in Canada, 1974

	Number of Plants					
Ceramic Product	Atlantic Provinces	Quebec	Ontario	Prairie Provinces	British Columbia	Total
Abrasives	—	2	6	—	—	8
Brick & Tile	4	8	35	6	3	56
Clay Sewer Pipe	2		2	2	1	7
Glass	1	5	8	4	2	20
Porcelain & Pottery	—	10	30	5	3	48
Porcelain Enamel	2	4	18	—	—	24
Refractories	—	3	11	4	—	18
	9	32	110	21	9	181

Note: Some plants produce more than one group of products.
Source: Based on revised data available to National Mineral Inventory, Mineral Development Sector.
—Nil.

Table 7. Canada, consumption (available data) of china clay, by industries, 1972-73

	1972	1973
	(short tons)	
Ceramic products	12,819	13,866
Paint and varnish	3,385	5,553
Paper and paper products[1]	128,513	127,582
Rubber and linoleum	8,413	8,290
Other products[2]	23,716	23,447
Total	176,846	178,738

Source: Statistics Canada. Component breakdown by Statistics Section, Mineral Development Sector.
[1] Includes paper and paper products and paper pulp. [2] Includes miscellaneous chemicals, cleansers, detergents, soaps, medicinals and pharmaceuticals and other miscellaneous products.

Specifications

The following specifications, published by the Canadian Standards Association, are applicable to the specified clay products manufactured in Canada:

- A 82.1 – 1965 Burned Clay Brick
- A 82.2 – 1967 Methods of Sampling and Testing Brick.
- A 82.3 – 1973 Calcium Silicate (Sand-Lime) Building Brick
- A 82.4 – 1954 Structural Clay Load Bearing Wall Tile (Reaffirmed 1972)
- A 82.5 – 1954 Structural Clay Non-Load-Bearing Tile (Reaffirmed 1972)
- A 82.6 – 1954 Standard Methods for Sampling and Testing Structural Clay-Tile (Reaffirmed 1972)
- A 60.1 – 1969 Vitrified Clay Pipe (le)
- A 60.2 – 1962 Methods of Testing Vitirfied Clay Pipe (rl) (Reaffirmed 1972)
- A 60.3 – 1969 Vitrified Clay Pipe Joints

World review

During 1974 reduced activity in all phases of the construction industry in the United States came as a direct and immediate result of a general economic recession. In turn, the resource industries supplying the construction industry were affected. Clay production was down to 61.1 million tons from 64.3 million tons, the entire reduction being in the common clay category — that used chiefly in the manufacture of construction material.

The major uses for specific clays in United States are as follows: *kaolin* — paper manufacture, refractories, rubber manufacture; *ball clay* — dinnerware, sanitaryware, floor and wall tile; *fire clay* — firebricks, foundry sands; *bentonite* — iron ore pelletizing, foundry sand bonding, drilling mud; *fuller's earth* — absorbents and fillers, insecticide carriers; *common clay* — construction material.

Demand for clays is expected to increase at annual rates of between two and five per cent through 1980, however, continued growth of the energy intensive clay-based industries could be severely impeded by persistent energy problems. Environmental problems and the need for planned land utilization must also be considered in any projection of future developments in the clay industry.

Clays were produced in 47 states at a total of 1,785 mines during 1974. The adequate reserves of high-quality clays of all types, together with possession of clay-processing technology, assure the United States a position as a major world supplier of clays.

After the United States, the five leading producers of kaolin are European countries, led by the United Kingdom. About 20 per cent of the United Kingdom's clay production is exported, mainly to Europe, the United States and Japan. In western Europe the paper manufacturing industries of West Germany, France and the Netherlands are the major users. Domestic production for these markets has had only limited success because of the inadequate quality of product.

Estimates place U.S.S.R. kaolin production second to that of the United Kingdom followed far back by France, Czechoslovakia and West Germany. Czechoslovakia is increasing its share of the European market at the expense of British and United States kaolin. In France many companies produce kaolin, although operations are generally small, fairly widely dispersed and relatively distant from major markets. On the other hand, the industry in Brittany, which accounts for about 80 per cent of France's output, is expected to expand its production substantially through more integrated support by a central body in Paris. Also, a major American producer has acquired an interest in an operation in Brittany which will bring new capital to the region along with additional technical and marketing expertise.

Greece produces approximately 60,000 tons of kaolin annually, almost all for domestic consumption.

Denmark produces about 20,000 tons of kaolin a year. Most of the output is utilized in the manufacture of low-alumina refractories and glazed heavy-clay products. Requirements for paper and other uses are mainly imported from Britain, Czechoslovakia and West Germany.

The Netherlands does not produce kaolin, but acts as a very important distribution point for American and British clay entering Europe.

Production of kaolin in Japan is on a very small scale except at the Itaya Mine, Yamagata Prefecture, Honshu Island, which produces about 150,000 tons a year. Total kaolin output is about 430,000 tons a year, most of which goes into the manufacture of refractories, for which it is best suited. The United States is the principal source of imports, supplying over 200,000 metric tons of kaolin and nearly 150,000 tons of other clays. Lesser amounts of kaolin are imported from South Korea, Britain and the U.S.S.R.

Outlook

Building construction expenditures in Canada, which in 1974 were close to $15 billion, are expected to increase by about $1 billion in 1975, indicating that demand for clay and clay products, as well as for other construction materials, will remain high. Average prices for most clay products are expected to rise slowly, reflecting greater costs associated with land acquisition, land rehabilitation, environmental factors and rising costs of energy.

The few known deposits of fire clays and ball clays in the developed areas of Canada are being utilized. Much assessment work has been done on deposits containing kaolin but, because of small size, high cost of beneficiation, or remoteness from transportation or industry, none has been developed. Ontario and Quebec are particularly deficient in developed deposits of refractory- or kaolin-type clays.

Technology concerning both chemical and mechanical processing of kaolins has advanced significantly in recent years in response to more stringent specifications by consumers. Major markets for kaolin are likely to remain strong while potential growth areas exist in paint and fibreglass applications and as catalysts in the oil refining industry.

Demand for high-grade, super-duty refractories continued to increase through 1974 and was supported by greater imports of both alumina and magnesite firebrick. Steel processes such as the basic oxygen furnace, pressure pouring and continuous casting, represent relatively new refractory requirements. New products and designs have also been dictated by changes in reducing atmospheres in the chemical and petrochemical industry, by increased demand for high-purity glass and by the need for more economical production of ceramics.

Clay and shale, like other low-cost construction materials, must be produced near the heavily populated areas where the markets are situated. This necessary feature of the industry will continue to produce increasingly complex problems related to rising land costs, land-use conflicts, environmental control requirements, and cost of land rehabilitation. Some end-use products such as brick and tile find competition from cement, glass, metals and plastic manufacturers, however, clays, being generally less expensive and very satisfactory for their intended uses, are usually able to hold their own, or to increase at the expense of the alternate materials, for many end-uses.

Bentonite and fuller's earth

Bentonite, a clay which consists primarily of montmorillonite, a hydrous aluminum silicate with weakly attached cations of sodium and calcium, is reviewed in a separate section of the Canadian Minerals Yearbook, 1974.

Fuller's earth is primarily a calcium montmorillonite clay characterized by natural bleaching and absorbent properties; it is similar to nonswelling bentonite. The terminology is confusing and bentonite and fuller's earth may not necessarily be separated in world trade and production statistics by country. Attapulgite, a magnesium-aluminum silicate, is a form of high-quality fuller's earth.

Prices

United States clay prices, according to Chemical Marketing Reporter, December 30, 1974.

	($ per ton)
Ball clay	
Domestic, crushed, moisture-repellent, bulk car lots, fob Tennessee	8 – 11.25
Imported lump, bulk, fob Great Lakes ports	40.50
Imported, airfloated, bags, car lots, Atlantic ports	70.00
China clay (kaolin)	
Water washed, fully calcined, bulk car lots, fob Georgia	110.00
Partially calcined, same basis	110.00
Dry-ground, airfloated, soft, fob Georgia	18.00

Tariffs

Canada

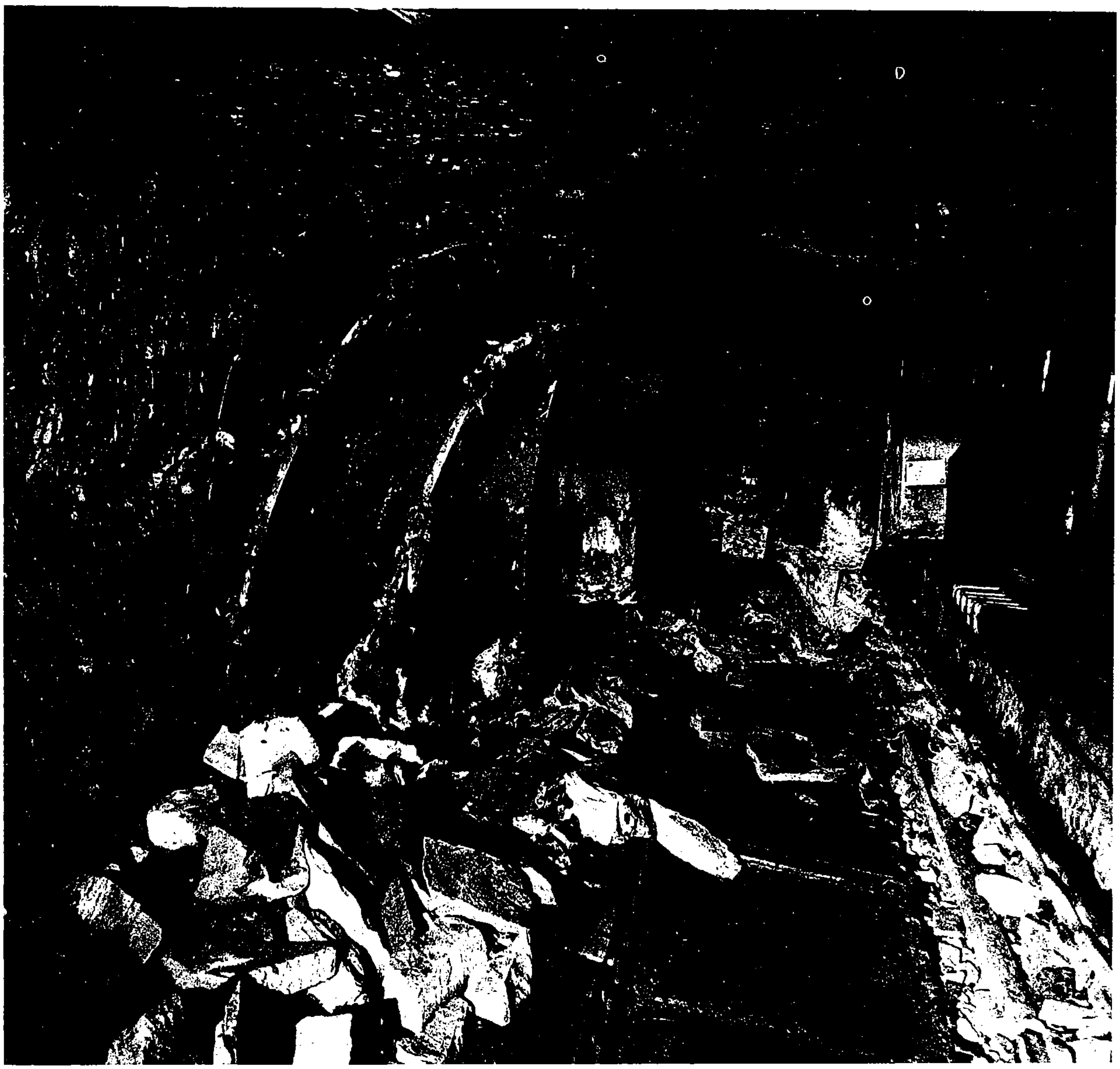
Item No.		British Preferential	Most Favoured Nation	General
		(%)	(%)	(%)
29500-1	Clays, including fire clay, pipe clay not further manufactured than ground	free	free	free
29525-1	China clay	free	free	25
28100-1	Firebrick containing not less than 90 per cent silica; magnesite firebrick or chrome firebrick; other firebrick valued at not less than $100 per 1,000, rectangular shaped, not to exceed 100 x 25 in.[3] for use in kiln repair or other equipment of a manufacturing establishment	free	free	free
28105-1	Firebrick, nop, of a class or kind not made in Canada, for use in construction or repair of a furnace, kiln, etc.	free	free	15
28110-1	Firebrick, nop	5	10	22½
28200-1	Building brick and paving brick	10	10	22½
28205-1	Manufactures of clay or cement, nop	12½	12½	22½
28210-1	Saggars, hillers, bats and plate setters, when used in the manufacture of ceramic products	free	free	free
28300-1	Drain tiles, not glazed	free	17½	20
28400-1	Drain pipes, sewer pipes and earthenware fillings therefor; chimney linings or vents, chimney tops and inverted blocks, glazed or unglazed, nop	15	20	35
28405-1	Earthenware tiles, for roofing purposes	free	17½	35
28415-1	Earthenware tiles, nop	12½	20	35
28500-1	Tiles or blocks of earthenware or of stone prepared for mosaic flooring	15	20	30
28600-1	Earthenware and stoneware, viz., demijohns, churns and crocks, nop	20	20	35
28700-1	All tableware of china, porcelain, semiporcelain or white granite, excluding earthenware articles (Feb. 20/73 – Feb. 19/74)	free	20	35
28705-1	Articles of chinaware, for mounting by silverware manufacturers	12½	17½	22½
28710-1	Undecorated tableware of china, porcelain, semiporcelain for use in the manufacture of decorated tableware	free	10	35
28800-1	Stoneware and Rockingham ware and earthenware, nop	17½	20	35
28805-1	Chemical stoneware	free	10	35
28810-1	Hand forms of porcelain for manufacture of rubber gloves	free	free	35
28900-1	Baths, bathtubs, basins, closets, closet seats and covers, closet tanks, lavatories, urinals, sinks and laundry tubs of earthenware, stone, or cement, clay or other material, nop (from Feb. 20/73 to Feb. 19/74)	12½	20	35

Tariffs (concl'd)

United States		(¢ per long ton)
521.51	Fuller's earth, not beneficiated	25
521.41	China clay or kaolin	33
521.54	Fuller's earth, wholly or partly beneficiated	50
521.81	Other clays, not beneficiated	free
521.84	Other clays, wholly or partly beneficiated	50
521.61	Bentonite	40
521.71	Common blue clay and other ball clays not beneficiated	42
521.74	Common blue clay and other ball clays, wholly or partly beneficiated	85
521.87	Clays artificially activated with acid or other material	0.05¢ lb

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Note: In addition to the above tariffs various duties are in existence on manufactured clay products, *viz.*, brick pottery, artware, etc.



A shearer being used in a longwall coal cutting and loading operation in # 26 Colliery near Glace Bay, Nova Scotia.
(NFB photo)

Coal and Coke

MICHAEL K. McMULLEN

In 1974 total coal production was 23 million tons, a marginal increase over 22.6 million tons in 1973; its value, however, rose sharply by approximately 41 per cent to $254 million. Regionally, coal output increased in British Columbia, Nova Scotia and New Brunswick and declined in Alberta and Saskatchewan. Bituminous coal production fell by 50,000 tons to 13.6 million tons, notwithstanding that several coking coal producers in western Canada experienced lengthy coal miners strikes during the year. Subbituminous coal output increased by 13 per cent to 5.6 million tons while lignite production declined to 3.8 million tons from 4 million tons in 1973. New mines came on stream in Alberta, Saskatchewan and Nova Scotia. Exports, which declined fractionally to 11.9 million tons, accounted for roughly one half of total coal production in Canada and 88 per cent of bituminous coal production. Shipments to Japan totalled 11 million tons in 1974. Imports fell 17 per cent to 13.6 million tons in large part due to a coal miners strike in the United States and a Great Lakes shippers strike. Of the coal consumed in Canada, about 17 million tons were used to generate electricity in thermal power stations and 8.3 million tons of coking coal were carbonized to make 6 million tons of coke. Lesser amounts of coal were consumed by industrial and commercial users throughout Canada.

The average value of all types of coal in Canada rose from $7.96 a ton in 1973 to $11.04 a ton in 1974, an increase of approximately 39 per cent. The largest increase was for bituminous coal which increased by 45 per cent to $17.07 a ton. This increase was due mainly to substantially higher prices paid for coking coal under export contracts and to higher prices paid for high Btu thermal coals as a result of higher oil prices. Indeed, for the first time since the development of the western Canadian coking coal industry for export to Japan in the early 1970s the coking coal industry exhibited positive financial results. The average value of production for subbituminous coal and lignite increased to $2.52 a ton and $2.16 a ton, or by 11 per cent and 2 per cent, respectively. These increases mainly reflected higher costs of production since most subbituminous coal and lignite production is related to integrated mine-mouth power generation operations.

It was apparent in 1974 that exploration permits and applications to develop new mines, both for coking and thermal coals were receiving closer scrutiny than before by provincial governments. Projects are being assessed primarily in terms of economic costs and benefits as well as the impact of coal development on the environment. During 1974 the Government of Alberta formally placed a moratorium on new coal developments in the eastern slopes of the Rocky Mountains pending the formulation of governmental guidelines on land use and resource development for this region.

Outlook

Production of all types of coal in Canada in 1975 can be expected to reach about 26 million tons, an increase of some 13 per cent over 1974. An estimated 13 million tons will be exported to Japan and another 800,000 tons will be sent to western Europe, the United States and South America. Imports are expected to be higher in 1975 than in 1974.

Prices for coking coal under contract can be expected to reach and maintain record levels in 1975 in line with commodity value and increased production costs. Although inventories for many steel products were being built up in late 1974 and early 1975 the effect was being felt mainly on the spot market where coal prices have taken a marked downturn in early 1975 and are down sharply from record levels reached in 1974. Prices on long-term contracts should not be so affected because of the general tightness of world supply and the concern by consumers of security of long-term supplies. These prices will likely increase to compensate for increasing costs of production.

The strong long-term demand for Canadian coking coal exports is indicated by the interest shown in Canada's coal resources by foreign countries. Besides Japan, who indicated that it would like to expand imports from Canada by some 80 per cent by 1985, West Germany, Italy, Brazil, the United Kingdom, Spain, South Korea and Mexico were also actively seeking Canadian coking coal supplies. The export market for steam coal could also develop favourably in the near-term depending, principally, on the international price of oil. Spot shipments of Canadian steam coal more than tripled in 1974 as shipments were made to many countries, particularly in Western Europe, indicating that markets exist there. Japan, which lifted its embargo on the importation of steam coal for power generation and heating in 1974 and set a quota of 800,000 tons for the year, is another potential market.

In addition to export markets it became evident in

1974 that a significant market for western Canadian coking coal and thermal coal could be developed in Ontario. Given continuing shortfalls in United States supply of both coking and thermal coal coupled with uncertainties relating to long-term availability of United States coal, Ontario steelmakers and Ontario Hydro began to look at Canadian sources of supply to complement imports from the United States. Testing of thermal bituminous coals from the west were undertaken by Ontario Hydro in 1974, and negotiations are underway for the delivery of some 3 million tons annually by the late 1970s. Ontario steelmakers began major tests of western Canada coking coals in 1974 and increased volumes are planned for 1975.

In addition to the traditional coal markets, attention is being focused on the long-term possibility of gasification and liquefaction of coal. Extensive resources of coal in western Canada, particularly subbituminous coal and lignite in the plains region, could provide the basis for such energy development. In 1974, TransCanada PipeLines Limited announced plans to begin a study of the potential development of a gasification plant in western Canada.

Although the markets for coal appear to be excellent, uncertainties as to future mine development prevail. These uncertainties include the availability of sufficient capital and mining equipment to bring a mine into production. Some governmental policies regarding resource development and environmental requirements are still under consideration and are having a modifying effect on the expansion of the supply base. Moreover, the need exists to increase both

Table 1. Canada, coal production[1] by types, provinces and territories 1973-74

	1973		1974^p	
	(short tons)	($)	(short tons)	($)
Bituminous				
Nova Scotia	1,175,587^r	15,568,013	1,410,043	24,323,242
New Brunswick	394,219	3,389,776	415,048	5,320,915
Alberta	4,256,676	48,645,510	3,581,141	61,694,772
British Columbia	7,772,866	92,369,714	8,146,979	139,965,099
Total	13,599,348^r	159,973,013	13,553,211	231,304,028
Subbituminous				
Alberta	4,939,721	11,258,253	5,594,869	14,099,070
Lignite				
Saskatchewan	4,028,280	8,500,156	3,842,140	8,299,022
All types, Canada total	22,567,349^r	179,731,422	22,990,220	253,702,120

Source: Statistics Canada.
[1] Production represents clean coal output, plus raw coal sales from the mine where there is a preparation plant at the mine, plus raw coal shipments where there is no preparation plant at the mine.
^{p} Preliminary.
^{r} Revised.

Table 2. Canada, coal production, imports and consumption, 1965, 1970-74

	Production	Imports[1]	Exports	Domestic Consumption
1965	11,500,069	16,595,393	1,225,994	25,835,511
1970	16,604,164	18,863,779	4,391,572	29,512,533
1971	18,432,199	18,136,181	7,733,775	28,249,835
1972	20,709,316	19,264,890	8,513,403	28,393,096
1973	22,567,349	16,347,840	12,023,700	27,415,021
1974^p	22,990,220	13,647,846	11,876,419	..

Source: Statistics Canada.
[1] Coal imports for consumption — from U.S.A. and United Kingdom.
^{p} Preliminary.
.. Not available.

transportation and terminal handling capabilities. These constraints, together with escalating construction, development and operating costs and continuing prospects for a tight skilled labour market have led to lengthening lead times for mine development and problems as to price and cost structures in the negotiating of contracts. It is unlikely that major mines now under development or those to be announced in 1975, particularly coking coal mines, will be fully on stream before 1980. Nevertheless, it is expected that the growth in coal production will be to 40 million tons in 1980 with production of subbituminous coal in Alberta and lignite in Saskatchewan for domestic power generation accounting for the bulk of expansion between 1975 and 1980.

Production and mine developments

British Columbia. The coal producing region in British Columbia is the Crowsnest Pass area of the southeastern portion of the province. This basin has large resources of low and medium-volatile bituminous coal characterized by thick coal seams which occur within faulted and disturbed lower Cretaceous rocks. Isolated smaller coal basins in other parts of the province contain coal seams ranging in rank from lignite to anthracite.

During 1974, Kaiser Resources Ltd, Fording Coal Limited and Byron Creek Collieries Limited produced coal in British Columbia, with Kaiser being the largest. In 1974, Kaiser produced about 4.9 million long tons of clean coking coal from its large Harmer Ridge surface mine and two underground mines located near Sparwood. The bulk of the coking coal was sent to Japan under long-term agreement. Some spot shipments of coking coal were made, with some 50,000 tons being sent to the two primary steel producers in Hamilton, Ontario. In addition, shipments of thermal coal were made to Ontario Hydro and to markets in Denmark and France.

The base price of Kaiser's Japanese contract, fob Roberts Bank, was increased from $21.63 a long ton in June progressively to $30.24 in November. By April 1975 the price had been substantially increased further to $48.57 a long ton. These higher coal prices and continuing successful mining and processing operations enabled the company in January 1975 to announce its first dividend to shareholders.

During 1974 Kaiser commenced a $4 million expansion program to increase the annual capacity of its surface mine by some 250,000 long tons by 1975. Expansion and improvements to Kaiser's underground hydraulic mine were also underway in 1974. When completed in 1975 the capacity of the hydraulic mine will be 1.2 million long tons annually.

In 1974 Kaiser entered into a partnership with Mitsubishi Corporation and Mitsui Mining Co., Ltd. of Japan, forming a new company called Kaiser Coal Canada Ltd., to investigate the feasibility of opening a new underground hydraulic mine about 5 miles south of its existing operations. The mine is envisaged as having a production capacity of 1.5 to 2.0 million long tons of clean coal annually.

Late in 1974 a commercial agreement for combining and marketing hydraulic coal mining technology was concluded between Kaiser, Mitsui Mining Co., Ltd. and the Ministry of Coal Industry of the Soviet Union. Under the agreement, hydraulic mining technology will be marketed to coal producers through sub-license agreements. Any royalties will be shared equally among the three parties. At year-end, Fording Coal Limited of British Columbia had signed an agreement to license this technology. Because of the nature of the coal seams in the mountain region the hydraulic mining technique holds promise of being widely used there.

Fording Coal Limited produced some 2 million tons of clean coking coal in 1974. The multi-seam surface mining operation located some 35 miles north of Sparwood near Elkford in the Fording Valley was affected by a seven-week mine workers' strike in January and February and by plant modifications being carried out later in the year. Nearly all of 1974 production was sent to Japan under a long-term contract which calls for shipments of 3 million tons annually. During the year a contract was signed for a trial shipment of 20,000 tons of coking coal to The Algoma Steel Corporation, Limited, Sault Ste. Marie, Ontario.

The base price paid to Fording under its long-term contract with Japanese consumers, fob Roberts Bank, was increased from $21.55 a long ton in April to $32.22 a long ton in September, retroactive to the beginning of 1974. On April 1, 1975 the price was increased to $47.00 on an interim basis.

In order to increase production, Fording investigated other possible areas for mining. The company is looking at the potential for an hydraulic mine at Eagle Mountain and signed an agreement in December 1974 with Kaiser Resources Ltd. and partners to use their hydraulic coal mining technology.

Byron Creek Collieries Limited, located near Corbin in the southeastern portion of the province, produced some 200,000 tons of thermal coal in 1974 from its surface mine. Spot shipments were made to Ontario Hydro and customers in Western Europe. A doubling of capacity is planned for 1975.

Brascan Resources Limited continued to conduct marketing studies to finance development of the Sukunka coking coal property of Brameda Resources Limited near Chetwynd in the northeastern portion of the province. Limited exploration and development work on the property was carried on in 1974. Consideration is being given to initial production from a small surface operation. Brascan has until June 30, 1975 to exercise options with Brameda to increase its equity to 60 per cent. During the year Brameda reported the termination of its agreement with the British Columbia Railway under which the latter was

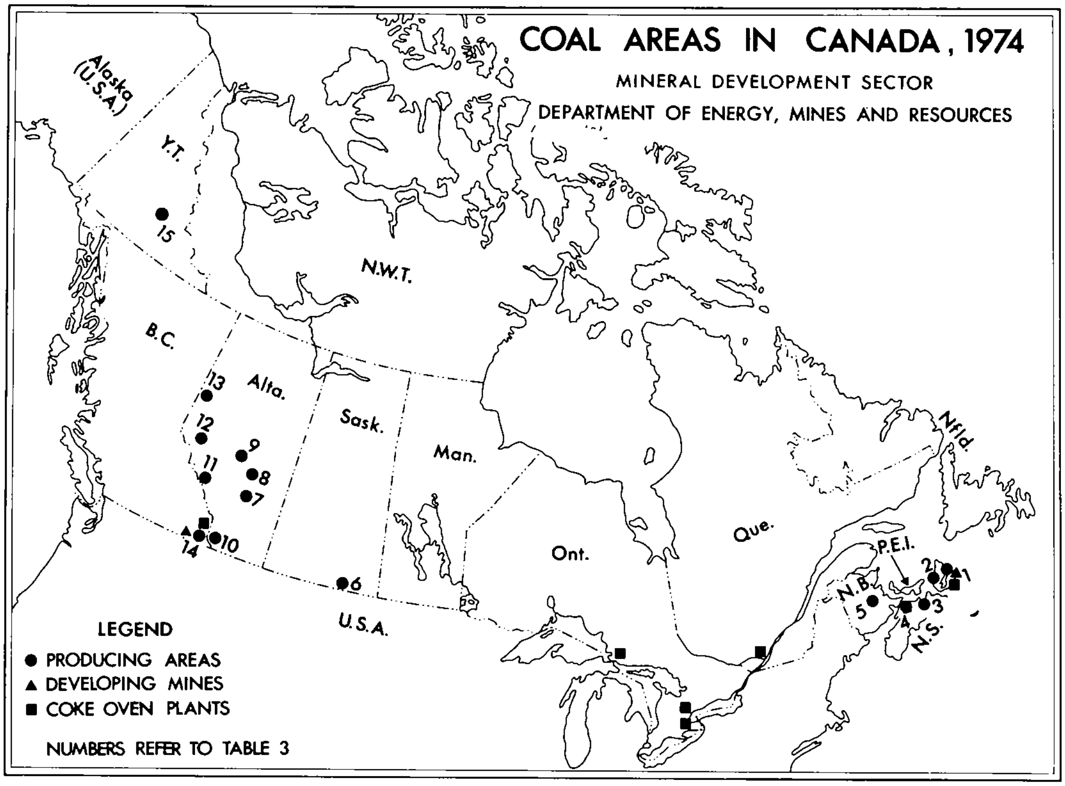


Table 3. Principal coal producers in 1974

Company and Mine Location	Estimated 1974 Production	Coal Rank	Chief Markets	Remarks
Nova Scotia	(short tons)			
1. Cape Breton Development Corporation (DEVCO)	(raw coal)			
Lingan Mine, Lingan	452,000	Hvb A	Power Generation	Underground
No. 26, Glace Bay	578,000	Hvb A	Metallurgical, Industrial, Domestic	Underground
Princess, Sydney Mines	113,000	Hvb A	Power Generation, Industrial, Residential	Underground
Point Aconi	72,000	Hvb A	Power Generation	Surface, initial production in 1974

Table 3. (cont'd)

Company and Mine Location	Estimated 1974 Production	Coal Rank	Chief Markets	Remarks
Alder Point	119,000	Hvb	Power Generation	Surface, operated only from late 1973 to mid-1974
2. Evans Coal Mines Limited St. Rose	26,000	Hvb B	Power Generation, Residential	Underground
3. Drummond Coal Company Limited, Drummond, Westville	21,000	Mvb & Hvb A	Power Generation	Underground
4. River Hebert Coal Company Limited	32,000	Hvb A	Power Generation	Underground
New Brunswick				
5. N.B. Coal Limited Minto, Chipman areas	465,000	Hvb A	Power Generation, Paper Mills	Surface, operates at 6 locations
Saskatchewan				
6. Manitoba and Saskatchewan Coal Company (Limited) M & S Mine, Bienfait	378,000	Lig A	Power Generation, Industrial	Surface
Boundary Dam Mine, Estevan	1,627,000	Lig A	Power Generation	Surface, began production in January 1974
6. Manalta Coal Ltd. Klimax Mine, Estevan	584,000	Lig A	Power Generation, Industrial	Surface
6. Utility Coals Ltd. c/o Manalta Coal Ltd. Utility Mine, Estevan	1,253,000	Lig A	Power Generation	Surface
Alberta				
Subbituminous mines				
7. Century Coals Limited Atlas, East Coulee	40,000	Sub B	Residential, Power Generation	Underground
8. Manalta Coal Ltd. Vesta Mine, Halkirk	423,000	Sub C	Power Generation, Residential	Surface
8. Forestburg Collieries Limited Diplomat Mine, Forestburg	619,000	Sub C	Power Generation, Residential	Surface
9. Manalta Coal Ltd. Whitewood Mine, Wabamun	2,044,000	Sub A & B	Power Generation	Surface
Highvale Mine, Sundance	2,329,000	Sub C	Power Generation	Surface
Roselyn Mine, Sheerness	30,000	Sub C	Power Generation	Surface

Table 3. (concl'd)

Company and Mine Location	Estimated 1974 Production	Coal Rank	Chief Markets	Remarks
Bituminous mines				
10. Coleman Collieries Limited Vicary Creek, Coleman	496,000	Mvb	Japan for coke-making	Underground
Tent Mountain, Coleman	473,000	Mvb	Japan for coke-making	Surface
11. The Canmore Mines, Limited Canmore	182,000 21,000*	An & Lvb	Japan for coke-making	Underground Surface
12. Cardinal River Coals Ltd. Cardinal River Mine, Luscar	1,086,000	Mvb	Japan for coke-making	Surface
13. McIntyre Mines Limited Smoky River Mines, Grande Cache	1,609,000* 741,000	Lvb	Japan for coke-making	Surface and Underground No. 9 Surface mine opened in 1974
British Columbia				
14. Kaiser Resources Ltd. Michel Colliery, Natal	969,000	Lvb	Japan for coke-making	Surface and Underground (hydraulic mining, room-and-pillar)
Harmer Ridge, Sparwood	6,583,000	Lvb	Japan for coke-making	Surface
14. Fording Coal Limited Fording Mine, Fording Valley	2,840,000	Lvb	Japan for coke-making	Surface
Byron Creek Collieries Limited, Corbin	200,000	Mvb	Ontario and Europe for steam generating	Surface
Yukon				
15. Cyprus Anvil Mining Corporation Carmacks Coal Mine, Carmacks	17,000	Hvb B	Anvil lead-zinc mine for heating and concentrate drying	Underground

Source: Data supplied to the Mineral Development Sector by companies.
An – Semi-anthracite; Lvb – Low volatile bituminous; Mvb – Medium volatile bituminous; Sub – Subbituminous; Lig – Lignite; Hvb – High volatile bituminous.
* Surface production.

to purchase a 40 per cent interest in the Sukunka project. Nearby, in the Quintette area, Denison Mines Limited continued exploration on its Babcock and Wolverine projects. Emphasis was again placed on the Babcock property where Denison shares interests with Alco Standard Corporation. The exploration program was completed in 1974 with financing provided by Mitsui Mining Co., Ltd. and Tokyo Boeki Ltd. Marketing studies and further investigations relating to mining methods are to be undertaken in 1975. Farther north in the Pine Pass region, Pine Pass Development Ltd. suspended exploration and drilling on property optioned from Pan Ocean Oil Ltd. but expects to resume activities in 1975. In the Peace River area Cinnabar Peak Mines Ltd. reported completion of a preliminary feasibility study with respect to coal reserves on its land holdings.

In the Crowsnest Pass region, Crows Nest Industries Limited undertook some limited development work on its Line Creek coal property with emphasis placed on mine design work. Some development work was carried out on the Elk River property owned jointly by Scurry-Rainbow Oil Limited and Emkay Canada Natural Resources Ltd. In the latter part of the year, West German and Italian steel interests were investigating the possible purchase of Emkay Canada's 50 per cent interest in this property. Farther to the south, Rio Tinto Canadian Exploration Limited (Riocanex), a subsidiary of Rio Algom Mines Limited, completed an extensive drilling and sampling program on the Sage Creek property in the Flathead Valley region just north of the Montana border. Development work will continue in 1975. This property is optioned from Pan Ocean Oil Ltd.

Alberta. Most of Alberta's coal resources are bituminous and subbituminous, but coal of all ranks from lignite to anthracite occurs in the province. Bituminous coal, much of which is of good coking quality, is located in the foothills and mountain belts, whereas subbituminous coal is found in the Plains region. Alberta is Canada's leading coal-producing province and has the largest number of coal mines. Coking coal is produced by four mining companies, namely McIntyre Mines Limited (formerly McIntyre Porcupine Mines Limited), Coleman Collieries Limited, Cardinal River Coals Ltd., and The Canmore Mines, Limited.

During 1974, McIntyre Mines Limited produced some 1.5 million long tons of clean coking coal from its underground No. 2 mine and No. 8 and 9 open-pit mines in the Smoky River area near Grande Cache. In April the No. 9 surface mine was brought on stream to replace the No. 8 mine which was phased out in August due to exhaustion of reserves.

In April, McIntyre reached agreement with its Japanese customers for delivery of 1.5 million long tons on a one-year contract, with prices to be based on eastern United States producer prices for coal of equal rank, quality and coking properties. One-year contracts with Bethlehem Steel Corporation for 300,000 tons and The Steel Company of Canada, Limited for 200,000 on the same pricing arrangements were also made. In

Table 4. Canada, coal production by rank, province, type of mining and average output per man-day, 1974^p

	Production[1]		Average output per man-day[2] (e)	
	Underground	Surface	Underground	Surface
	(short tons)			
Bituminous				
Nova Scotia	1,326,072	218,153	2.5	5.0
New Brunswick	—	415,048	—	8.0
Alberta	1,662,135	3,435,974	15.0	30.0
British Columbia	968,932	9,749,913	15.0	26.0
Subbituminous				
Alberta	50,280	5,544,589	11.0	80.0
Lignite				
Saskatchewan	—	3,842,140	—	95.0
Canada 1974^p	4,007,419	23,205,817	10.8	50.0
1973	4,446,492	22,584,805	11.5	51.4
Total, all mines				
1974^p	27,213,236		44.6	
1973	27,031,297		44.8	

Sources: Statistics Canada, and the Department of Energy, Mines and Resources.
[1] Raw coal production only. [2] Mine production and related employment only, excludes preparation plant workers, executive administrative, sales and office employees.
Man-day refers to approximately an eight-hour man-shift.
^{p} Preliminary.
^{e} Estimated.
— Nil.

October McIntyre concluded agreement with its Japanese customers to receive an advance on coal deliveries of $16.3 million to be received before April 1, 1975 and an immediate price increase of $11.00 a long ton to $40.23 fob Vancouver. In addition a new three-year agreement was finalized calling for delivery of 1.5 million long tons a year beginning April 1, 1975. In April 1975 an fob price Vancouver of $58.57 was set for McIntyre coal shipped to Japan. In 1975, McIntyre will ship 200,000 tons to The Steel Company of Canada, Limited in Hamilton and 150,000 tons to Sydney Steel Corporation in Sydney, Nova Scotia.

In June, McIntyre made an agreement with Meadowlark Farms, Inc. a subsidiary of Amax Coal Company, Inc. for exploration and evaluation of the Copton coal property located near the No. 9 mine. Work under this agreement began in 1974.

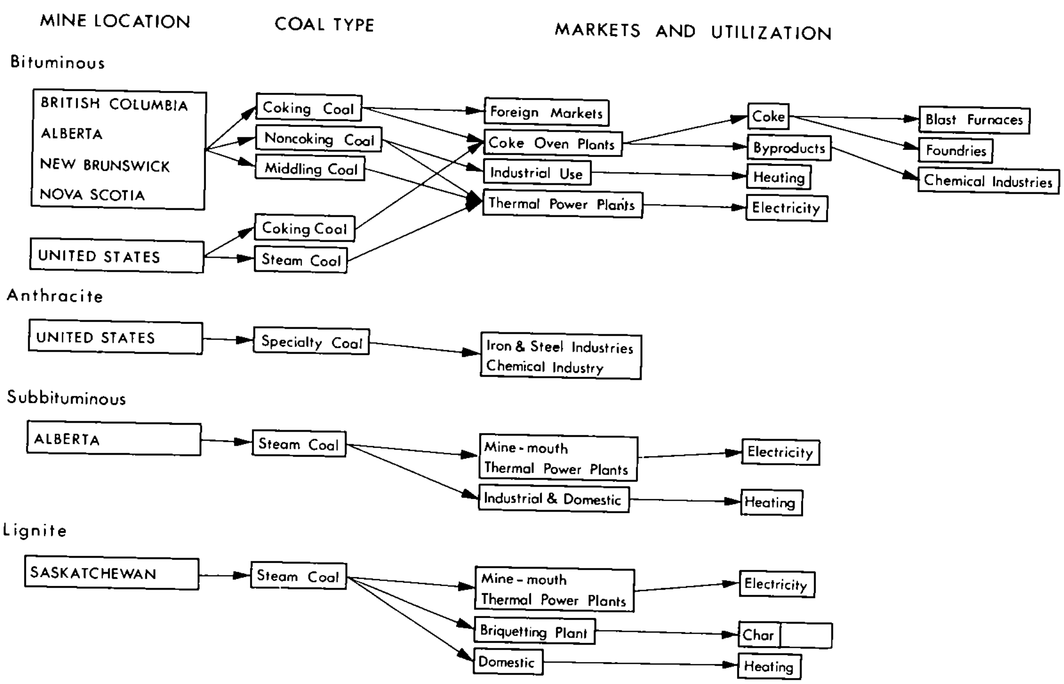
Coleman Collieries Limited produced coal in the Crowsnest Pass area from one open-pit location at Tent Mountain and from two underground mines at Vicary Creek in 1974. Most of the 880,000 tons of clean coking coal produced were shipped to Japan. During the year, preproduction stripping was carried out on its new No. 4 open-pit location in the Tent Mountain area which is scheduled for production in early 1975. A second new pit is planned for later in 1975. With the start of operations of these new pits Coleman will reduce its production from current underground mining operations. Investigations relating to a new underground mine at Tent Mountain will be undertaken during 1975.

In April 1974, Coleman negotiated a price of $29.00 a ton fob Port Moody for clean coking coal shipped to Japan under contract. The volume of coal to be shipped in the fiscal year 1974 was set at 680,000 long tons. In September the price was raised to $30.96 a long ton. Effective April 1, 1975, Coleman agreed to a price of $45.96 a long ton under a new three-year agreement calling for shipments of some 750,000 tons in 1975, increasing to an annual rate of 900,000 long tons commencing in April 1976. Besides shipments to Japan, Coleman made spot deliveries of both coking and thermal coal to Italy, France, Holland, Belgium and South Korea in 1974.

Cardinal River Coals Ltd. managed to produce about 800,000 long tons, or roughly one half of its rated annual capacity of 1.5 million long tons of clean coking coal in 1974 due to a protracted coal miners strike. The surface mine, located near Luscar was shut down between April 23 and September 11. The company

COAL'S ROUTE TO CONSUMPTION

MINERAL DEVELOPMENT SECTOR
DEPARTMENT OF ENERGY, MINES AND RESOURCES



expanded production capability of its surface mine by 50 per cent in 1974 and carried out exploration work on its other properties during the year.

Cardinal River, which holds a contract with Japanese steel works to ship 1.5 million long tons annually, negotiated a base price increase from $20.82 a long ton, fob Vancouver, to $32.00 a long ton in October. Effective April 1, 1975 a price of $48.55 a long ton will be applicable to shipments.

The Canmore Mines, Limited produced mainly semi-anthracite coal from its underground and surface mine in the Cascade area. Nearly all of the 140,000 long tons of clean coal produced were shipped to Japan. A second underground mine is being developed in the Cascade area.

Gregg River Resources Ltd., a wholly-owned subsidiary of Manalta Coal Ltd., signed a contract in 1974 to supply 21 million metric tons of coking coal to Japanese steelmakers over a 15-year period from its proposed Gregg River mine near Hinton. The Japanese consortium agreed to provide a $20 million loan to finance part of the $60 million venture. The initial price for coal was set at $US 32.24 a ton, fob Vancouver. The project, however was formally deferred by the Government of Alberta pending establishment of policy guidelines on land use and resource development for the Foothills region.

Consolidation Coal Company of Canada completed extensive exploration and mine feasibility studies on its Brazeau project near Nordegg. During the year the company made a submission to the Government of Alberta for a mining permit and negotiated with Japanese steelmakers for a long-term contract. The Nordegg mine project is planned for production of 1.5 million long tons of clean coking coal a year over a 15-year period with marginal quantities of thermal coal.

Canpac Minerals Limited announced plans in 1974 to open an underground coal mine in the Shaughnessy area, 15 miles west of Lethbridge. Initial production at a rate of 750,000 tons a year is planned for 1979.

In the exploration field the area north of Blairmore and Coleman was active in 1974. Consolidation Coal Company of Canada carried out exploration programs on properties optioned from Scurry-Rainbow Oil Limited. In particular, extensive work was done on the Grassy Mountain thermal coal property including test shipments for Ontario Hydro. The Granby Mining Company Limited carried out exploration and test work on its Granridge coking coal property (Isolation Ridge) which was optioned from Canpac in late 1973.

Table 5. Producers' disposition of Canadian coal[1] 1974

Destination	Originating Province					
	Nova Scotia	New Brunswick	Saskatchewan	Alberta	British Columbia and Yukon	Canada
	(short tons)					
Railways in Canada	5,118	—	75,674	474	—	81,266
Newfoundland	891	—	—	—	—	891
Prince Edward Island	19,710	—	—	—	—	19,710
Nova Scotia	1,150,484	5,587	—	—	—	1,156,071
New Brunswick	25,628	358,055	—	—	—	383,683
Quebec	59,310	137,879	—	7,481	—	204,670
Ontario	761	—	45,152	217,088	14,337	277,338
Manitoba	—	—	393,467	84,020	—	477,487
Saskatchewan	—	—	3,315,679	216,572	—	3,532,251
Alberta	—	—	—	5,467,306	—	5,467,306
British Columbia	—	—	—	15,402	370,104	385,506
Total Canada	1,261,902	501,521	3,829,972	6,008,343	384,441	11,986,179
United States	—	2,747	11,435	270,842	7,923	292,947
Japan	—	—	—	2,944,562	7,488,184	10,432,746
Other	26,088	—	—	—	292,087	318,175
Total Shipments	1,287,990	504,268	3,841,407	9,223,747	8,172,635	23,030,047

Source: Statistics Canada.
[1] Saleable coal (raw coal, clean coal and middling sales).
— Nil.

Coal testing is scheduled in the 1975 program of work. Bralorne Resources Limited updated engineering studies in 1974 on its Savanna Creek coking coal project and is planning additional exploration on its south block in 1975.

In the Ram River — Nordegg region, Consolidation Coal earned a 50 per cent interest in a Scurry-Rainbow coal property with the completion of a test drilling program. Brascan Resources Limited has an option on the Wharf Resources Ltd., Nordegg coal property and will begin work there in 1975. Pan Ocean Oil Ltd. plans to option its Ram River coal holdings for exploration work during 1975.

In the coal branch area southeast of Hinton many companies carried out exploration and test work on thermal coal properties, principally due to the interest of Ontario Hydro in foothills high Btu bituminous coal. These included Luscar Ltd. at Coal Valley, Manalta Coal Ltd. at Mercoal and Denison Mines Limited at Coalspur. The Granby Mining Company Limited and Associated Porcupine Mines Limited have a joint exploration program underway near Hinton.

To the north, in the Smoky River area Cyprus Anvil Mining Corporation conducted limited work on its optioned Kakwa property and at Fox Creek, 150 miles northwest of Edmonton, Shell Canada Limited continued work on its thermal coal property.

Subbituminous coal production from the Plains region of Alberta increased to 5.6 million tons in 1974, and the industry is expected to continue expanding based on demand for coal to fuel power stations. Nearly all production in 1974 was used for mine-mouth power generation at Calgary Power Ltd.'s Wabamun and Sundance stations on Lake Wabamun and Alberta Power Limited's Battle River station east of Drumheller.

Manalta Coal Ltd. produced 4.5 million tons from Calgary Power's Highvale and Whitewood mines in 1974. With expansion of the Sundance power station to 2,100 megawatts by 1980, annual coal requirements from the Highvale mine will be nearly 8 million tons. In the Forestburg-Halkirk area east of Red Deer, Manalta and Forestburg Collieries Limited each operate a surface mine that supplies coal to Alberta Power's Battle River station. Manalta produced about 425,000 tons at its Vesta mine and Forestburg produced about 600,000 tons. Coal requirements for the Battle River station will more than triple by 1979 as capacity is increased to 740 megawatts.

Table 6. Canada, exports and imports of coal, 1973-74

	1973		1974p	
	(short tons)	$	(short tons)	$
Exports				
Japan	11,712,105	160,046,000	10,993,226	229,880,000
United States	184,001	3,241,000	396,309	11,992,000
West Germany	—	—	165,484	3,584,000
Denmark	—	—	109,039	1,653,000
Chile	114,980	1,369,000	25,760	357,000
Italy	—	—	53,698	1,193,000
France	—	—	53,480	1,045,000
United Kingdom	11,760	389,000	43,797	1,358,000
South Korea	—	—	34,646	612,000
St. Pierre-Miquelon	854	19,000	980	33,000
Total	12,023,700	165,064,000	11,876,419	251,707,000
Imports (for consumption)				
Anthracite				
United States	332,999r	5,624,000	235,276	5,052,000
Bituminous				
United States	16,014,841	160,824,000	13,410,293	296,844,000
United Kingdom	—	—	2,277	110,000
Total	16,347,840	166,448,000	13,647,846	302,006,000

Source: Statistics Canada.
p Preliminary; — Nil; r Revised.

Saskatchewan. Coal production, all lignite, comes from four surface mines in the Estevan-Bienfait region of southeastern Saskatchewan. Most production is sold to Saskatchewan Power Corporation (SPC) for use in its nearby power stations. The other important lignite market is Manitoba where shipments are made to The Manitoba Hydro-Electric Board (Manitoba Hydro) for power station use. Smaller sales are also made to industrial and local consumers.

Total lignite production in 1974 totalled some 3.8 million tons, down from 4 million tons in 1973. At Estevan, Manitoba and Saskatchewan Coal Company (Limited) produced 1.6 million tons from its new Boundary Dam mine which commenced initial production in January 1974. This mine and the nearby Utility Coals Ltd. mine, which produced some 1.3 million tons during the year, are captive suppliers to the adjacent SPC Boundary Dam power station. When the expansion at the Boundary Dam station to 882 megawatts is completed in 1977, annual coal requirements will increase to some 4.5 million tons. At Bienfait, Manalta Coal Ltd.'s Klimax mine produced some 584,000 tons in 1974 while the M & S mine of Manitoba and Saskatchewan Coal Company (Limited) produced 378,000 tons.

To the west of Estevan in the Willow Bunch area a new coal mining centre will be opening up to provide lignite for a new lignite-fired power station to be built by SPC at Poplar River near Coronach. Initial requirements for the first unit of 300 mW will be approximately 1.5 million tons a year. In northern Saskatchewan in the La Ronge area, Brascan Resources carried out an exploration and drilling program during 1974.

During 1974, the joint Government of Canada — Government of Saskatchewan drilling program to determine lignite resources in the province was expanded to include evaluation of lignite quality. The enlarged program is scheduled for completion in 1976.

New Brunswick. All coal in New Brunswick is surface mined in the Grand Lake coal basin in the Minto-Chipman area by N.B. Coal Limited, a provincial Crown company. In 1974, production increased to 415,000 tons from 394,000 in 1973. Most production is sold to the New Brunswick Electric Power Commission (N.B. Power) for use in its Grand Lake power station near Minto. Approximately 180,000 tons were delivered to pulp and paper companies in Quebec during 1974.

In 1974, a joint drilling program to update recoverable reserves in the Minto-Chipman area by the Government of New Brunswick and N.B. Power was completed. In 1975, it is planned to initiate a joint program involving the Government of Canada and the Government of New Brunswick to evaluate coal resources in the province, principally those outside the Minto basin.

Nova Scotia. In Nova Scotia, demand for both coking coal and steam coal remained high and production increased during 1974. During the year Cape Breton Development Corporation (DEVCO), which supplied all but about 75,000 tons of Nova Scotia output from

Table 7. Canada, supply and demand of coal, 1963 and 1973

	1963	1973		1963	1973
	(short tons)			(short tons)	
Supply			Demand		
Production	10,451,623	22,567,349	Residential	3,087,777	105,551
Landed imports	14,740,448	16,638,928	Railways	324,513	86,335
Total inventory change	+363,672	−232,444	Ship's bunkers	261,369	127,457
			Government and institutional	231,000	61,000
Total supply	24,828,399	39,438,721			
			Subtotal	3,904,659	380,343
Demand					
Domestic sales					
Electric utilities	5,150,179	16,673,301	Coal mine and local use	784,633	294,031
Mining and manufacturing	7,085,714	1,737,693	Unaccounted for coal	1,006,594	−152,896
Coke-making	5,842,253	8,482,549	Total domestic demand	23,774,032	27,415,021
Subtotal	18,078,146	26,893,543			
			Exports	1,054,367	12,023,700
			Total demand	24,828,399	39,438,721

Source: Statistics Canada.

the Sydney coalfield, produced 1.3 million tons compared with 1.1 million tons in 1973.

In August 1974 DEVCO's new mine at Lingan started its first longwall and by mid-November was producing at a rate of some 15,000 tons of saleable coal a week. A second and third longwall are scheduled to commence in 1975. At DEVCO's No. 26 mine at Glace Bay, a new belt-haulage system including an underground bunker was completed in 1974 replacing the rope-haulage method previously used. The No. 26 mine is DEVCO's largest producer and the main supplier of coking coal to Sydney Steel Corporation. DEVCO's No. 12 mine at New Waterford, which was closed due to an explosion and fire in 1973, was permanently sealed in 1974. Construction of a new preparation plant began in 1974 at Grand Lake midway between the Lingan and No. 26 mines. The plant, which includes facilities specifically designed to remove sulphur compounds, is scheduled for operation by late 1976. A small surface mine at Alder Point that opened in early 1974 to supplement coal deliveries by DEVCO to Nova Scotia Power Corporation was replaced in the latter part of 1974 with a new surface mine at Point Aconi.

During 1974 Thorburn Mining Limited started up a coal reclamation project at Stellarton based on a process developed by the Department of Energy, Mines and Resources. Coal is being recovered from coal waste dumps and sold to the Nova Scotia Power Corporation for power station use. Three coal mine waste dumps are to be reclaimed at an annual rate of 50,000-60,000 tons.

Exploration was active in 1974 on both Cape Breton Island and mainland Nova Scotia, with emphasis placed on proving up reserves for possible surface mining operations. During 1974 Cumberland Mining Associates conducted a drilling and assessment program in the Springhill area. A joint drilling program to be conducted by the Nova Scotia Department of Mines involving funding by the Government of Canada and the Government of Nova Scotia, is planned to commence in 1975 and will encompass several coal bearing areas of the province.

Trade and markets

Exports. In 1974 exports of bituminous coal amounted to 11.9 million tons; a slight decline from 12.0 million tons in 1973. The value of exports however, increased sharply to $252 million from $165 million in 1973. Of total exports, about 65 per cent originated from mines in British Columbia with most of the balance from Alberta. Export shipments accounted for approximately one half of total production and 88 per cent of bituminous coal production. Japan received nearly 11 million tons or 93 per cent of total exports compared with 11.7 million tons or 97 per cent in 1973. All shipments to Japan were of coking quality. Spot shipments nearly tripled in 1974 to 900,000 tons as shipments of both steam coal and coking coal were made to nine countries, including shipments of over 100,000 tons to three, namely the United States, West Germany and Denmark.

Imports. Canada imported 13.6 million tons in 1974, a decrease of nearly 2.7 million tons from 1973. Bituminous coal accounted for 13.4 million tons with the rest being anthracite. With the exception of a small spot shipment from the United Kingdom all imports were from the Appalachian region of the eastern United States. The sharp fall in imports from the United States was, in large part, due to the coal miners strike late in the year, shortages of rail hopper cars and a Great Lakes shippers strike during August and September. About 6.6 million tons or 49 per cent of bituminous coal imports were imported for thermal power generation use in Ontario with approximately 5.5 million tons imported for coke-making purposes. The balance of imports was used for heating and specialty markets.

Thermal power industry

Coal used for the generation of electricity in Canada totalled some 17 million tons in 1974, up slightly from 16.6 million tons in 1973. Approximately 9.6 million tons were domestic coals and the remainder was imported coal for Ontario. At the end of 1974 total capacity of power stations in Canada having coal-fired capability stood at some 11,400 megawatts (mW). New coal-fired capacity under construction, announced or planned for installation by 1981 totals some 5,000 mW. In addition major expansion is proposed for the 1981–1985 period, particularly in the coal producing provinces of western Canada. Indeed, British Columbia Hydro and Power Authority (B.C. Hydro), which has no coal-fired stations in its system, is actively investigating the development of the Hat Creek lignite deposit near Ashcroft for major power generation use by the mid-1980s.

Ontario Hydro is the largest user of coal in Canada. In 1974 Ontario Hydro burned some 7.4 million tons of bituminous coal, virtually all imported from the United States. A total of 6.6 million tons were imported during the year; the balance coming from stockpiles. At present nearly all Ontario Hydro's coal demands are met by long-term supply contracts with coal companies in West Virginia and Pennsylvania. Consolidation Coal Company and Eastern Associated Coal Corp. are the two main suppliers to Ontario Hydro. During 1974 Ontario Hydro announced that agreement had been reached with United States Steel Corporation for the development of a new thermal coal mine in Pennsylvania. Ontario Hydro will invest up to $38 million in the project and receive 3 million tons a year over a 30-year period. Initial deliveries from the mine are scheduled to begin in 1977, with shipments of 3 million tons annually expected in 1979.

Expansion of Ontario Hydro's Nanticoke power station on Lake Erie continued as the fourth 500 mW unit came on line. When completed in 1977 Nanticoke will be the largest thermal power station in Canada

Table 8. Canada — Japan contracts for coking coal[1]

Company	Importing Agent	Purchasers	Basic Annual Shipments	Present Contract Expiry Date	Basic Price[2] (fob port)	Overland Trans-portation	Shipping Terminal
			(millions of long tons)		($ Cdn.)		
The Canmore Mines, Ltd., Canmore, Alberta.	Toyo Menka Kaisha Ltd.	Mitsubishi Chemical Industries Ltd., Tokyo Gas Co., Toho Gas Co.	0.15	1977	$40.97	CP Rail	Port Moody
Cardinal River Coals Ltd., Luscar, Alberta.	C. Itoh & Co., Mitsui & Co., Ltd.	Nippon Steel Corporation Nippon Kokan Kaisha Kawasaki Steel Corp., Sumitomo Metal Industries Ltd. Kobe Steel Ltd.	1.5	1985	48.55	Canadian National	North Vancouver
Coleman Collieries Ltd., Coleman, Alberta.	Toyo Menka Kaisha Ltd., Marubeni-Iida Co.	Nippon Steel Corp., Nippon Kokan Kaisha Kawasaki Steel Corp., Sumitomo Metals Industries Ltd., Kobe Steel Ltd., Nisshin Steel Co. Ltd. Nakayama Steel Works Ltd., Osaka Iron and Steel Co. Ltd.,	0.75	1978	45.96	CP Rail	Port Moody
Fording Coal Ltd., Elkford, British Columbia.	Marubeni-Iida Co., Mitsui & Co., Ltd.	Nippon Steel Corp., Nippon Kokan Kaisha Kawasaki Steel Corp., Sumitomo Metal Industries Ltd. Kobe Steel Ltd., Nisshin Steel Co. Ltd., Nakayama Steel Works Ltd., Osaka Iron and Steel Co. Ltd.,	3.0	1986	47.00[3]	CP Rail	Roberts Bank
Kaiser Resources Ltd., Sparwood, British Columbia	Mitsubishi Corporation	Nippon Steel Corp., Nippon Kokan Kaisha Kawasaki Steel Corp., Sumitomo Metal Industries Ltd., Kobe Steel Ltd., Nisshin Steel Co. Ltd., Osaka Iron and Steel Co. Ltd., Yahagi Iron Co. Ltd.,	4.5	1985	48.57	CP Rail	Roberts Bank
McIntyre Mines Limited, Grande Cache, Alberta	Kawatetsu Trading Co., Mitsubishi Corp., Marubeni-Iida Co., Sumitomo Shoji, Nissho-Twai Ltd.	Nippon Steel Corp., Nippon Kokan Kaisha Kawasaki Steel Corp., Sumitomo Metal Industries Ltd., Kobe Steel Ltd., Nisshin Steel Co. Ltd. Nayakayama Steel Works Ltd., Osaka Iron and Steel Co., Ltd.,	1.5	1978	58.57	Alberta Resources Railway & Canadian National	North Vancouver

[1] As of April 1, 1975. [2] Does not include railroad price increases from April 1, 1975. [3] Interim price.

with total capacity of 4,000 mW and will consume annually some 7.5 million tons of bituminous coal. The station was shut down for nearly four and one-half months in 1974, following a fire in the No. 2 unit in late July. The entire station was shut down until mid-December to allow investigators to determine the cause of the accident. The damaged unit will not be ready for operation until late 1975. Plans are underway for the construction at Thunder Bay, Ontario of two lignite-fired, 150 mW units to be added by 1980–81 to

Table 9. Principal coal-fired thermal power stations in Canada, 1974

Utilities	Station	Total Station Capacity (kilowatts)	Remarks
Nova Scotia			
1. Nova Scotia Power Corporation	Glace Bay	111,000	4 small units converted to dual firing with oil or coal
2. Nova Scotia Power Corporation	Trenton	210,000	
3. Nova Scotia Power Corporation	Harrison Lake	25,000	One unit of 1,500 kW capacity discontinued in 1973
New Brunswick			
4. New Brunswick Electric Power Commission	Chatham	32,500	
5. New Brunswick Electric Power Commission	Grand Lake No. 1	13,750	
New Brunswick Electric Power Commission	Grand Lake No. 2	85,000	
Ontario			
6. Ontario Hydro	Richard L. Hearn	1,222,500	
7. Ontario Hydro	Lakeview	2,422,500	
8. Ontario Hydro	Nanticoke	2,022,500	Four 500 mW units to be added by 1978
9. Ontario Hydro	J. Clark Keith	271,500	
10. Ontario Hydro	Lambton	2,022,500	
11. Ontario Hydro	Thunder Bay	128,300	Two 150 mW lignite-fired units to be added by 1980
Manitoba			
12. Manitoba Hydro	Selkirk	155,800	
13. Manitoba Hydro	Brandon	237,000	
Saskatchewan			
14. Saskatchewan Power Corporation	Estevan	70,000	
15. Saskatchewan Power Corporation	Boundary Dam	582,000	300 mW addition scheduled for 1977
16. Saskatchewan Power Corporation	Queen Elizabeth	232,000	
Alberta			
17. Alberta Power Limited	Drumheller	15,000	Operated only briefly in 1974
18. Alberta Power Limited	Battle River	212,000	150 mW addition scheduled for 1975, and 375 mW addition for 1979
19. Calgary Power Ltd.	Wabamun	582,000	
20. Calgary Power Ltd.	Sundance	600,000	Four 375 mW units to be added by 1980
21. Alberta Power Limited	H.R. Milner	150,000	

Source: Statistics Canada.

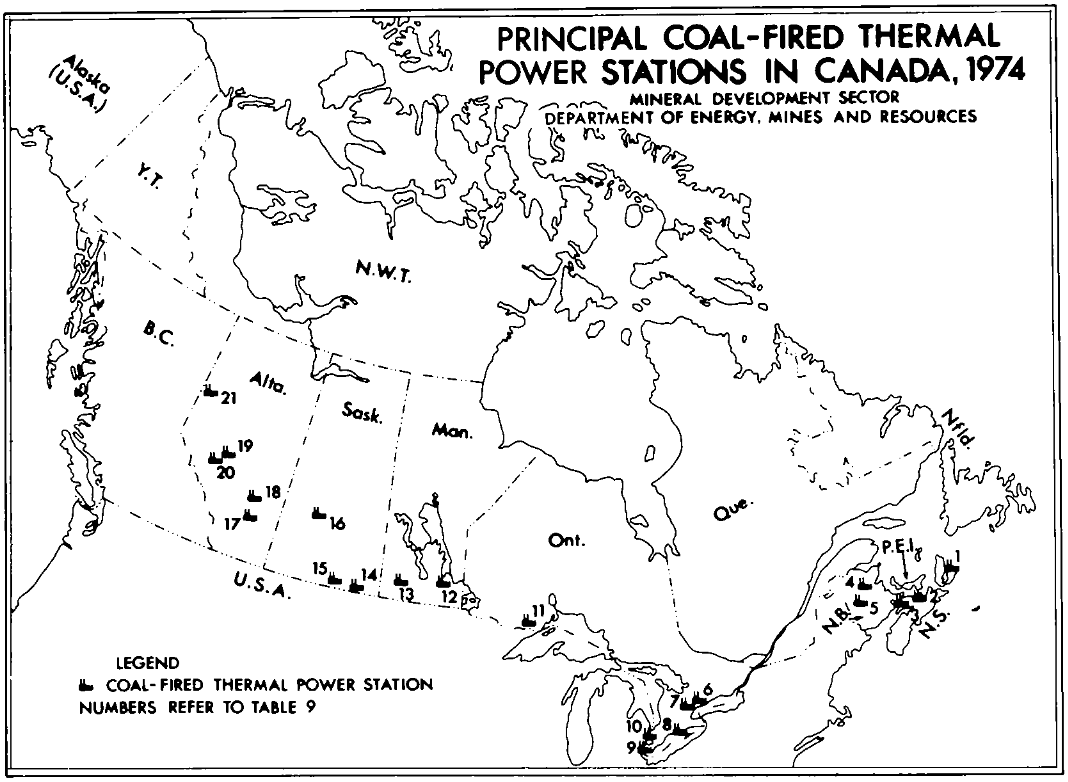


Table 10. Coal used by thermal power stations in Canada, by provinces, 1959-1974

	Nova Scotia	New Brunswick	Ontario	Manitoba	Saskat-chewan	Alberta	Total Canada
			(thousands of short tons)				
1959	426	141	196	34	435	187	1,419
1960	494	202	118	56	770	206	1,846
1961	504	168	272	116	964	229	2,253
1962	515	121	1,493	111	1,129	356	3,725
1963	534	107	2,807	66	1,054	582	5,150
1964	584	245	3,081	145	1,109	1,101	6,265
1965	698	368	3,932	193	1,196	1,335	7,722
1966	881	324	3,858	87	1,230	1,499	7,879
1967	835	303	4,889	42	1,471	1,573	9,113
1968	712	264	6,088	197	1,492	2,346	11,099
1969	745	165	7,082	56	1,238	2,621	11,907
1970	604	125	8,483	555	2,170	3,253	15,190
1971	759	299	9,436	492	2,200	4,027	17,213
1972	731	310	8,376	452	2,364	4,534	16,767
1973	645	213	7,292	425	3,093	4,932	16,600
1974[p]	663	322	7,409	145	3,199	5,259	16,997

Source: Statistics Canada.
[p] Preliminary; — Nil.

the existing 128 mW coal-fired station. Annual lignite consumption for these two new units is estimated to be some 1.3 million tons. A new 800 mW coal-fired station is also planned for this region near Atikokan and is proposed to be brought on line in the 1981 – 1985 period.

During 1974 Ontario Hydro tested a number of samples of high Btu bituminous coals from western Canadian coal properties. These included shipments from Byron Creek Collieries and Kaiser Resources Ltd., in British Columbia and Consolidation Coal Company of Canada (Grassy Mountain), Luscar Ltd., and Manalta Coal Ltd. (Coal Branch) and Canpac Minerals Limited (Lethbridge region) in Alberta. This program will continue in 1975 with emphasis placed on blending of washed coals. Ontario Hydro tentatively plans to take up to 3 million tons of western Canadian coals by 1978 if tests of these coals prove successful and if negotiations can be completed for long-term production and transportation commitments.

During 1974, plans were announced by Federal Industries Ltd. to build a new coal handling terminal on McKellar Island at Thunder Bay. The project is estimated to cost some $30 million and to take two years to construct. The terminal can be served by both the Canadian National and Canadian Pacific railroads. Initial throughput of 3 million tons is planned for 1977, with Ontario Hydro considered to be the main customer. However, in early 1975 it was announced that construction would be delayed because negotiations between Ontario Hydro and coal suppliers had not yet been completed.

In Alberta, Calgary Power Ltd. received approval in 1974 for the addition of another 375 mW unit to its Sundance power station located on the south shore of Lake Wabamun. This will be the third 375 mW unit and the fifth unit to be added at Sundance. Application has now been made for the addition of another 375 mW unit. With completion of the sixth unit total capacity of the Sundance station will be 2,100 mW. At this rated gross capacity, the station will require some 8 million tons of subbituminous coal annually from the nearby Highvale mine making Sundance the largest single user of coal in Canada. Calgary Power is actively considering the development of a new power station in the Dodds-Round Hill area southeast of Edmonton where the company has extensive coal holdings. Development of this site would be for the 1980–85 period.

At Forestburg, Alberta Power Limited continued construction of a 150 mW addition to its Battle River power station which is scheduled for commissioning in late 1975. A new 375 mW unit was approved in 1974 and is scheduled for completion in 1979–80. Additional expansion is also being considered for this station in the 1980–85 period. At Grande Cache, where Alberta Power brought the H.R. Milner 150 mW station on line in 1973, inappropriate middling supply from the nearby coal preparation plant of McIntyre Mines forced the station to switch to a blend of oxidized coal and primary rejects from the preparation plant.

In Saskatchewan, a 300 mW addition is under construction at the Boundary Dam power station at Estevan. Upon completion in 1977, total capacity of the six units at the station will be 882 which will require some 4.5 million tons of lignite annually. Lignite is supplied by two nearby mines, the Utility Coals Ltd., mine and the Manitoba and Saskatchewan Coal Company (Limited's) Boundary Dam mine, which commenced production in January 1974. During 1974, studies continued, and hearings were held to assess the siting of a new lignite-fired station on the Poplar River near Coronach in the Willow Bunch area of southern Saskatchewan. Approval for the station was given by the Government of Saskatchewan in early 1975. Initially, the Poplar River station is to have capacity of 600 mW with the first 300 mW unit scheduled for service in mid-1979. A new lignite mine will be developed nearby.

In Manitoba at Brandon and Selkirk dual-fired power stations of Manitoba Hydro had a combined capacity of 393 mW. In recent years these stations have been using approximately 400,000 — 450,000 tons in total of Saskatchewan lignite annually. However, coal use was reduced substantially to 145,000 tons in 1974 as Manitoba Hydro utilized its available hydro capacity.

In New Brunswick, the New Brunswick Electric Power Commission operates its Grand Lake power station on high-volatile bituminous coal mined from the nearby Minto coalfield. The dual-fired station at Chatham also uses some coal. Consideration is being given to the addition of a 200 mW dual-fired unit at Dalhousie to burn coal and oil for service in the late 1970s. Approximately 300,000 tons of coal would be required annually for this new unit.

The Nova Scotia Power Corporation operates three coal-fired power stations in the province fuelled with high-volatile bituminous coals from Nova Scotia. The bulk of the coal comes from the mines of DEVCO on Cape Breton Island. In 1974 modifications were completed at the Glace Bay station to improve efficiency and the reliability for the supply of steam to the nearby Glace Bay heavy-water plant. During the year Nova Scotia Power continued to evaluate the possibility of adding new coal-fired capacity to its system. The location and size of such expansion is mainly dependent upon adequate supplies of coal being made available, sufficient for the service life of any new generating unit.

Coke industry

In 1974, approximately 8.3 million tons of coking coal were carbonized to produce 6.0 million tons of coke. About 90 per cent of the coking coal used in Canada was imported from the United States. The three steel companies in Ontario operate coke oven plants in Hamilton and Sault Ste. Marie. All have captive United

States mines and long-term contracts. In Sydney, Nova Scotia, the Sydney Steel Corporation uses a combination of Nova Scotia and United States coals to produce coke for its steel mill. The integrated steelmakers account for over 90 per cent of coke production in Canada.

During 1974 coal production from United States mines was disrupted due, largely, to coal mine strikes and a Great Lakes shipping strike. Moreover, shipments were affected by a shortage of rail cars. Thus deliveries to Ontario steel mills were less than anticipated and, consequently, necessitated some reduced coke oven operation and reductions of inventories of both coal and coke. The Great Lakes shipping season was extended to mid-January 1975 to facilitate the late movement of coal into Ontario.

Of the approximately 5.5 million tons of coking coal imported from the United States in 1974 approximately 3.1 million tons or some 55 per cent came from captive mines. Approximately 5.0 million tons, or 83 per cent of coke produced in Canada, was charged to blast furnaces for pig iron production. The remainder of the coke was consumed by foundries, chemical plants and nonferrous metal smelters. The market for coke byproducts such as gas, ammonia, tar and light oils is limited in Canada mainly because of competition from petroleum-based products. However, the steel companies attempt to use as many coke byproducts as possible in their operations.

Coke trade usually is small, but large fluctuations, mainly because of cyclical demand, can occur. In 1974 shipments of some 288,000 tons, valued at $9.5 million, were exported to four countries, with the bulk going to the United States. Imports of coke amounted to 406,000 tons, valued at $35.5 million, with shipments coming from the United States, West Germany and the United Kingdom.

In 1974, an average of 1.44 tons of coking coal was required to produce a ton of coke in Canada. The coke rate, the amount of coke consumed per ton of pig iron produced in blast furnaces was 1,020 pounds, down 10 pounds from the rate in 1973. Based on these two factors it is estimated that, in 1974, about 1,460 pounds (0.73 ton) of coking coal were required per ton of basic pig iron produced in Canada.

About 95 per cent of the coke produced in Canada is manufactured in standard slot-type ovens at coke oven plants in Ontario, Nova Scotia and Quebec. The three largest coke oven plants are owned and operated by integrated steel companies, The Algoma Steel Corporation, Limited, The Steel Company of Canada, Limited, and Dominion Foundries and Steel, Limited.

The Steel Company of Canada (Stelco) imports the bulk of its coking coal from subsidiary and joint-venture mines in the United States for its coke oven facilities in Hamilton, Ontario. In 1974 some 3,285,644 tons of coal were charged to coke ovens to produce some 2,232,000 tons of coke.

The new Beckley mine in West Virginia in which Stelco has a 12.5 per cent equity interest commenced production in 1974. Annual capacity of 1.5 million tons of low-volatile bituminous coal is scheduled to be reached in 1976 with Stelco's share to be a minimum of 187,500 tons yearly. At Stelco's Griffith iron ore mine in northwestern Ontario a SL/RN kiln was being built in 1974 for start up in mid-1975. This direct reduction process will use Alberta subbituminous coal as the reducing agent in the production of concentrated metallic iron. Up to 400,000 tons of coal, to be shipped from the Forestburg area of Alberta, will be required annually. During 1974, Stelco purchased some 200,000 tons of low-volatile bituminous coking coal from McIntyre Mines Limited of Alberta for use in the blast furnaces in Hamilton. A similar quantity will be taken from McIntyre in 1975 and, in addition, some 100,000 tons will be taken from Kaiser Resources Ltd.

The Algoma Steel Corporation, Limited (Algoma) of Sault Ste. Marie, Ontario produced some 1,462,000 tons of coke in 1974 from 2,148,000 tons of coking coal. During 1974 construction continued on the new No. 9 coke battery which is scheduled for operation in late 1975. Rehabilitation of the No. 7 coke battery is also planned for 1975. Construction of the new No. 10 coke battery, which is to be the same size as No. 9, began in 1974.

Algoma brought its new low-volatile bituminous coal Maple Meadow mine at Fairdale, West Virginia on stream in late 1974. Rated capacity is 1.25 million tons annually. Starting in 1976, 400,000 tons of annual production from this mine is to be sold to Stelco. Algoma expanded its coal supply capacity in the United States with the acquisition of a high volatile bituminous coal producing property in West Virginia in 1974. This Indian Creek mine, presently producing 500,000 tons annually, will be expanded to produce some 1.5 million tons annually. Algoma tested some coking coal from western Canada in 1974 and will continue this program in 1975.

Dominion Foundries and Steel, Limited's (Dofasco) coke oven plant at Hamilton produced some 1.2 million tons of coke in 1974. The annual coking coal requirements are approximately 1.8 million tons. Coking coal is imported from the United States with approximately 1.7 million tons or some 95 per cent of Dofasco's requirements provided through long-term agreements and the company's 9 per cent interest in Ittman Coal Company of West Virginia. Approximately one million tons annually is supplied by the Eastern Associated Coal Corp. and some 250,000 tons by Ittman. Dofasco is pursuing ownership interests in both western Canada and the United States for future supplies of coking coal. In 1974, Dofasco tested coal shipments from Kaiser Resources Ltd. and will receive some 100,000 tons from Kaiser in 1975.

During 1974, the coke ovens of Sydney Steel Corporation (Sysco) in Sydney, Nova Scotia produced some 510,000 tons of coke from 723,000 tons of coking coal. The bulk of the coal was supplied from DEVCO's

Table 11. Coke oven and other carbonization plants in Canada

Company	Battery and No. of Ovens	Oven Type	Year Built	1974 Plant Capacity (coal input)	1974 Coke Production	Byproducts
				(thousands of tpy)		
The Algoma Steel Corporation, Limited, Sault Ste. Marie, Ontario	No. 5 — 86	Koppers-Becker Underjet	1943	2,200	1,462	Naphthalene, light oil, gas, tar
	No. 6 — 57	Koppers-Becker Underjet	1953			
	No. 7 — 57	Wilputte Underjet	1958			
	No. 8 — 60	Wilputte Underjet	1967			
	No. 9 — 60	Wilputte Underjet	Scheduled for operation in 1975			
	No. 10 — 60	Wilputte Underjet	New battery under construction			
The Steel Company of Canada, Limited, Hamilton, Ontario	No. 3 — 61	Wilputte Underjet	1947	3,400	2,232	Tar, sulphate of ammonia, sodium phenolate, gas, light oil
	No. 4 — 83	Wilputte Underjet	1952			
	No. 5 — 47	Wilputte Underjet	1953			
	No. 6 — 73	Otto Underjet	1967			
	No. 7 — 83	Otto Underjet	1972			
Dominion Foundries and Steel, Limited, Hamilton, Ontario	No. 1 — 25	Koppers-Becker Gun Type Comb	1956	1,800	1,239	Tar, light oil, gas, ammonium sulphate, sulphur
	No. 2 — 35	Koppers-Becker Gun Type Comb	1951			
	No. 3 — 45	Koppers-Becker Gun Type Comb	1958			
	No. 4 — 53	Koppers-Becker Gun Type Comb	1967			
	No. 5 — 53	Koppers-Becker Gun Type Comb	1971			
Sydney Steel Corporation, Sydney, Nova Scotia	No. 5 — 53	Koppers-Becker Underjet	1949	900	510	Tar, crude oil, gas
	No. 6 — 61	Koppers-Becker Underjet	1953			
Gaz Metropolitain, inc., Ville la Salle, Quebec	No. 1 — 59	Koppers-Becker	1928	345	226	Tar, light oil, gas
	No. 2 — 15	Koppers-Becker	1947			
Manitoba and Saskatchewan Coal Company (Limited), Char and Briquetting Division, Bienfait, Saskatchewan	2 units	Lurgi carbonizing retort	1925	110	35 (char)	Creosote, lignite tar, lignite pitch
Kaiser Resources Ltd., Natal, British Columbia	10 units	Curran-Knowles	1939	245	154	Crude tar, gas, coke breeze
	10 units	Curran-Knowles	1943			
	16 units	Curran-Knowles	1949			
	16 units	Curran-Knowles	1952			
	3 units	Mitchell	1963			

Table 12. Canada, coal coke production and trade, 1973-74

	1973		1974p	
	(short tons)	$	(short tons)	$
Production				
Ontario	5,038,112	*	5,100,000	*
Other provinces	881,147	*	900,351	*
Total	5,919,259	*	6,000,351	*
Imports				
United States	338,758	12,751,000	415,250	21,929,000
West Germany	55,666	1,747,000	80,258	8,007,000
United Kingdom	—	—	65,632	5,594,000
Total	394,424	14,498,000	561,140	35,530,000
Exports				
United States	303,504	9,313,000	177,976	7,640,000
West Germany	55,049	656,000	74,328	1,304,000
Romania	27,803	404,000	—	—
Netherlands	16,045	222,000	18,268	279,000
Japan	—	—	17,012	231,000
Belgium-Luxembourg	3,153	29,000	—	—
Greenland	4	1,000	—	—
Total	405,558	10,625,000	287,584	9,454,000

Source: Statistics Canada.
* Practically all coke production is used by producers in the iron and steel industry and is not given a value.
p Preliminary; — Nil.

Table 13. Canada, coke production and trade, 1970-1974.

	Production		Imports		Exports	
	Coal Coke	Petroleum Coke	Coal Coke	Petroleum Coke	Coal Coke	Petroleum Coke
	(short tons)					
1970	5,668,219	207,649	394,953	779,079	273,890	53,289
1971	5,105,792	206,439	646,428	733,890	317,765	12,314
1972	5,154,260	267,167	509,065	612,565	262,877	971
1973	5,919,259	315,845	394,424	702,904	405,558	2,167
1974p	6,000,351	302,487	561,140	822,361	287,584	27,492

Source: Statistics Canada.
p Preliminary.

No. 26 mine with the remainder from the eastern United States. In 1975, Sysco plans to take up to 150,000 tons of coking coal from McIntyre Mines, Limited in Alberta and some 30,000 tons of coking coal from Poland.

The Lasalle Coke division of Gaz Metropolitain, inc. in Montreal produces coke mainly for foundry use from imported United States coals. In 1974, 226,000 tons of coke were produced from 289,000 tons of coal. Trial shipments of western Canadian coking coal are planned for 1975.

Kaiser Resources Ltd. produces coke at its plant at

Natal, British Columbia. In 1974, 154,000 tons of coke were produced from coal produced at the nearby Michel colliery. This coke is sold mainly for use in non-ferrous smelters.

At Bienfait, Saskatchewan the Manitoba and Saskatchewan Coal Company (Limited) produced about 35,000 tons of char from lignite during 1974. A large portion of the char is exported to the United States.

Table 14. World coal production

	1969	1970	1971	1972	1973[p]
	(thousands of short tons)				
North America	573,910	622,918	574,557	620,084	618,366
South America	9,000	7,777	8,031	8,595	8,444
Europe	1,744,425	1,782,768	1,897,001	1,874,611	1,901,022
Africa	61,108	63,227	67,826	68,066	72,687
Asia	521,844	558,517	556,275	564,632	591,222
Oceania	79,247	83,524	82,132	94,274	96,837
World					
Lignite (estimate)	838,245	869,626	881,458[r]	886,414[r]	903,072[e]
Bituminous and anthracite (by subtraction)	2,151,289	2,249,105	2,304,364	2,343,848	2,385,506
Total, all types	2,989,534[r]	3,118,731	3,185,822[r]	3,230,262[r]	3,288,578[e]

Source: U.S. Bureau of Mines.
[p] Preliminary; [r] Revised; [e] Estimated.

Cobalt

MICHEL A. BOUCHER

Cobalt production in 1974 by the three Canadian producers increased from 3,344,352 pounds in 1973 to 4,240,000 pounds. World production of cobalt in 1974 is estimated at 29,620,000 pounds, compared with 27,954,000 in 1973.

Demand for cobalt in 1974 was very strong until the end of the year when the general decline in economic activity led to a decrease in demand. During the year the price of cobalt metal increased from $3.20 a pound in January 1974 to $3.75 by year-end.

Cobalt production is highly inelastic, since virtually all world production is obtained as a byproduct of the copper and nickel industries and thus supply at any time is controlled largely by supply-demand interactions in the copper and nickel markets. The Republic of Zaire accounts for about 60 per cent of world production, with Zambia, Canada and Morocco responsible for 20 per cent.

Canadian production, developments and consumption

The three producers of cobalt in Canada: The International Nickel Company of Canada, Limited (Inco); Falconbridge Nickel Mines Limited, and Sherritt Gordon Mines Limited, produced a total of 4,240,000 pounds of contained cobalt in 1974. The largest producer is Inco, which recovers cobalt in the form of crude oxide at its nickel refineries at Port Colborne, Ontario and Thompson, Manitoba. Ungraded cobalt oxides and salts are recovered at the company's nickel refinery at Clydach, Wales. Also Inco has a new refinery at Copper Cliff, Ontario, where it intends to produce high-purity cobalt salts. Falconbridge Nickel Mines Limited recovers cobalt at its refinery in Kristiansand, Norway. The company has postponed indefinitely the construction of its refinery at Becancour, Quebec where some 500,000 pounds of high-purity cobalt salts a year were to be produced.

Sherritt Gordon Mines Limited recovers metal powder from nickel refinery end-solutions at its hydrometallurgical refinery at Fort Saskatchewan, Alberta. The refinery treats nickel-copper concentrates from its Lynn Lake mine operation in Manitoba and also, on a toll basis, concentrates from the Giant Mascot Mines Limited mine near Hope, British Columbia and from Western Mining Corporation Limited's nickel operations in Western Australia.

In the short-term, no major new nickel developments are due to come on stream in Canada so cobalt production is expected to remain relatively stable.

Major consumers in Canada

Cobalt metal. Atlas Steels, Division of Rio Algom Mines Limited; Canadian General Electric Company Limited; (CGE) Deloro Stellite, Division of Canadian Oxygen Limited; Dussek Brothers (Canada) Limited; The Indiana Steel Products Company of Canada Limited; Macro Division of Kennametal Inc.; and Nuodex Products of Canada, Limited.

Cobalt oxide. Ferro Industrial Products Limited; Consumers Glass Company, Limited; Dominion Glass Company, Limited.

Cobalt salts. Dussek Brothers (Canada) Limited; Nuodex Products of Canada Limited; Domtar Chemicals Limited; The Canadian Salt Company Limited.

These companies account for over 90% of the total Canadian consumption of cobalt, which was 408,000 pounds in 1974.

World development

One new source of cobalt came on stream in 1974 when Amax Inc. rehabilitated its nickel-cobalt refinery at Port Nickel, Louisiana. Plans call for the production of 600 tons of cobalt; half from Botswana feed, and half from New Caledonia nickel matte. Amax holds shares in each of its suppliers.

In 1975 two cobalt refineries are scheduled to begin production in Japan. They are Sumitomo Metal Mining Co. Ltd. and Nippon Mining Co. Ltd. Plant capacities will be 1,500–1,600 tons per year (tpy) for Sumitomo and 1,200 tpy for Nippon.

Sumitomo will refine mixed nickel-cobalt sulphides imported from Marinduque Mining and Industrial Corporation in the Philippines, which began production of nickel and cobalt late in 1974. Production capacity is 1,650 tpy of cobalt in mixed sulphides. Nippon will refine mixed nickel-cobalt sulphides from Australia. The likely source is Queensland Mines Limited, which was scheduled to begin production late in 1974. Production from Queensland is expected to be

Table 1. Canada, cobalt production, trade and consumption, 1973-74

	1973		1974p	
	(pounds)	($)	(pounds)	($)
Production[1] (all forms)				
Ontario	2,528,297	6,913,957	3,566,000	12,110,000
Manitoba	775,148	1,867,840	674,000	2,165,000
British Columbia	40,907	117,403	—	—
Total	3,344,352	8,899,200	4,240,000	14,275,000
Exports				
Cobalt metal				
United States	1,165,775	3,529,000	1,006,569	3,472,000
South Africa	11,611	35,000	16,052	171,000
France	13,743	44,000	13,911	52,000
United Kingdom	12,261	53,000	8,411	46,000
Japan	9,311	49,000	6,355	29,000
Other countries	1,673	10,000	5,542	17,000
Total	1,214,374	3,720,000	1,056,840	3,787,000
Cobalt oxides and hydroxides[2]				
United Kingdom	954,500	1,601,000	1,444,500	3,241,000
United States	175,100	325,000	—	—
Total	1,129,600	1,926,000	1,444,500	3,241,000
Consumption[3]				
Cobalt contained in:				
Cobalt metal	291,858	..	281,858	..
Cobalt oxide	61,321	..	46,526	..
Cobalt salts	78,241	..	80,445	..
Total	431,420	..	408,829	..

Source: Statistics Canada.
[1] Production (cobalt content) from domestic ores. [2] Gross weight. [3] Available data reported by consumers.
p Preliminary; — Nil; .. Not available.

650 tons of cobalt metal and approximately 3,900 tpy of mixed nickel-cobalt sulphides. Output from these two refineries in Japan will cover about half of Japan's domestic needs of about 4,500 tpy which are presently imported, principally from Zaire. As a result, increased supplies should become available from Zaire for western markets.

In the Republic of Zaire, Société Minière de Tenke Fungurume is scheduled to start production of 130,000 tpy of copper and 6,500 tpy of cobalt by 1977.

The economics of recovery for lateritic nickel ores, which contain cobalt, changed significantly as a result of the increases in the price of oil. Pyrometallurgical techniques designed to produce ferronickel and nickel oxide, with no recovery of cobalt, were favoured prior to the increase in oil prices. Re-evaluation of some projects and modifications to processing techniques could result in the recovery of more cobalt than was previously expected.

Two lateritic nickel deposits are scheduled to come into production in 1976 and could provide additional supplies of cobalt. In Indonesia, P.T. International Nickel Indonesia will begin production of a nickel-cobalt matte in 1976. Initial production is 16 million pounds a year of contained nickel, and plans to increase production to 40 million pounds a year of contained nickel have been submitted to the Indonesian government. In Guatemala, the Exploraciones y Explotaciones Mineras Izabal, S.A. (Exmibal) project is scheduled to produce 2.5 million ppy of nickel, contained in a nickel matte, in 1976. Both projects are controlled by Inco.

Morocco has a new five-year plan, which calls for cobalt output from the Bow Azzer deposit to

Table 2. Canada, cobalt production, trade and consumption, 1965-74

		Exports			Imports	
	Production[1]	Cobalt Metal	Cobalt Oxides and Hydroxides	Cobalt Ores[2]	Cobalt Oxides[2]	Consumption[3]
			(pounds)			
1965	3,648,332	292,191	1,414,200	..	..	366,036
1966	3,511,169	627,990	1,308,300	..	..	392,177
1967	3,603,773	1,498,559	1,934,500	..	..	293,086
1968	4,029,549	1,210,909	1,646,500	..	..	358,098
1969	3,255,623	1,155,291	1,199,800	..	..	393,658
1970	4,561,213	839,849	1,845,000	..	..	327,030
1971	4,323,318	748,502	2,466,500	..	..	220,994
1972	3,351,108	860,481	1,615,700	..	..	381,260
1973	3,344,352	1,214,374	1,129,600	..	..	431,420
1974p	4,240,000	1,056,840	1,444,500	..	..	408,829

Source: Statistics Canada.
[1] Production from domestic ores, cobalt content. From 1967, production includes cobalt content of Inco and of Falconbridge shipments to overseas refineries, but prior years exclude Inco shipments to Britain. [2] Gross weight. [3] Consumption of cobalt in metal, oxides and salts.
p Preliminary; — Nil; .. Not available.

reach nearly 9,000 tons by 1977. The U.S.S.R. is also reported to be planning substantial increases in cobalt production.

Current technology and uses

The major applications of cobalt materials are currently divided between four principal markets: the fields of heat-resisting alloys and superalloys; the permanent magnet materials; tool, die and wear-resistant alloys; and nonmetallic uses.

The largest application is in high temperature, cobalt-base alloys used in parts such as nozzle guide vanes and turbine rotor blades in the gas turbine industry. Cobalt-base superalloys are continuing to increase in importance in the fields of industrial and marine turbine applications, especially with the increasing development of high-chromium compositions having high-oxidation and corrosion resistance. Continuing development of the superalloy field is strongly dependent on the aerospace industry and increasing applicability in the pyrometallurgical and chemical industries.

The use of cobalt in various magnetic materials continues to expand, especially in the electronic and electrical industries. The principal types of cobalt-containing magnet materials are the magnet steels used for soft and permanent magnets, with cobalt contents varying from a fraction of one per cent to more than 50 per cent. The Alnico steels containing aluminum, nickel and cobalt are used extensively in d.c. electrical motors and generators, where they compete directly with another group of cobalt-containing materials called ferrites — magnetic iron oxides — such as $CoFe_2O_4$. The most recently developed permanent magnet alloys are cobalt-rare earths permanent high

Table 3. World production of Cobalt, 1972-74

	1972	1973	1974p
	(short tons of contained cobalt)		
Republic of Zaire	14,453	16,625	17,000
Zambia	2,300	2,200	2,300
Canada	1,676	1,672	2,120
U.S.S.R.	1,800	1,850	..
Cuba	1,700	1,800	..
Morocco	1,766	1,567	1,600
Finland	1,400	1,400	..
Australia	830	840	1,000
Total	25,925	27,954	29,620[1]

Sources: U.S. Bureau of Mines, *Minerals Yearbook Report for 1972-73;* for 1974 *U.S. Commodity Data Summaries* January 1975; for Canada, Statistics Canada.
[1] Total includes estimates for unavailable figures 1974 = 5600.
p Preliminary; .. Not available.

energy magnets containing 60 to 70 per cent cobalt. Because of their high costs, however, these magnets are restricted to use in high-performance instruments produced in limited quantities. Their costs would be reduced with the development of high-volume use such as an in-house application.

Table 4. United States, consumption of cobalt by uses, 1972-73

	1972	1973
	('000 lbs. cobalt content)	
Steel (ingots and castings)		
High-speed and tool	361	518
Stainless steel	39	32
Alloy (excluding stainless and tool)	227	273
Cutting and wear-resistant materials		
Cemented or sintered carbides	1,273	2,511
Other materials	3,688	4,037
Welding and hardfacing rods materials	199	391
Magnetic alloys	3,441	4,302
Non-ferrous alloys	651	789
Electrical materials	..	..
Chemical and Ceramic uses		
Catalysts	702	1,150
Ground coat frit	144	165
Glass decolorizer	61	64
Pigments	165	217
Other	173	197
Miscellaneous and unspecified	315	526
Salts and driers; lacquers, varnishes, paints, inks, pigments enamels, feeds electroplating (estimate)	2,691	3,569
Total	14,130	18,741

Sources: U.S. Bureau of Mines, *Mineral Yearbook, 1972* and preprint from the U.S. Bureau of Mines, *Mineral Yearbook, 1973.*

.. Not available.

Other uses of metallic cobalt are the production of wear-resistant alloys for high-speed tools, cemented carbides, glass-metal seal alloys in the scientific and engineering industries, and springs and balance wheels in precision instruments such as watches. Certain Co-Cr alloys are also finding increased acceptance in the dental and surgical fields as prosthetic devices and in surgical implants.

Nonmetallic uses of cobalt are also increasing and now consume 30 per cent of total cobalt production in such uses as driers in paints, varnishes, printing inks and enamels, and in chemicals, pigments and animal feeds. Increasing applications are being found for cobalt as catalysts, especially the new cobalt-molybdenum catalyst used for the desulphurization of oil and gas. These catalysts are presently employed by the United States Bureau of Mines in the processing of oil shales. The radioisotope cobalt-60 is used in therapeutic medicine and also for the investigation of physical strains in metals.

Prices

A strong demand for cobalt in 1974, combined with world inflation, pushed the price of cobalt up from $3.20 a pound in January to $3.75 in July. The price of the ultrafine grade of cobalt powder used by the carbide industry rose from $4.80 a pound in January to $6.61 in July. General Services Administration of the United States (GSA) also raised its price during the year. In January, GSA cobalt awards were made at prices ranging from $2.75 to $2.87 a pound, and at the end of the year the price range had reached $3.50 to $3.60 a pound.

Prices of cobalt in U.S. currency

	Dec. 1973	Dec. 1974
	(U.S. $)	(U.S. $)
Cobalt metal per lb fob New York, Chicago		
Shot 99%+		
less than 50 Kg	3.30	3.85
50-Kg drums	3.25	3.80
250-Kg	3.20	3.75
Powder, 99%+, 300 and 400 mesh		
50-Kg drums	4.17	5.07
extra fine. 125-Kg drums	4.95	6.61
S grade, 10-ton lots	3.50	4.00

Source: *Engineering Mining Journal*, December 1973 and 1974.

Outlook

In 1975, production will probably increase slightly, and consumption should decrease due to the economic slowdown. Prices are likely to drop. Over a longer term, production from the laterites, combined with the mining of manganese nodules, could bring a world over-supply of cobalt.

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
		(%)	(%)	(%)
33200-1	Cobalt ore	free	free	free
35103-1	Cobalt metal, excluding alloys, in lumps, powders, ingots or blocks	free	free	25
35110-1	Cobalt metal, in bars	free	10	25
92824-2	Cobalt oxides	free	10	20
92824-1	Cobalt hydroxides (1/7/74 to 30/6/84)	10	15	25

United States

Item No.			
601.18	Cobalt ore	free	
632.20	Cobalt metal, unwrought, waste and scrap	free	
632.84	Cobalt metal alloys, unwrought		9% ad. val.
633.00	Cobalt metal, wrought		9% ad. val.
418.68	Cobalt compounds other than cobalt oxide and cobalt sulphate		6% ad. val.
426.24 426.26	Cobalt salts		6% ad. val.
418.60 418.62	Cobalt oxide and Cobalt sulphate		1.2¢ per lb.

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Columbium (Niobium), Tantalum and Cesium

MICHEL A. BOUCHER and J.G. GEORGE

COLUMBIUM

World demand for columbium was strong in 1974, and higher prices were paid for columbium concentrates. Demand is growing at 12–15 per cent annually, and this rate is expected to continue because oil and gas pipeline construction is expanding and high-strength low-alloy steels are being more widely used.

The price of columbium has fluctuated widely in the past decade as a result of the relatively young market for the metal and because brokers and traders were responsible for much of the sales. For the past few years however, producers have assumed more responsibility over their marketing and there has been cooperation in adjusting production to balance demand. For these reasons prices should be more stable in the long-term.

Canadian production and developments

In 1974, St. Lawrence Columbium and Metals Corporation with mine, mill and concentrator near Oka, Quebec, continued to be Canada's sole producer of columbium; along with the larger operation of Companhia Brasileira de Metalurgia e Mineração (CBMM) at Araxà Brazil, it is one of only two mines in the world producing columbium in pyrochlore concentrates as a primary product. Canada's production (shipments) of columbium pentoxide, Cb_2O_5, contained in concentrates were 4,113,000 pounds valued at \$6,452,000.00 compared with 3,176,895 pounds of Cb_2O_5 valued at \$4,232,831 in 1973. Most of the Canadian production is exported in the form of concentrates containing from 51 to 54 per cent Cb_2O_5, mainly to European consumers who transform it into ferrocolumbium for use by the steel industry.

Some of the Canadian production is converted to ferrocolumbium by St. Lawrence Columbium and Metals Corporation near Oka, Quebec; by Masterloy Products Limited, at Gloucester, near Ottawa; and by Fundy Chemical International Ltd. at Surrey, B.C. Fundy, however, will relocate its B.C. operation in Quebec in 1975.

The prospect of a better price in a more stable market has encouraged St. Lawrence Columbium to expand its milling operations from 2,200 tons of concentrates a day to 3,000 tpd. The expansion should be completed in early 1975. During the year, St. Lawrence discovered two new ore zones which bring the mine's indicated and proven ore reserves to 25.6 million tons grading 0.44 per cent Cb_2O_5. The new ore has a high calcium content which makes for easy milling, better recoveries and a higher grade concentrate.

At St. Honoré, Quebec, Niobec Inc. is building a plant that will produce columbium pentoxide. The company expects to come into production in early 1976. Niobec Inc., is 50 per cent owned by Quebec Mining Exploration Company (Soquem)—a Quebec Crown Corporation—25 per cent by Teck Corporation Limited and 25 per cent by Copperfields Mining Corporation Ltd. Copperfields, however, with a 30 per cent interest in Teck Corporation has a total interest in Niobec Inc. of 32.5 per cent.

The mill, with a capacity of 1,500 tons a day, will be able to produce 5,500,000 pounds of columbium pentoxide a year. It has also been designed so that capacity can be expanded quickly if required. Reserves are reported to be 40 million tons of ore averaging 0.76 per cent, to a depth of 850 feet for open-pit mining. Financing to the amount of \$13 million was arranged through Canadian chartered banks, customers, and sponsors. The major customers will be Continental Alloys S.A. (CASA) of Luxembourg, Mitsui Mining & Smelting Co., Ltd. and Metallurg Inc.

Minerals and Canadian occurrences

The predominant commercial minerals of columbium and tantalum are the columbite–tantalite mineral series and the pyrochlore–microlite series. Columbite–tantalite have the theoretical composition $(Fe, Mn)OCb_2O_5$ and $(Fe,Mn)OTa_2O_5$ and occur as accessory minerals in pegmatites and residual placer deposits. The pyrochlore–microlite series have theoretical compositions $NaCaCb_2O_6F$ and $(Na,Ca)_2(Cb,Ta)_2O_6F$, often exhibiting pronounced enrichment in rare-earths and radioactive minerals, and occur almost exclusively in carbonatite-alkalic rock complexes.

The major source of the world columbium supply is from columbium-bearing pyrochlore occurring as an accessory mineral in the carbonatite complexes in Canada and Brazil. Alternative sources of columbium as columbite and tantalite are recovered as coproducts of tin from alluvial deposits, notably in Nigeria, where concentrates containing 65 per cent or more of the combined oxides of columbium and tantalum are obtained.

There are 30 or more known carbonatite occurrences in Ontario and several in Quebec, Labrador, British Columbia and the Northwest Territories. The major occurrences of columbium minerals in carbonatite complexes include:

in Quebec, near Oka, the columbium–pyrochlore producing mine of St. Lawrence Columbium and Metals Corporation; the property of Columbium Mining Products Ltd.; the property of Main Oka Mining Corporation, and, near Chicoutimi, the St. Honoré deposits of Quebec Mining Exploration Company (SOQUEM) and Copperfields Mining Corporation Limited.

in Ontario, the James Bay property of Imperial Oil Enterprises Ltd., and Consolidated Morrison Explorations Limited and associated companies; the Manitou Island deposit of Nova Beaucage Mines Limited near North Bay; the Lackner Lake property of Multi-Minerals Limited near Chapleau; and the Nemegosenda Lake property of Dominion Gulf Company near Chapleau.

World production and developments

Precise statistical information on world production and shipments of columbium is not well documented because columbium–tantalum statistics are often quoted in terms of combined metal content and not reduced to individual metal figures.

SOQUEM and Battelle Columbus Laboratories estimate that world shipments of columbium pentoxide were 32,600,000 pounds in 1974. Brazil supplied 22 million pounds, Canada 4 million, other countries 4 million and the General Services Administration (GSA) of the United States supplied 2.6 million pounds. The GSA stockpile is now down to about 2.5 million pounds of contained columbium.

Companhia Brasileira de Metalurgia e Mineração (CBMM) of Brazil is the largest producer of columbium concentrates. As shown in the following table, CBMM's output of ferrocolumbium has increased considerably in the last two years.

Adjoining the mill is a pyrometallurgical plant owned by CBMM that produces ferrocolumbium (averaging approximately 60 to 65 per cent Cb). Annual capacity of the ferroalloy plant is estimated at 10 million pounds of columbium contained in ferroalloy. Sales of pyrochlore concentrates are made by CBMM to columbium processing companies in the United States, Europe and Japan. Molybdenum Corporation

Table 1. Canada, columbium (niobium) and tantalum production, trade and consumption, 1973-74

	1973		1974	
	(pounds)	($)	(pounds)	($)
Production				
Columbium (Cb_2O_5 content of shipments)	3,176,895	4,232,831	4,113,000	6,452,000
Tantalum (Ta_2O_5 content of shipments)	170,582	1,164,749	430,000	3,646,000
Imports[1] from United States				
Columbium and columbium alloys wrought	2,636	27,847	4,391	30,309
Tantalum and tantalum alloys wrought, nes	5,437	341,624	5,137	324,435
Tantalum and tantalum alloys, unwrought waste and scrap	—	—	—	—
Tantalum and tantalum alloy powder	16,527	212,957	12,483	292,653
Exports[2] to United States				
Columbium ore and concentrates	667	530	8,671	7,614
Consumption by the steel industry				
Ferrocolumbium and ferrotantalum–columbium (Cb and Ta-Cb content)	452,000	. .	. .	. .

Source: Statistics Canada, except otherwise noted.
[1] From U.S. Department of Commerce, *Export of Domestic and Foreign Merchandise,* Report FT 410. Values in U.S. currency. [2] From U.S. Department of Commerce, *Imports of Merchandise for Consumption,* Report FT 135. Values in U.S. currency.
[p] Preliminary; . . Not available.

Table 2. Canada, columbium (niobium) and tantalum production, trade and consumption, 1964-74

	Production[1]		Imports[2], from U.S.					
	Cb_2O_5 Content	Ta_2O_5 Content	Columbium and Alloys, Wrought	Tantalum and Alloys, Wrought	Tantalum and Alloys, Unwrought, Waste and Scrap	Tantalum and Alloys, Powder	Exports[3], Columbium Ores and Conc., to U.S.	Consumption, Ferro. and ferrotantalum–columbium Cb and Ta-Cb Content
	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)	(lb)
1964	2,163,359	—	—	—	—	—	1,940,133	74,000
1965	2,333,967	—	—	721	—	—	1,860,631	58,000
1966	2,637,997	—	—	1,533	—	2,730	1,524,279	40,000
1967	2,159,557	—	185	1,245	34,914	1,155	890,884	78,000
1968	2,181,304	—	375	1,972	3,433	1,830	295,333	288,000
1969	3,414,495	130,298	1,178	1,871	4,405	7,488	919,577	244,000
1970	4,694,239	317,024	—	854	1,870	2,480	1,270,362	292,000
1971	2,332,663	449,610	5,061	1,487	14,237	3,100	341,237	292,000^r
1972	3,873,787	41,120	1,633	1,160	3,175	1,446	65,113	580,000
1973	3,176,895	170,582	2,636	5,437	—	16,527	667	452,000
1974^p	4,113,000	430,000	4,391	5,137	—	12,483	8,671	..

Source: Statistics Canada, unless otherwise noted.
[1] Producers' shipments of columbium and tantalum ores and concentrates and primary products, Cb_2O_5 and Ta_2O_5 content. [2] From U.S. Department of Commerce, *Exports of Domestic and Foreign Merchandise*, Report FT 410. Quantities in gross weight of material. [3] From U.S. Department of Commerce, *Imports of Merchandise for Consumption*, Report FT 135. Quantities in gross weight.
^{p} Preliminary; .. Not available; —Nil.

of America (now Molycorp Inc.) which has a 33 per cent interest in CBMM, markets ferrocolumbium to steel companies in the United States and Canada. Molycorp is probably the largest seller of Fe-Cb in the U.S. and the Company's policy is to maintain reasonably low and stable prices in order to encourage increased consumption.

Brasimet Comercio e Industria SA will proceed with the development of its Catalao pyrochlore deposit and will build a 1,000 tpd mill on the site of the deposit. Production is planned for the beginning of 1976. During the year, Mitsubishi Corporation acquired Tin and Associated Minerals of Nigeria, a columbium producer.

World consumption

World demand for columbium in 1974, was about 25 million pounds of contained metal, an approximate increase of 15 per cent over 1973. The pattern of consumption remained similar to that of previous years; 55 per cent Common Market; 20 per cent U.S.; 10 per cent Japan; 5 per cent Canada and 10 per cent all others.

Table 5 shows the U.S. consumption pattern for columbium.

Almost 80 per cent of the columbium consumed in the United States comes from Brazil, the remaining is imported from Nigeria, Canada and Malaysia. In recent years columbium consumption in Germany has been growing rapidly. Consumption in Japan for the first half of 1974 was up about 10 per cent over 1973. The stronger demand for columbium in Europe and Japan however was partly due to shortages of vanadium during the year. Vanadium is used instead of columbium in many applications.

Current technology and uses

The steel industry is the predominant consumer of columbium in the form of ferrocolumbium, which is used as an additive agent in the production of four major classes of steel, namely high-strength low-alloy (HSLA) carbon steel, stainless steels, low-alloy steels and superalloys. Pre-eminent amongst these steels in terms of present columbium consumption are the HSLA steels, in which the addition of 0.03–0.07 per cent columbium controls and refines the grain size effecting improved impact properties and increase in tensile strength to 60,000–70,000 psi. HSLA steels have found widespread applicability in the construction of oil and gas transmission pipelines. Canadian

Table 3. Production of columbium (Cb) and tantalum (Ta) concentrates, 1971-73[1, 2]

	1971			1972			1973[p]		
	Cb	Ta	Cb-Ta	Cb	Ta	Cb-Ta	Cb	Ta	Cb-Ta
	(thousands of pounds gross)								
Brazil									
pyrochlore	13,435	—	—	21,242	—	—	42,827	—	—
columbite–tantalite	139	640	—	143	660	—		287[e]	—
Canada									
pyrochlore	4,669	—	—	7,756	—	—	5,739	—	—
tantalite	—	843	—	—	77	—	—	215	—
Nigeria	3,031	9	—	3,000	2	—	2,734	2	—
Zaire	—	—	262	—	—	214	—	—	102
Mozambique									
Columbite–tantalite	—	128	—	—	93	—	—	64	—
microlite	—	117	—	—	134	—	—	123	—
Malaysia	—	—	54	—	—	196	—	—	202
Thailand	46	46	—	15	15	—	44	9	—
Portugal	—	24	—	—	26	—	—	26	—
Rwanda	—	—	71	—	—	82	—	—	90
South Africa (Rep. of)	—	1	—	—	—	—	—	—	—
Australia	—	—	165	—	—	558	—	—	441
Other countries[3]	4	6	107	—	—	96	—	—	96
Totals	21,324	1,814	659	32,156	1,007	1,146	51,344	726	931

Source: U.S. Bureau of Mines *Minerals Yearbook 1973* Preprint.
[1] Excludes tin slag bearing columbium-tantalum. [2] Concentrates containing important amounts of both elements are shown under Cb-Ta when composition data is insufficient. [3] Other countries that produce columbium and/or tantalum minerals include: Argentina, Ivory Coast, Uganda.
[p] Preliminary; —Nil; [e] Estimated.

Table 4. Average grade of ore milled, pyrochlore concentrates production and ferrocolumbium production at CBMM (1970-74)

	1970	1971	1972	1973	1974
	(short tons)				
Average grade of ore milled (% Cb_2O_5)	3.81	3.39	3.37	3.45	3.30
Pyrochlore concentrates (Cb_2O_5)	14,644	6,717	10,620	20,905	19,400
Ferrocolumbium	2,118	1,571	3,067	6,296	7,664

Note that the ratio of ferrocolumbium production to pyrochlore concentrate production has increased from 15 per cent in 1970 to 40 per cent in 1974. The annual production capacity of the CBMM's mill is estimated at 28 million pounds of columbium oxide contained in concentrates. Plans have been made to expand the annual capacity to 60 million pounds, but the completion date has not been established.

Table 5. A United States consumption pattern for columbium

	1970	1971	1972	1973	1974 Oct. cumulative	1974 Full-year estimated
	(pounds of columbium contained)					
Steel						
Carbon and HSLA	705,621	821,668	1,874,305	2,180,154	1,922,255	2,306,706
Stainless steel	522,007	588,411	644,936	712,525	409,395	441,274
Full alloy steel	829,416	789,507	302,740	361,143	365,974	439,169
Steel totals	2,057,044	2,199,586	2,821,981	3,253,822	2,697,624	3,187,149
Superalloys	472,231	591,063	665,300	685,743	837,885	1,005,462
Other alloys	76,370	37,665	57,387	67,853	29,288	35,146
Miscellaneous and unspecified	24,793	51,523	131,736	48,969	50,874	61,049
Primary totals	2,630,528	2,879,837	3,676,404	4,056,387	3,615,671	4,288,806
Cb in FeTaCb	120,000[e]	113,705[e]		39,597	28,436	34,123
Cb Metal				222,727	113,334	136,001
Sub totals				4,318,711	3,757,441	4,458,930
Late reports	—	—	—	—		250,000[e]
Grand total	2,730,528	2,993,542	3,676,404	4,318,711		4,708,930

Source: U.S. Bureau of Mines.
[e] Estimated; — Not available.

natural gas pipelines commonly use Arctic grade X-65 HSLA steel containing 0.06 per cent columbium and 0.042 per cent carbon, which yields high strength to cost ratio and excellent weldability properties. About 33 per cent of total HSLA tonnage employs columbium. Of the 65 per cent remaining, about 50 per cent goes into automotive uses. Considering the properties and technologies desired in the automotive industries, Cb-HSLA steel would appear to have a strong potential for penetrating this giant market in future years.

HSLA steels are also finding increasing application as structural steels in stadiums, bridges and buildings, such as the World Trade Centre in New York; they are also used in various permutations with other additive materials such as molybdenum, cerium and vanadium in the construction of ships, storage tanks, highway guard rails, railroad cars and electrical transmission poles.

Throughout the world, construction activities continue at a brisk pace, particularly in the pipeline sector. Major pipe producers in Germany and Japan have orders well into the future and foresee a continuing demand for pipeline steels. New HSLA construction steels have been introduced in Europe. Sweden is a large consumer of columbium per ton of steel produced. It is expanding its steel industry with a major new facility which may create a significant increase in world columbium demand.

Prototype development and research work continue on many applications of columbium as a superconductor. The National Accelerator Laboratory in Batavia, Ill., has begun construction of the world's largest superconductor magnet. When completed, this magnet ring will utilize about 90,000 pounds of Cb-Ti superconductor and will quadruple the energy capacity of the accelerator. Research and development on magnetic levitation transport systems is active in several countries. Japanese National Railways has developed operating prototypes and is committed to installing an operational system for the Tokyo-Osaka route by the 1980s.

Columbium applications in superconductors also include prototype motors and generators, magnets for magnetohydrodynamic and fusion generators, electrical transmission lines, and electric storage devices. Japan is now piloting a cryogenic power system with encouraging results. Columbium is one of the two or three most promising materials for the severe requirements of "first-wall" thermonuclear reactors. Since Cb-Ti superconductor wire is already cost-competitive with its copper counterpart on a current-carrying basis, columbium may find increasing superconductor application in the next few years. Promising as the potential might be for columbium metal, however, the present superconductor market is a developmental one—substantial, but not rich—hovering between 100,000 and 200,000 pounds a year.

Prices

The price of Canadian pyrochlore was increased during the year from $1.44 a pound of Cb_2O_5 to $1.80. While the list price of CBMM remained at $1.42, this is a nominal quotation and does not reflect actual sales. The spot price for low-alloy ferrocolumbium was raised from $3.10 a pound to $3.65.

In the United States ferrocolumbium prices increased from $3.20 a pound in March, to $4.00 at the beginning of 1975. At the end of the year NiCb was sold by Shieldalloy at $10.40 a pound.

Prices also moved higher in European and other foreign markets reflecting increased raw material costs.

TANTALUM

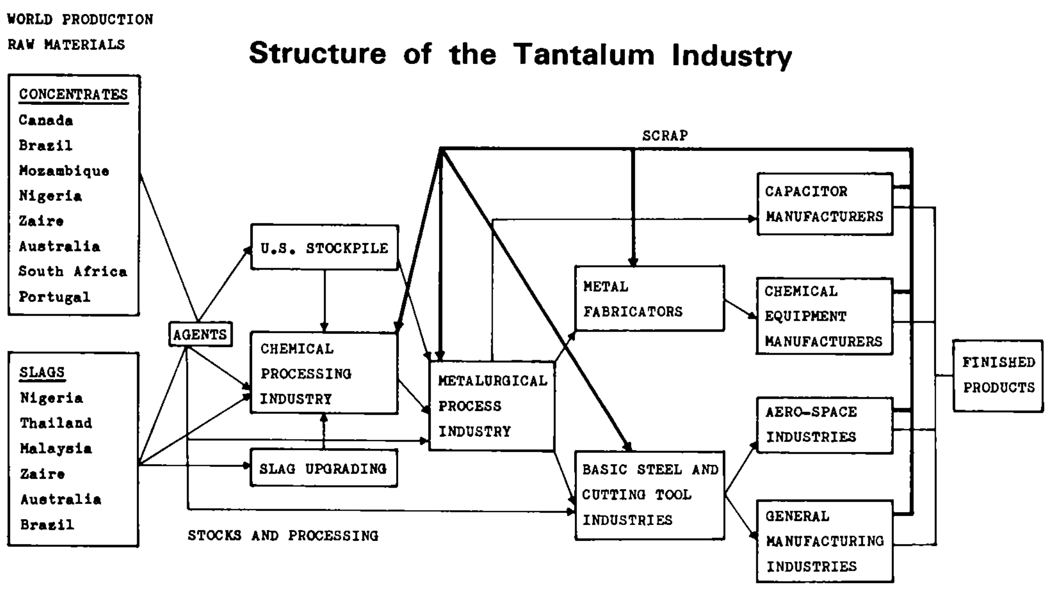
Many major developments in the tantalum industry took place in 1974. The following are of particular interest to Canada: higher prices paid for the tantalite concentrates produced by Tantalum Mining Corporation of Canada Limited (Tanco); the signing of a five-year contract by Tanco that includes the sale of tantalum, cesium and rubidium product; the sale by International Chemalloy Corporation of 24.9 per cent of its interest in Tanco to Kawecki Berylco Industries, Inc.; and the incorporation of the "Tantalum Producers International Study Center" (TIC), in Brussels, Belgium, on October 24, 1974.

Canadian production and developments

In 1974, Canada shipped 430,000 pounds of Ta_2O_5 in concentrates, valued at $3,646,000 or $8.48 a pound. This compares with 170,582 pounds of Ta_2O_5 valued at $1,164,749 in 1973 for an average price of $6.83 a pound. The improved situation is mainly due to a strong demand for tantalum by the capacitor manufacturing industry and GSA releases were such as to not create an oversupply situation.

Tanco's plant at Bernic Lake, Manitoba was shut down in June 1973, because of accumulated inventories sufficient for forward sales, and at that time all sales were suspended indefinitely due to a depression of market prices below Tanco's minimum selling price. The plant reopened in January 1974 and has been operating at full capacity since. Tanco's reserves are estimated at 1,260,000 tons averaging 0.221 per cent Ta_2O_5. The deposit also contains 300,000 tons of pollucite ore averaging 23 per cent Cs_2O and 160,000 tons

Structure of the Tantalum Industry



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grading 5 per cent Cs_2O; five million tons of spodumene ore averaging 2.98 per cent Li_2O; and 108,000 tons of lepidolite ore grading 2.24 per cent Li_2O and containing undetermined amounts of gallium and rubidium. In addition there is a beryl zone containing about one million tons grading 0.22 per cent BeO.

During the year, Tanco signed a five year \$18–\$20 million sales contract covering the sale of tantalum, cesium and rubidium from its Bernic Lake mine. In order to obtain security of supply, Kawecki Berylco Industries Inc. purchased a 24.9 per cent interest in Tanco from Chemalloy in April 1974. This reduced Chemalloy's interest in Tanco to 50.1 per cent. Kawecki is the largest single customer of Chemalloy's tantalum division, with sales of over \$100 million annually. Kawecki will assist Chemalloy in the financing, engineering and construction of a \$10 million plant at Bernic Lake to recover lithium from a new ore body and will provide technical assistance to develop markets for the cesium which is also recovered at the Bernic Lake mine.

Tantalum alloys or metal are not produced in Canada. A large consumer of tantalum metal is the electronics industry and particularly the electrolytic capacitors industry. In 1974, Canada's imports of fixed tantalum electrolytic capacitors from the United States were 3,864,406 units valued at \$1,062,250 or 27.5¢ a unit.

World supply

World production figures for tantalum are not readily available. However the situation will soon be corrected by the establishment of the Tantalum Producers International Study Center, (TIC), a non-profit association whose main purpose is to provide full data on tantalum raw material production. TIC is an organization that will also provide geological, technical and other information on tantalum such as transportation, pollution, safety, etc. Noncommunist world tantalum raw materials production increased in 1974 to about 1.7 million pounds of Ta_2O_5 in concentrates and tin slags, from 1.4 million pounds in 1973.

Production of Ta_2O_5 in 1974 is estimated as follows by Newmont Services Ltd. of the United States:

> Canada, 270,000 lb.; Thailand, 600,000 lb. in tin slag and 110,000 lb. as concentrate; Brazil, 160,000 lb.; Australia, 150,000 lb.; Mozambique, 60,000 lb.; Malaysia, Zaire and other African countries, approximately 350,000 lb.

Sales by the General Services Administration of the United States (GSA) were 800,000 pounds Ta_2O_5 and producers' stocks that had been accumulated during the 1970-71 recession were depleted by 500,000 pounds. Total supply is estimated at 3 million pounds Ta_2O_5 or 2.46 million pounds Ta.

The U.S. Bureau of Mines estimates that U.S. imports of tantalum concentrates were 1.9 million pounds (gross weight) in 1974 compared with 1.1 million pounds in 1973. The major suppliers to the U.S. in 1974 were Canada (42%), Brazil (9%), Thailand (6%) and West Germany (6%). The average value of imported concentrates was \$9.00 a pound of Ta_2O_5 in concentrate. Important tantalum products manufacturing plants in the United States include: Fansteel Inc.; Norton Company of Canada, Limited, Metals Division; Union Carbide Corporation; Teledyne Wah Chang Albany; LiTungsten Corp.

World consumption and uses

Shipments of tantalum in all forms by processors exceeded 2 million pounds Ta in 1974, up from 1.7 million pounds in 1973. U.S. requirements were about 1.6 million pounds. Of this, about 1,000,000 pounds was consumed by the electronics industry, primarily for the production of electrolytic capacitors. Another 300,000 pounds was consumed in the production of sheet, tube and other mill products mostly for the chemical industry; some 240,000 pounds was consumed by the cutting tools industry; and 60,000 pounds by the alloy additives, salts, oxides and tantalum carbide industries.

Some 1.4 billion tantalum capacitors were shipped by manufacturers throughout the world. In the United States 75 per cent of the demand for capacitors comes from the industrial market including computers, telecommunications and instrumentation. In Japan, 193,000 pounds of tantalum was used by the capacitor industry; of this, 160,000 was consumed as powder; 24,000 as wire; 2,000 as foil, and the remainder was used in other forms. Industrial products consumption in Japan accounted for 142,500 pounds of tantalum; of this, 88,000 was used as carbide; 24,000 as oxide; 16,500 as powder and 14,000 as mill products.

Outlook

The electronics market has grown quickly during the past decade and more particularly during the past two years. It is doubtful that this growth rate will continue.

It is believed that the price of tantalite ore concentrates reflect the demand for increased money for exploration and development and that releases from the United States stockpile will continue to be such as not to create oversupply situations.

Prices

Spot tantalite ore at the beginning of 1974 was \$7.50 to \$8.80 a pound of Ta_2O_5 (60% basis, cif. U.S. ports), rising to \$16–\$17 a pound of Ta_2O_5 at year-end.

Some 500,000 pounds of Ta_2O_5 in concentrates was awarded in 1974 at prices up to \$15.71 a pound of Ta_2O_5, compared with late 1973 sales at \$7.69 to \$8.21 a pound. Tantalum sheet and rod also moved substantially during the year.

CESIUM

Cesium is a soft, silvery white, ductile metal with a melting point of 28.7°C, a boiling point of 705°C and a density of 1.87 grams per cubic centimetre at 20°C. It is one of the three metals (the others are mercury and gallium) which are liquid at room temperature. Cesium is the fortieth most common element in the earth's crust, about as abundant as germanium. It is the eighth lightest metallic element but, of the five naturally occurring alkali metals, cesium is the most electropositive, has the highest density, highest vapour pressure, lowest boiling point and lowest ionization potential. Because of these properties cesium is used in preference to other alkali metals in such spaceage applications as space-propulsion and energy conversion.

Cesium emits electrons when exposed to visible light, ultra-violet light or infrared light. Precautions must be taken in handling, transporting and storing cesium metal because in air or water, it is very reactive chemically; and when exposed to a combination of air and water it reacts violently. The vigor of the reaction of cesium with water is evidenced by the fact that the metal reacts with ice at all temperatures above −116°C, liberating hydrogen. The reaction with cold water is explosive. Cesium is an efficient scavenger for traces of oxygen in highly evacuated containers. It resembles potassium and rubidium in the metallic state and is similar in chemical behaviour to potassium and rubidium but oxidizes more readily than any of the other alkali metals.

Occurrences and recovery

Of the naturally occurring alkali metals, cesium is the least abundant. It is widely distributed in the earth's crust and, usually, in low concentrations. It occurs in certain granites and granitic pegmatites, with granites having been estimated to contain an average of about one part per million of cesium. Greater concentrations of cesium are found in lepidolite, carnallite, beryl, leucite, spodumene, petolite and related minerals. Although commercial quantities of cesium have been obtained from both lepidolite and carnallite, the most important economic source of the metal is the rare mineral pollucite. Pollucite is usually found in complex, generally well-zoned pegmatite dykes that are rich in lithium minerals, especially lepidolite.

Pollucite, a mineral resembling quartz in lustre and transparency, is a hydrated silicate of aluminum and cesium ($Cs_2O.Al_2O_3.4SiO_2$) with the theoretically pure mineral containing 45 per cent cesium oxide (Cs_2O). Naturally occurring pollucite usually contains from 6 to 32 per cent Cs_2O. The higher-grade variety of pollucite has a specific gravity of 2.9 and a hardness of 6.5 on Mohs' scale. It is colourless to white, or greyish or pinkish white.

The largest known reserves of pollucite are: 50,000 tons* in the Karibib area in South-West Africa, 150,000 tons in the Bikita district of Rhodesia, and 460,000 tons at the mine of International Chemalloy Corporation (formerly Chemalloy Minerals Limited) at Bernic Lake in southeastern Manitoba, Canada, about 110 miles northeast of Winnipeg. Mozambique also has pollucite deposits but their quantity and grade are not known. Other deposits are found in the island of Elba, at Veratrask, Sweden, at West Paris in Maine, and in the Black Hills near Custer, South Dakota. A second Canadian occurrence is at the Valor property in Lacorne Township, northwestern Quebec, formerly owned by Massval Mines Limited.

The only known Canadian cesium-bearing deposit of economic importance is that of International Chemalloy Corporation. The property is operated by Tantalum Mining Corporation of Canada Limited which is 50.1 per cent owned by International Chemalloy Corporation; 24.9 per cent by Kawecki Berylco Industries, Inc.; the remaining 25 per cent interest being held by the Manitoba Development Corporation (MDC) which is the investment agency of the Manitoba government. The pollucite ore zone is separate from the company's tantalum and lithium orebodies (although these do contain low cesium values) which are contained in the same deposit. The pollucite unit consists of three sheet-like bodies, the largest of which ranges up to 45 feet in thickness and lies in the southeast quadrant of the pegmatite. As of July 31, 1973 the company's cesium reserves consisted of 300,000 tons of pollucite averaging 23 per cent Cs_2O in the main zone and 160,000 tons averaging 5 per cent Cs_2O in the lower and western zones. The main zone is open to the south and could be extended by further drilling. In addition, there are large areas of the pegmatite body containing quantities of pollucite averaging 1 to 3 pounds of Cs_2O a ton which have not yet been assessed for ore reserves. Also, deeper holes below the main pegmatite body have indicated a second sill approximately 100 feet below the main body which contains pollucite, tantalite and spodumene mineralization.

At the Valor property in northwestern Quebec, masses of pollucite up to five feet in maximum exposed dimension are scattered through part of a lenticular core zone of a complex zoned dyke. The zone consists chiefly of quartz, cleavelandite and spodumene, with irregular masses and disseminations of lepidolite.

Ores naturally rich in pollucite have been upgraded experimentally with some success, but satisfactory methods to concentrate pollucite economically from low-tenor ores have not yet been developed. The United States Bureau of Mines has, however, devel-

* The term "ton" refers to the short ton of 2,000 pounds avoirdupois.

oped experimentally a froth flotation process for concentrating pollucite ore. When applied to a low-grade cesium ore from the state of Maine grading about 8 per cent Cs_2O, the ore was upgraded to over 21 per cent Cs_2O with a cesium recovery of almost 87 per cent.

Thermochemical and hydrometallurgical methods are used for the production of cesium salts and compounds from pollucite ore. Cesium metal can be produced by direct thermochemical reduction of pollucite ore under vacuum or in an atmosphere of an inert gas (argon or helium) or by thermo-chemical reduction of a cesium compound under vacuum. Frequently used methods of producing elemental cesium are the heating of cesium carbonate with magnesium at about 675°C under hydrogen, or the heating of cesium chloride with calcium at the same temperature under vacuum. In both cases the metal is condensed from the vapour state in the absence of air, frequently under an inert oil to protect it from reaction with the atmosphere. Cesium metal has also been produced on a laboratory scale by electrolysis but this method of recovery has not yet proved economically feasible.

Production and consumption

Little statistical data is available on the production and consumption of pollucite or cesium metal and compounds. Annual world mine production of pollucite ore was estimated at only 20 tons as recently as 1968. Since then, an increasing demand has resulted in a significantly greater output of pollucite. Up to the end of August 1973, pollucite shipments from Chemalloy's Bernic Lake property totalled some 1,000 tons with the grade averaging about 28 per cent Cs_2O. In 1974 Chemalloy produced about 280 tons of pollucite averaging 28.3 per cent Cs_2O, all of which was shipped to Russia in the form of crushed ore.

Until 1968, world consumption of cesium metal and compounds was probably less than ten tons a year. In the past few years there has been a major increase in consumption mainly because of the increasing quantities of cesium compounds used in experimental magnetohydrodynamic (MHD) electrical power generators. The U.S.S.R. is probably the largest consumer of cesium in the world. It has imported over 800 tons of pollucite from Canada over the last five years which suggests an annual consumption in the range of 50,000 pounds of cesium a year. The U.S.S.R. is doing extensive research in MHD generation of electricity and cesium oxide is used as the seed in the process.

Uses

At present there are no large-scale commercial uses for cesium. Most of the metal and its compounds are currently consumed in the developmental research of thermionic power conversion units, ion propulsion and MHD electrical power generators. In MHD pilot plants, which make use of cesium's ionization potential, a fuel (coal, oil or gas) is burned. The hot gas is seeded with an easily ionized element such as cesium or potassium, or mixed cesium-potassium, in the form of carbonates to increase its conductivity. The ionized gas (plasma) is accelerated through a chamber surrounded by a strong magnetic field resulting in the generation of electricity which is drawn off through electrodes placed in the channel. The amount of power generated depends on the degree of ionization, the velocity of the plasma, and the magnetic field strength. Major increases in efficiency and cheaper power with little or no pollution (cesium carbonate when used as the "seed" is said to scrub out the harmful sulphur oxides produced by the burning coal or char) can be expected from MHD generators. Cesium salts as well as the metal are possible additives for MHD applications which are still in the research and development phase. While alternative materials, such as rubidium, potassium and sodium, may be used in the process, present knowledge is that cesium compounds are the most efficient.

In thermionic converters, the heat from nuclear reaction radiates to a surrounding metal (cathode) which emits large masses of electrons. The electrons travel through a space filled with a gas such as cesium vapour to an anode which then has a potential with respect to the cathode and electricity can flow through a circuit joining the anode and cathode. The most important factor limiting the efficiency of thermionic generators is the "space charge" effect. It is caused by the mutual repulsion of electrons wherein electrons in the space between the electrodes repel those emerging from the cathode and return them to the cathode. Ionized cesium gas is used to electrically neutralize the space charge. Nuclear heating is used in thermionic converters as it can serve as the source for the high temperature (1,900°C) required.

In the ion-propelled engine vapourized cesium is ionized while passing through a heated porous tungsten disc. The cesium ions become positively charged and an electric field accelerates the positive ions to a velocity of some 300,000 miles per hour. The high-velocity ions are neutralized by the injection of electrons and then exhausted through a nozzle to develop thrust. Since ion propulsion is essentially a low thrust system, one of its potential uses lies either in the maintenance of orbiting space vehicles in their orbits, or in the movement of such vehicles from one orbit to another. An ion engine could be used to move a vehicle from earth orbit to Mars orbit, for example, but could not be used for take off from or for landing on either planet.

Commercial applications for cesium include its use in photomultiplier tubes, vacuum tubes, scintillation counters, magnetometers, infrared lamps, pharmaceuticals and as reagents in microanalysis. Another commercial outlet is in photoelectric cells, developed in the early 1930s where the photoemmissive properties of cesium are utilized. In photoelectric cells light energy, falling on the cesium cathode, causes electrons to be emitted. Light-sensitive cathodes of cesium on a conducting base, such as silver, may be constructed for photocell use, and many alloys of cesium are also photoelectric. The compound $SbCs_3$ has a significantly high photoelectric sensitivity. An alloy of cesium and silver is used in the emitron or "electric eye" used in television.

In biological research, concentrated cesium chloride solutions are used for density gradient ultracentrifuge separation of DNA, viruses and other large molecules. This could be an important use for cesium and may be one of its largest end-uses apart from research into MHD power generation. Rubidium salts are sometimes used instead of or in conjunction with cesium chloride for ultracentrifuge gradient density separations. Cesium bromide is used in the manufacture of optical crystals. Cesium fluoride is used as a fluoridating agent in organic syntheses and cesium hydroxide with rubidium hydroxide can be used in place of lithium hydroxide in alkaline storage batteries for operation at temperatures as low as $-50^{\circ}C$. The metal may also act as a scavenger of gases and other impurities in chemical processing and in both ferrous and nonferrous metallurgy. Cesium phosphate is used in the form of mixed crystals with rubidium and/or ammonium salts for piezoelectric purposes. Rubidium can be used in place of cesium in some applications.

Outlook

So far, the market for cesium metal and compounds has been quite limited as its high cost and extreme reactivity restricts its use to applications where its unique properties are important. Its relatively high cost also encourages the substitution of other materials wherever possible. The greatest potential for sharply increased consumption of cesium appears to be in a technological breakthrough in the research and development of a power generating process using cesium.

Grades, specifications and prices

Although cesium metal is produced in 99, 99.5, 99.9 and 99.97 per cent purities, the two main grades in which it is usually marketed are: standard, with a minimum cesium content of 99.5 per cent; and high purity, with a minimum cesium content of 99.9 per cent. Nonmetallic impurities, particularly oxygen, critically affect the corrosive properties and hence the utility of cesium metal. Cesium salts are also available and include: acetate, bromide, carbonate, chloride, chromate, fluoride, hydroxide, iodide, nitrate and sulphate. In 1961 the standard specification for technical-grade cesium salts was raised from 97 to 99 per cent pure. Cesium is also available in a series of oxides.

A recent nominal quotation for raw pollucite ore of good grade and quality is 75¢ a pound of contained Cs_2O. Cesium salts sell for about $25 to $50 a pound depending on the type of salt, grade and quantity purchased. Cesium metal of 99+ per cent purity has been quoted at $100 to $375 a pound, depending on the quantity and grade purchased. Two United States companies that supply cesium metal are Kawecki Berylco Industries, Inc. and MSA Research Corporation.

United States Prices

United States prices in U.S. currency quoted in Metals Week of December 27, 1974. 1973 year-end prices are shown in brackets when differing.

		($)
Columbium ore Columbite per lb. pentoxide nominal spot cif U.S. ports	(1.35–1.45)	no quote after June 1973
Pyrochlore per lb Cb_2O_5 Canadian fob mine or mill, contract only	1.56	($) (1.44)
Brazilian fob shipping point, contract only	1.42	
Ferrocolumbium per lb Cb, tons lots fob shipping point, low-alloy standard grades	3.65	(3.10)
high-purity grade (mel-Ni)	6.82–8.65	(5.00–5.26)
Columbium metal per lb 99.5 to 99.8% free alongside U.S. shipping point		

	Powder roundel	Ingot
	($)	($)
Reactor	30.00–45.00	18.00–25.00 (17.50–28.00)
Tantalum metal per lb powder fob shipping point depending on size of lot	35.40–44.50	(30.00–37.00)
Tantalum rod	45.00–54.00	(30.00–40.00)
Tantalum sheet	50,00–57.00	(36.00–60.00)

Tariffs

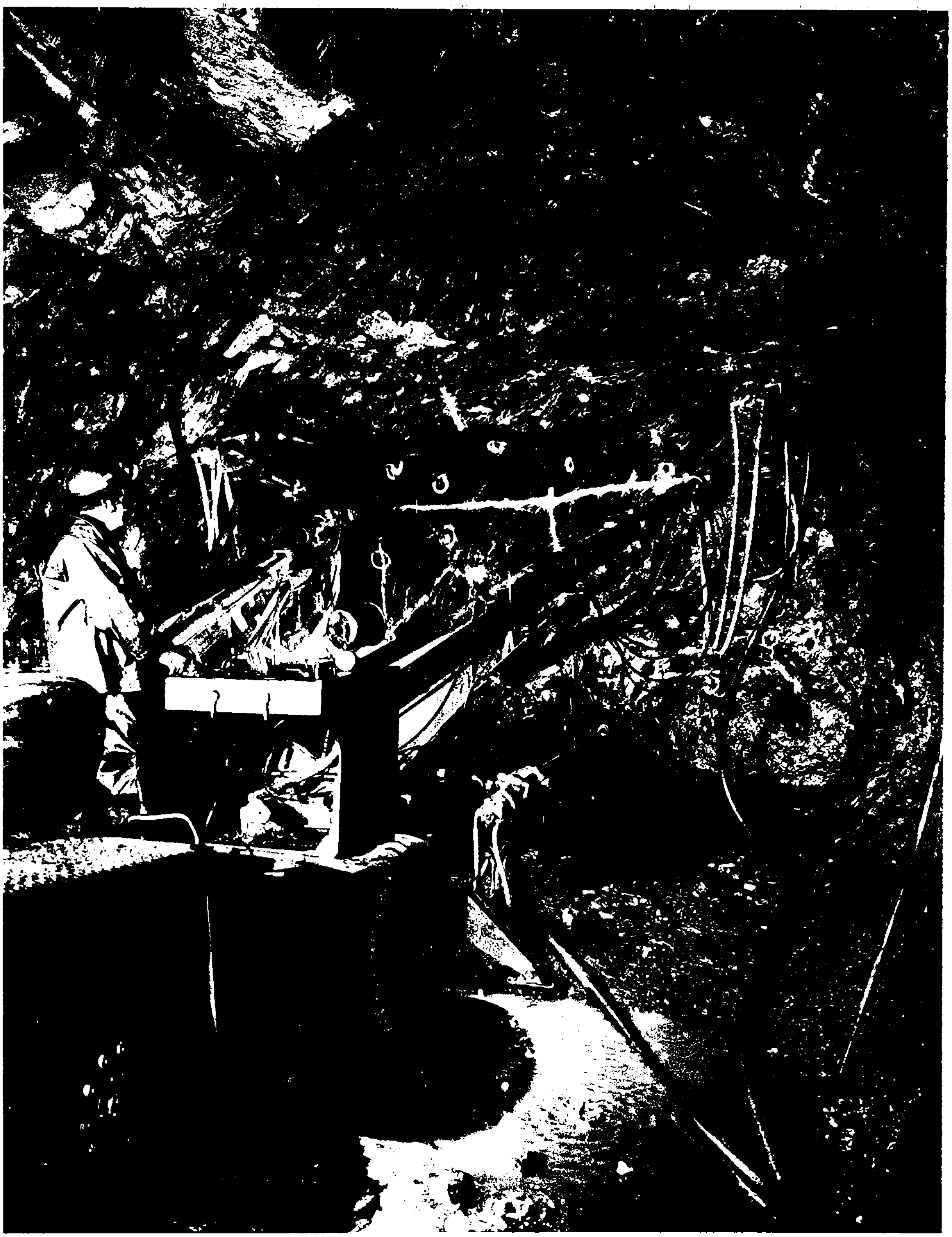
Canada

Item No.		British Preferential	Most Favoured Nation	General
			(%)	(%)
32900-1	Columbium and tantalum ores and concentrates	free	free	free
35120-1	Columbium (niobium) and tantalum metal and alloys in powder, pellets, scrap, ingots, sheets, plates, bars, rods, tubing or wire for use in Canadian manufacture (expires 31 Oct. 1973)	free	free	25
37506-1	Ferrocolumbium, ferrotantalum, ferro-tantalum-columbium	free	5	5

United States

Item No.		
601.21	Columbium ores and concentrates	free
601.42	Tantalum ores and concentrates	free
628.15	Columbium metal, unwrought, waste and scrap (duty on waste and scrap suspended to June 3, 1973)	5
628.17	Columbium, unwrought alloys	9
628.20	Columbium metal, wrought	5
629.05	Tantalum metal, unwrought, waste and scraps (duty on waste and scrap suspended to June 3, 1973)	5
629.07	Tantalum, unwrought alloys	7.5
629.10	Tantalum metal, wrought	9

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.



A three-boom drill jumbo drilling a development heading for Granduc Operating Company, at Tide, British Columbia.
(George Hunter photo)

Copper

G.E. WOOD

The simultaneous economic boom conditions of 1973 in North America, Europe and Japan carried over into the first six months of 1974.

However, business activity slackened in all the major copper-consuming economies as the year progressed. Copper demand dropped dramatically in the final quarter as copper consumers began severe inventory liquidation. As a consequence, world consumption of refined copper in 1974 declined to 9.0* million tons from 9.7 million tons in 1973.

World production of refined copper rose to 9.6* million tons in 1974, an increase of 2.0 per cent relative to production of 9.4 million tons in 1973.

The acute commodity shortages which developed late in 1973 led to aggressive inventory accumulation by copper conumers during the first half of 1974 before the dimensions of the business downturn became apparent. Stocks of refined copper held in metal exchange warehouses and in the hands of producers also increased steadily throughout the year. London Metal Exchange (LME) warehouse stocks rose from a level of less than 40,000 tons in December 1973 to 140,000 tons at the end of 1974.

Copper prices during 1974 reflected the worsening economic situation. The LME cash price of wirebar increased from an average of 92 cents a pound (U.S.) in January to an average of $1.37 a pound in April. From this peak, prices declined steadily to end the year with an average of 58 cents a pound in December.

Canadian mines produced 928,551 tons of recoverable copper in 1974, an increase of 20,310 tons relative to 1973. The value of this production was $1,400,101,000 in 1974 compared with $1,157,507,211 in 1973, reflecting the higher average realized price more than the production increase. Canada's mine production of copper was exceeded by that of Chile in 1974 resulting in a drop for Canada from third to fourth place on the world scale of copper producers. Within Canada, British Columbia mines produced more copper than those of any other province, with a marginally higher total than Ontario. A substantial decline in Canadian copper production is expected to occur in 1975 as a result of lower world copper consumption and lower prices.

Canada continues to export a large proportion of its copper production in concentrate form to Japan, 315,540 tons of contained copper in 1974 compared with 328,877 tons of contained copper in 1973. In Japan, where the 1974 economic downturn began earlier than the other major copper market areas, imported copper concentrates and refined copper stocks built up to serious levels during the second half of 1974. For the second time in three years Japanese concentrate buyers made approaches to Canadian mines late in 1974 for reductions in contractual shipments to Japan. Resulting shipment reductions and expiry of a number of concentrate sales contracts will cause a large decrease in shipments of copper concentrates from Canada to Japan in 1975.

Refined copper output from Canada's two domestic refineries increased to 616,329 tons in 1974 from 548,488 tons in 1973, for an 89 per cent utilization of rated capacity compared with 79 per cent in 1973. The shortage of blister copper from domestic smelters reported in 1973 improved during 1974 as expanded smelting capacity, primarily at Gaspé Copper Mines, Limited gradually came on stream.

Producers' domestic shipments of refined copper increased to 273,357 tons in 1974 from 254,613 tons in 1973. The increase was a result of increased consumption by copper mills producing sheet, strip, bars, rolls, pipe, copper wire and rod mills. Exports of refined copper decreased marginally in 1974 and imports showed a small but significant increase.

Canadian mines

The increase in Canadian mine production of recoverable copper in 1974 compared with 1973 was the smallest recorded in the last six years. This resulted from a slowdown in new mine development, and from reduced world consumption of refined copper during 1974.

A new copper-zinc mine was developed to the production start-up stage by the Sturgeon Lake Joint Venture late in 1974. The mine is located in the Sturgeon Lake area in Northwestern Ontario. The orebody will be mined by open-pit methods and is expected to achieve commercial production early in 1975.

Kanichee Mining Incorporated opened a new copper-nickel mine during 1974. The mine is located in the Temagami area of northern Ontario.

*Preliminary figures.

The International Nickel Company of Canada, Limited (Inco) resumed production at the Crean Hill nickel-copper mine in January 1974. The Crean Hill is an underground mine located at Sudbury and was one of thirteen Inco mines operating in Ontario at the end of 1974.

Consolidated Churchill Copper Corporation Ltd. reopened its copper mining operation 80 miles west of Fort Nelson, B.C. early in 1974. The operation had been shut down since October 1971.

It is expected that mine production of recoverable copper will decline in 1975 from 1974 levels due primarily to the reduction in deliveries of concentrates to Japanese smelters and mine closures resulting from depressed copper prices.

Table 1. Canada, copper production, trade and consumption 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Production[1]				
British Columbia	350,099	446,664,289	327,221	509,902,000
Ontario	287,323	365,305,858	319,742	498,220,000
Quebec	157,841	201,389,415	157,962	246,105,000
Manitoba	71,333	91,013,999	83,024	82,611,000
Yukon	11,593	14,791,665	11,300	17,605,000
New Brunswick	10,310	13,154,636	11,282	17,580,000
Saskatchewan	10,224	13,044,793	9,156	14,265,000
Newfoundland	8,647	11,031,913	8,100	12,623,000
Northwest Territories	867	1,106,319	764	1,190,000
Nova Scotia	4	4,324	—	—
Total	908,241	1,157,507,211	928,551	1,400,101,000
Refined	548,488	..	616,329	..
Exports				
Copper in ores, concentrates and matte				
Japan	328,877	430,099,000	315,540	489,523,000
Norway	24,993	23,908,000	26,881	54,455,000
United States	14,831	15,199,000	22,419	24,376,000
West Germany	10,038	13,051,000	10,752	15,613,000
Belgium and Luxembourg	1,558	1,742,000	1,490	2,378,000
United Kingdom	1,141	1,285,000	1,615	2,151,000
Finland	—	—	196	461,000
Other countries	399	89,000	132	121,000
Total	381,837	485,373,000	379,025	589,078,000
Copper in slag, skimmings and sludge				
United States	51	32,000	163	128,000
United Kingdom	2,195	6,478,000	80	64,000
Other countries	574	535,000	—	—
Total	2,820	7,045,000	243	192,000
Copper scrap (gross weight)				
United States	11,268	15,911,000	8,510	14,227,000
Belgium and Luxembourg	2,766	2,851,000	3,954	6,068,000
South Korea	2,148	2,643,000	1,210	1,516,000
West Germany	2,713	2,888,000	883	1,200,000
Spain	1,949	2,735,000	922	1,125,000
Japan	1,789	1,894,000	335	324,000
United Kingdom	1,302	1,058,000	451	323,000

Table 1. (cont'd)

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Exports (cont'd)				
Copper scrap (gross weight) (concl'd)				
Italy	260	280,000	241	288,000
Brazil	80	122,000	155	254,000
Netherlands	289	380,000	143	175,000
Other countries	2,925	4,796,000	378	337,000
Total	27,489	35,558,000	17,182	25,837,000
Brass and bronze scrap (gross weight)				
United States	11,629	11,578,000	12,080	17,432,000
Belgium and Luxembourg	1,268	1,141,000	2,400	3,104,000
Italy	1,387	1,216,000	2,230	2,723,000
West Germany	4,131	4,388,000	1,434	2,038,000
Japan	2,759	2,280,000	1,539	1,712,000
United Kingdom	1,953	1,897,000	1,077	1,029,000
South Korea	734	607,000	383	424,000
Other countries	723	683,000	617	759,000
Total	24,584	23,790,000	21,760	29,221,000
Copper alloy scrap, nes (gross weight)				
United States	640	559,000	1,088	1,201,000
Belgium and Luxembourg	746	753,000	510	625,000
South Korea	331	216,000	686	248,000
Japan	354	366,000	146	167,000
Other countries	652	615,000	533	381,000
Total	2,723	2,509,000	2,963	2,622,000
Copper refinery shapes				
United States	126,466	156,179,000	113,844	179,620,000
United Kingdom	101,558	133,740,000	101,095	165,393,000
West Germany	29,798	39,587,000	29,301	48,346,000
France	14,742	20,554,000	15,954	27,292,000
People's Republic of China	—	—	9,575	17,592,000
Sweden	4,443	6,113,000	7,746	13,055,000
Belgium and Luxembourg	7,461	10,261,000	7,039	12,052,000
Italy	7,297	9,633,000	6,263	10,444,000
Portugal	3,549	4,752,000	3,587	6,223,000
Switzerland	3,737	5,682,000	3,470	5,878,000
Brazil	1,275	1,719,000	2,930	4,705,000
Japan	11,511	13,906,000	3,002	4,682,000
Spain	1,729	2,053,000	1,800	2,871,000
Other countries	4,394	6,430,000	6,075	9,973,000
Total	317,960	410,609,000	311,681	508,126,000
Copper bars, rods and shapes, nes				
United States	4,643	6,908,000	9,183	16,688,000
Venezuela	912	1,252,000	2,654	6,399,000
Pakistan	1,598	1,633,000	3,117	6,181,000
Iran	1,454	2,567,000	2,494	5,850,000
Switzerland	2,341	3,146,000	2,739	5,295,000
Lebanon	2,368	3,192,000	1,268	2,655,000

Table 1. (cont'd)

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Exports (cont'd)				
Copper bars, rods and shapes, nes (concl'd)				
Dominican Republic	1,103	1,607,000	900	1,951,000
Israel	330	370,000	799	1,429,000
Nigeria	573	1,018,000	551	1,397,000
Other countries	9,055	12,751,000	3,993	8,465,000
Total	24,377	34,444,000	27,698	56,310,000
Copper plates, sheet, strip and flat products				
United States	7,430	12,915,000	8,026	17,716,000
Venezuela	337	592,000	514	1,474,000
United Kingdom	458	720,000	261	619,000
New Zealand	47	91,000	75	217,000
Australia	29	51,000	28	69,000
Norway	22	43,000	24	58,000
Peru	—	—	17	53,000
Mexico	—	—	17	51,000
Other countries	80	105,000	16	53,000
Total	8,403	14,517,000	8,978	20,310,000
Copper pipe and tubing				
United States	11,604	15,272,000	7,355	12,159,000
United Kingdom	6,401	10,991,000	1,854	4,665,000
New Zealand	756	1,629,000	933	2,732,000
Israel	564	850,000	561	1,387,000
South Africa	88	186,000	251	519,000
Venezuela	200	391,000	123	473,000
Spain	49	107,000	172	446,000
Other countries	1,057	1,876,000	955	2,790,000
Total	20,719	31,302,000	12,204	25,171,000
Copper wire and cable (not insulated)				
United States	936	1,061,000	622	1,060,000
United Kingdom	35	77,000	151	365,000
Cuba	—	—	138	242,000
Iran	—	—	74	205,000
Other countries	583	877,000	302	523,000
Total	1,554	2,015,000	1,287	2,395,000
Copper alloy refinery shapes				
United States	11,628	17,113,000	8,347	15,801,000
Japan	960	1,083,000	1,103	1,492,000
Venezuela	176	309,000	377	1,023,000
Israel	—	—	196	574,000
Australia	80	120,000	254	556,000
United Kingdom	318	508,000	151	337,000
New Zealand	83	150,000	59	142,000
Other countries	348	432,000	171	313,000
Total	13,593	19,715,000	10,658	20,238,000

Table 1. (cont'd)

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Exports (cont'd)				
Copper alloy pipe and tubing				
United States	3,029	4,910,000	2,065	4,289,000
New Zealand	72	173,000	125	375,000
Israel	—	—	114	294,000
United Kingdom	76	158,000	90	213,000
South Africa	7	11,000	34	143,000
Philippines	—	—	41	126,000
Taiwan	5	8,000	46	103,000
Other countries	296	516,000	150	420,000
Total	3,485	5,776,000	2,665	5,963,000
Copper alloy wire and cable, not insulated				
United States	127	233,000	573	660,000
United Kingdom	1	5,000	61	155,000
Colombia	—	—	51	120,000
New Zealand	7	21,000	16	50,000
Other countries	13	39,000	11	35,000
Total	148	298,000	712	1,020,000
Copper alloy fabricated materials, nes				
United States	644	1,172,000	934	2,352,000
Indonesia	200	498,000	776	1,913,000
United Kingdom	70	90,000	141	327,000
Malaysia	—	—	38	98,000
New Zealand	2	4,000	57	63,000
Other countries	149	269,000	99	233,000
Total	1,065	2,033,000	2,045	4,986,000
Wire and cable, insulated[2]				
United States	9,195	15,331,000	7,161	15,327,000
Dominican Republic	858	1,369,000	1,331	2,568,000
Cuba	4	37,000	1,282	2,465,000
Turkey	125	277,000	430	987,000
West Germany	697	944,000	499	891,000
Panama	366	649,000	411	849,000
Pakistan	97	94,000	866	846,000
Israel	19	36,000	460	790,000
United Kingdom	91	213,000	202	545,000
Argentina	—	—	182	428,000
Bermuda	268	389,000	167	365,000
Guyana	260	233,000	125	295,000
Australia	177	343,000	98	282,000
Other countries	2,941	5,549,000	1,456	3,276,000
Total	15,098	25,464,000	14,670	29,914,000
Total exports of copper and products		1,100,448,000		1,321,383,000

Table 1. (concl'd)

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Imports				
Copper in ores, concentrates and scrap	52,319	54,045,000	54,166	59,523,000
Copper refinery shapes	18,937	25,605,000	24,368	39,283,000
Copper bars, rods and shapes, nes	346	537,000	1,280	2,208,000
Copper plates, sheet strip, and flat products	816	1,582,000	743	1,944,000
Copper pipe and tubing	6,184	11,138,000	3,041	7,659,000
Copper wire and cable, except insulated	682	1,562,000	1,682	1,671,000
Copper alloy scrap (gross weight)	5,922	5,290,000	5,722	6,301,000
Copper powder	555	1,029,000	463	1,052,000
Copper alloy refinery shapes, rods and sections	9,420	12,358,000	9,739	18,824,000
Brass plates, sheet and flat products	3,929	5,880,000	2,920	6,273,000
Copper alloy plates, sheet, strip and flat products	910	2,400,000	1,704	4,470,000
Copper alloy pipe and tubing	1,943	3,939,000	2,201	6,208,000
Copper alloy wire and cable, except insulated	682	1,562,000	678	1,999,000
Copper and alloy fabricated material, nes	2,252	4,053,000	1,706	4,037,000
Insulated wire and cable	..	21,755,000	..	27,763,000
Copper oxides and hydroxides	326	405,000	502	707,000
Copper sulphate	1,430	561,000	575	359,000
Copper alloy castings	283	591,000	303	857,000
Total imports of copper and products	..	154,292,000	..	191,138,000
Consumption[3]				
Refined	254,613	..	273,357	..

Source: Statistics Canada.
[1] Blister copper plus recoverable copper in matte and concentrate exported. [2] Includes also small quantities of non-copper wire and cable, insulated. [3] Producers' domestic shipments, refined copper.
p Preliminary; — Nil; .. Not available; nes Not elsewhere specified.

Smelters and refineries

The Gaspé smelter of Gaspé Copper Mines, Limited, (Gaspé) a subsidiary of Noranda Mines Limited, continued to experience difficulties in 1974. These difficulties were attributed by Gaspé to the construction program of the expanded smelter facilities. The construction project was terminated prematurely due to construction labour problems, leaving a large number of new equipment modifications to Gaspé's regular staff. This resulted in a serious shortfall in production. The expanded facilities have a design capacity of 100,000 tons a year compared with 70,000 tons a year before the expansion. As a consequence of these start-up problems, Noranda declared *force majeure* on contracted copper deliveries from the Gaspé smelter throughout most of 1974. The shortfall in copper production declined progressively throughout 1974 as smelter operations improved. Smelter production in 1974 at Gaspé amounted to 69,700 tons compared with 48,900 tons in 1973.

Noranda Mines Limited curtailed 1975 capital spending plans late in 1974. This resulted in the deferment of construction of an oxygen plant and a sulphuric acid plant at the Horne smelter at Noranda. These facilities were part of a plan to expand the capacity of the Noranda continuous smelting reactor installation.

Falconbridge Nickel Mines Limited began to implement plans for its smelter modernization at Sudbury during 1974. Of the total estimated cost of $95 million, $4.1 million had been spent by year-end. These expenditures were made on site preparation. Construction is expected to begin in the spring of 1975.

Production of refined copper at Canada's two copper refineries increased substantially in both cases in 1974. Canadian Copper Refineries Limited produced

Table 2. Canada, copper production, trade and consumption, 1965-74

	Production		Exports			Imports	Consumption[2]
	All Forms[1]	Refined	Ore and Matte	Refined	Total	Refined	Refined
				(short tons)			
1965	507,877	434,133	87,000	199,830	286,830	5,747	224,684
1966	506,076	433,004	94,888	190,691	285,579	10,492	262,557
1967	613,314	499,846	128,976	275,919	404,895	5,310	219,680
1968	633,313	524,474	161,835	276,619	438,454	5,824	250,104
1969	573,246	449,232	157,816	210,034	367,850	18,137	226,281
1970	672,717	543,727	177,888	292,403	470,291	14,542	237,916
1971	721,430	526,403	225,005r	314,901r	539,906r	21,899	221,053
1972	793,303	546,685	297,409r	340,533r	637,942r	17,902r	228,907
1973	908,241	548,488	381,837	317,960	699,797	18,937	254,613
1974p	928,551	616,329	379,025	311,681	690,706	24,368	273,357

Source: Statistics Canada.
[1] Blister copper plus recoverable copper in matte and concentrates exported. [2] Producers' domestic shipments, refined copper.
p Preliminary; r Revised.

427,000 tons in 1974 compared to 383,000 tons in 1973, as a result of additional capacity installed in 1973. Inco's refinery at Copper Cliff produced 183,600 tons of refined copper in 1974 compared with 164,000 tons in 1973. Increased copper production in this case resulted from increased mine production undertaken to increase nickel deliveries in 1974.

World supply and demand

Mine production. World mine production of copper in 1974 was 8,573,000 short tons; an increase of 270,000 short tons over 1973 production. Chile increased its production from 811,000 tons in 1973 to 990,000 tons in 1974, an increase of 22 per cent. Canadian production in the same period grew by a more modest 20,310 tons, or 2¼ per cent. United States mine production of copper was affected by strikes at the time of contract renewals in July. It is estimated that the combined losses of production at all mines was 140,000 tons.

Late in the year, falling demand and prices and rapidly escalating world stocks of refined copper led CIPEC countries and other major copper producing countries to agree to limit copper production and shipments by as much as 10 per cent of 1974 levels. These cutbacks were expected to be further increased in 1975.

Smelter and refinery production

World production of refined copper is shown in Table 10. Chilean production shows the biggest percentage change with production increase of 122,000 tons in 1974 over 1973, an increase of 26.6 per cent. United States production declined by 176,000 tons in 1974, a decrease of 7.6 per cent.

Canadian production of refined copper in 1974 amounted to 616,300 tons compared to 548,500 tons in 1973, an increase of 12.4 per cent. This increase resulted from capacity increases in 1973 and indirectly as a result of higher nickel production in 1974.

Major expansions in copper smelting capacity are under development in Chile, the People's Republic of China, Japan, Mexico, Philippine Republic, Poland, Zambia, United States and U.S.S.R. The construction of a new copper smelter in South Korea using the Noranda continuous smelting process has been deferred.

Expansion of copper refining capacity is underway in Chile, the People's Republic of China, Mexico, Peru, Poland, Republic of South Africa, United States, U.S.S.R. and Zambia.

In view of the extremely depressed state of the world copper market early in 1975 it is likely that deferral or cancellation of some of the planned mine smelter and refinery capacity will occur.

The trend towards installation of new smelting and refining facilities in producer countries rather than in consumer countries continued through 1974.

Awareness of environmental effects of copper smelter gas and dust emissions continued to result in moves towards implementation of new smelter technology during 1974 and it is likely that this trend will continue. Kennecott Copper Corporation announced plans to use the Noranda continuous smelting process in its smelter modernization program at the Garfield smelter in Utah. Several other new smelting methods are also receiving careful study by producers.

Table 3. Producing copper mines in Canada, 1974 and (1973)

Company and Location	Mill or Mine Capacity[1]	Grade of Ore: Copper	Grade of Ore: Zinc	Grade of Ore: Nickel	Grade of Ore: Silver	Ore Produced	Contained Copper Produced	Remarks
	(tons ore/day)	(%)	(%)	(%)	(oz/ton)	(tons)	(tons)	
Newfoundland								
American Smelting and Refining Company, Buchans	1,250 (1,250)	1.01 (1.00)	11.24 (11.51)	— —	3.25 (3.45)	264,000 (124,000)	2,399 (1,109)	1973 production reduced due to 7-month labour strike.
Consolidated Rambler Mines Limited,								
East mine,	—	1.38	—	—	—	32,340	414	Vertical shaft being sunk at the Ming mine for future ore extraction.
Ming mine,	1,200	3.16	—	—	0.57	183,201	5,356	
East and Ming mines, Bai Verte	(1,200)	(2.45)	—	—	(0.33)	(292,011)	(6,269)	
New Brunswick								
Anaconda Canada Limited, Caribou mine, Restigouche County	700 (1,000)	3.76 (3.4)	3.95 (3.0)	— —	2.30 —	163,432 (45,000)	2,044 (960)	Three months production only in 1973. Copper ore exhausted in 1974.
Brunswick Mining and Smelting Corporation Limited, No. 6 and No. 12 mines, Bathurst	10,000 (9,850)	0.38 (0.34)	6.70 (7.00)	— —	2.32 (2.53)	2,607,965 (3,288,081)	3,815 (4,283)	Production lost due to a two-month strike in 1974. Major expansion program begun centred around new production shaft.
Heath Steele Mines Limited, Newcastle	3,100 (3,100)	1.04 (0.86)	4.39 (4.90)		1.98 (1.83)	1,085,495 (1,077,816)	7,243 (6,167)	Sinking of new shaft to 3,000-foot level continued. Mill expansion and mine development proceeding for 4,000 tpd capacity by 1977.
Nigadoo River Mines Limited, Robertville	1,000 (1,000)	0.33 —	2.74 —	— —	3.79 —	205,691 —	268 —	A new orebody was being developed on the 750-foot level in 1974.

Quebec								
Bouzan Joint Venture, Patino Mines (Québec) Limited – Kerr Addison Mines, Limited, Chibougamau	— —	1.72 (1.81)	— —	— —	— —	15,500 (13,444)	. . —	Labour difficulties and high development requirements were responsible for low 1974 production.
Campbell Chibougamau Mines Ltd., Main, Cedar Bay, Henderson, Grandroy mines, Chibougamau	4,000 (4,000)	1.03 (1.30)	— —	— —	0.22 (0.24)	960,552 (1,186,842)	9,125 (14,273)	
Falconbridge Copper Limited, Lake Dufault Division, Norbec and Millenbach mines, Noranda	1,500 (1,500)	2.38 (3.65)	3.54 (4.41)	— —	0.99 (1.41)	553,187 (555,292)	11,615 (18,892)	Potential new ore zone discovered from surface exploration in 1974.
Opemiska Division, Perry and Springer mines, Chapais	3,000 (3,000)	1.85 (2.14)	— —	— —	0.32 (0.34)	927,059 (1,062,818)	16,374 (21,576)	Sinking of new shaft at Cooke mine completed to 1,029-foot level in 1974. Planned depth 1,978 feet.
Sturgeon Lake Joint Venture, (Falconbridge Copper Limited/ Sturgeon Lake Mines Limited/ NBU Mines Limited)	1,200 —	2.05 —	7.59 —	— —	— —	82,592 —	973 —	Production began in September 1974 upon the completion of construction.
Gaspé Copper Mines, Limited, Needle Mountain and Copper Mountain mines, Murdochville	33,750 (33,750)	0.61 (0.62)	— —	— —	0.05 (0.05)	10,630,690 (6,729,078)	48,245 (28,295)	Start up of expanded smelter facilities was slow and problematic but improved steadily throughout 1974.
Icon Sullivan Joint Venture, Chibougamau	650 (650)	3.05 (2.80)	— —	— —	— —	199,500 (210,516)	5,883 (5,734)	Ore reserves almost exhausted at the end of 1974.
Joutel Copper Mines Limited, Joutel	700 (700)	1.79 (1.93)	— —	— —	— —	58,298 (49,495)	877 (972)	The mine also produced 101,396 tons of zinc ore with a grade of 6.81% zinc in 1974.
Louvem Mining Company Inc. Louvicourt	500 (800)	1.95 (1.81)	— —	— —	0.958 (0.28)	158,183 (253,281)	2,920 (4,365)	New zinc orebody 2,500 feet west of shaft was prepared for mining during 1974.
Madeleine Mines Ltd., St. Anne des Monts	2,500 (2,500)	1.27 (1.31)	— —	— —	0.22 —	804,390 713,980	9,499 (8,748)	

Table 3. (cont'd)

Company and Location	Mill or Mine Capacity[1]	Grade of Ore: Copper	Grade of Ore: Zinc	Grade of Ore: Nickel	Grade of Ore: Silver	Ore Produced	Contained Copper Produced	Remarks
	(tons ore/day)	(%)	(%)	(%)	(oz/ton)	(tons)	(tons)	
Quebec (cont'd)								
Manitou-Barvue Mines Limited, Val-d'Or	1,600 (1,600)	— —	2.20 (2.07)	— —	2.58 (2.96)	225,303 (197,930)	25 (33)	
Mattagami Lake Mines Limited, Matagami	3,850 (3,850)	0.62 (0.57)	7.5 (7.4)	— —	0.88 (0.84)	1,406,265 (1,387,251)	6,619 (5,919)	
Noranda Mines Limited, Horne Division	2,200 (3,200)	2.8 (2.51)	—	—	0.59 (0.56)	390,000 (485,783)	10,248 (11,608)	It is expected that production will decline further in 1975.
Normetal Mines Limited, Normetal	838 (1,000)	0.97 (1.38)	4.58 (4.86)	— —	1.1 (1.37)	250,492 (297,889)	2,004 (3,750)	Depletion of ore reserves is expected to result in mine closure in May or June 1975.
Orchan Mines Limited, Orchan and Garon Lake Mines, Matagami	1,900 (2,000)	1.18 (1.16)	4.78 (5.77)	— —	0.5 (0.69)	364,030 (450,230)	3,556 (4,248)	Production from a new zinc-copper deposit is planned for 1976 by the Norita Division.
Patino Mines (Québec) Limited, Copper Rand, Copper Cliff and Portage mines, Chibougamau	2,800 (2,800)	1.56 (1.61)	— —	— —	0.20 (0.19)	859,332 (973,395)	12,755 (14,989)	Production reduced by a strike which began 16 November 1974 and still in progress at year-end. Production is expected to begin in late 1975 from the Lemoine copper-zinc deposit.
Rio Algom Mines Limited, Mines de Poirier, Joutel	1,800 (1,800)	2.06 (2.42)	— —	— —	1.8 —	437,053 (638,883)	8,046 (14,543)	Mine to be closed in 1975.
Société Minière d'Exploration Somex Ltée, Lac Edouard	250 (250)	0.50 (0.50)	— —	1.50 (1.50)	— —	52 (90,000)	— (170)	Mine closed 14 January 1974.

Sullivan Mining Group Ltd., Stratford Centre, Cupra Division	1,500 (1,500)	2.49 (2.41)	4.78 (4.88)	— —	1.112 (1.09)	87,474 (89,814)	2,054 (2,007)	
D'Estrie Mining Company Ltd.,	— —	2.56 (2.74)	2.72 (3.16)	— —	1.155 (1.23)	162,081 (130,265)	3,916 (3,323)	Ore trucked to Cupra mill.
Clinton mine	— —	2.64 —	2.50 —	— —	0.95 —	52,656 —	1,282 —	Ore hauled by truck to the Sullivan mill. Ore reserves reduced in light of recent information.
Ontario								
Consolidated Canadian Faraday Limited	1,200 (1,200)	0.30 (0.30)	— —	0.72 (0.76)	— —	326,378 (331,851)	753 (880)	
Ecstall Mining Limited, Kidd Creek Mine, Timmins	10,000 (10,000)	1.75 (1.61)	9.20 (9.78)	— —	3.17 (3.72)	3,723,865 (3,609,657)	56,649 (55,769)	Work continued on a second mine shaft in 1974. When the shaft is completed, mine production will increase to 5 million tons a year. The company also plans to build a 130,000-tons-a-year copper smelter and refinery at the Hoyle Township complex.
Falconbridge Nickel Mines Limited, East, Falconbridge, Fecunis, Hardy Openpit, Longvack South, North, Onaping and Strathcona mines, Sudbury	12,300 (12,000)	. . . .	. . . .	. . . .	. . . .	4,336,652 (4,292,900)	26,991[2] (26,862)[2]	Strathcona mill was expanded to 12,300 tpd capacity in 1974. Smelter modernization program began in 1974.
Kanichee Mining Incorporated, Temagami	500	0.72	—	0.49	—	122,451	619	Production began in 1974.

Table 3. (cont'd)

Company and Location	Mill or Mine Capacity[1]	Grade of Ore Copper	Grade of Ore Zinc	Grade of Ore Nickel	Grade of Ore Silver	Ore Produced	Contained Copper Produced	Remarks
	(tons ore/day)	(%)	(%)	(%)	(oz/ton)	(tons)	(tons)	
Ontario (concl'd)								
The International Nickel Company of Canada, Limited, Clarabelle, Coleman, Copper Cliff North, Copper Cliff South, Creighton, Frood-Stobie, Garson, Kirkwood, Levack, Little Stobie, MacLennan, Victoria and Crean Hill mines, Sudbury Area, Shebandowan Mine, Shebandowan	68,000	1.15	—	1.30	—	18,021,305 (15,966,093)	183,600[2] (163,356)[2]	Production was resumed at the Crean Hill mine in January 1974. Scheduled operations were completed at the Clarabell open-pit mine in December 1974. Mining at this site will be resumed upon development of an extension.
Mattabi Mines Limited, Sturgeon Lake	3,000 (3,000)	0.91 (1.10)	8.81 (11.37)	— —	4.31 (5.31)	1,138,965 (1,111,765)	8,708 (9,966)	
Noranda Mines Limited, Geco Division, Manitouwadge	5,000 (5,000)	1.72 (1.70)	4.72 (4.53)	— —	1.56 (1.63)	1,826,704 (1,463,585)	29,169 (22,920)	Phase I of waste water treatment facilities installed.
Pamour Porcupine Mines, Limited, Schumacher Division, Schumacher	3,000 (2,100)	0.628 (0.63)	— —	— —	0.105 (0.12)	706,940 (777,670)	4,084 (4,541)	The company also produced 214,130 tons of gold ore with an average grade of 0.201 oz/ton.
Selćo Mining Corporation Limited, South Bay Division, Uchi Lake	500 (500)	2.0 (1.86)	13.0 (13.04)	— —	3.0 (3.18)	195,000 (191,614)	3,060 (3,195)	
Teck Corporation Limited, Silverfields Mining Division, Cobalt district	275 —	0.4 —	— —	— —	12.5 —	87,891 —	34 —	
Willroy Mines Limited, Manitouwadge Division, Manitouwadge	1,700 (1,700)	0.42 (0.98)	3.06 (2.74)	— —	1.37 (1.42)	394,154 (430,486)	1,375 (3,793)	

Manitoba								
Dumbarton Mines Limited,	..	..	—	..	—	..	..	
Bird River	..	(0.30)	—	(0.76)	—	(331,851)	(881)	
Falconbridge Nickel Mines Limited,								
Manibridge mine,	1,000	..	—	..	..	183,758	..	
Wabowden	(1,000)	..	—	..	..	(135,716)	—	
Hudson Bay Mining and								
Smelting Co., Limited,	8,500	2.34	3.22	—	0.63	1,574,948	35,030	Development of the Centennial mine was continued, erection of the mine plant was completed and mine development was begun at Westarm mine. Ore production reduced due to shortage of trained miners.
Anderson, Chisel Lake, Dickstone, Flin Flon, Ghost, Osborne, Schist, Stall Lake, White Lake, and Centennial mines, Flin Flon and Snow Lake	(8,500)	(2.45)	(3.61)	—	(0.75)	(1,815,027)	(42,100)	
The International Nickel								
Company of Canada, Limited,	17,700	..	—	..	—	3,767,202	..	Copper production included in Inco's Ontario production.
Birchtree, Pipe and Thompson mines, Thompson	(18,400)	..	—	..	—	(3,043,648)	—	
Sherritt Gordon Mines, Limited,								
Farley Mine,	3,000	0.429	—	0.873	—	432,235	1,625	1974 production 30% below forecast. Future of the mine is in doubt.
Lynn Lake	(3,500)	(0.39)	—	(0.84)	—	(675,907)	(2,140)	
Fox mine	3,000	2.10	1.98	—	0.33	1,008,111	19,850	Zinc recovery improved during 1974.
Lynn Lake	(3,000)	(2.01)	(2.01)	—	—	(963,416)	(17,310)	
Ruttan mine,	10,000	1.065	1.676	—	0.20	3,358,257	31,833	Expanded underground development program planned for 1975. Ore grades lower than expected in upper levels of the open pit.
Ruttan Lake	(10,000)	(1.14)	—	—	—	(1,518,052)	(18,650)	

Table 3. (cont'd)

Company and Location	Mill or Mine Capacity[1]	Grade of Ore: Copper	Grade of Ore: Zinc	Grade of Ore: Nickel	Grade of Ore: Silver	Ore Produced	Contained Copper Produced	Remarks
	(tons ore/day)	(%)	(5)	(%)	(oz/ton)	(tons)	(tons)	
Saskatchewan								
Hudson Bay Mining and Smelting Co., Limited, Flin Flon mine, Flin Flon		See Manitoba operations for this company, which includes production from both Manitoba and Saskatchewan mines.						
British Columbia								
Anaconda Canada Limited, Britannia mine, Britannia Beach	3,000 (3,000)	1.26 (1.45)	— —	— —	5.03 —	399,164 (548,801)	4,786 (7,740)	The mine was closed November 1, 1974.
Bethlehem Copper Corporation Heustis, Iona and Jersey mines, Highland Valley	16,000 (16,000)	0.505 (0.58)	— —	— —	— (1.61)	6,346,402 (6,339,122)	29,319 (33,543)	
Brenda Mines Ltd., Peachland	24,000	0.186 (0.20)	—	—	—	9,549,588 (8,867,800)	15,267 (16,201)	The ore mined in 1974 also had an average grade of 0.085% MoS_2.
Consolidated Churchill Copper Corporation Ltd., Magnum Mine, Fort Nelson	900 —	— —	— —	— —	— —	201,450 —	5,320 —	The mine was closed in March 1975.
Craigmont Mines Limited, Merritt	5,350 (5,300)	1.45 (1.39)	— —	— —	— —	1,796,692 (1,429,556)	25,775 (18,725)	1973 and 1974 production curtailed by a strike from September 1973 to January 1974.

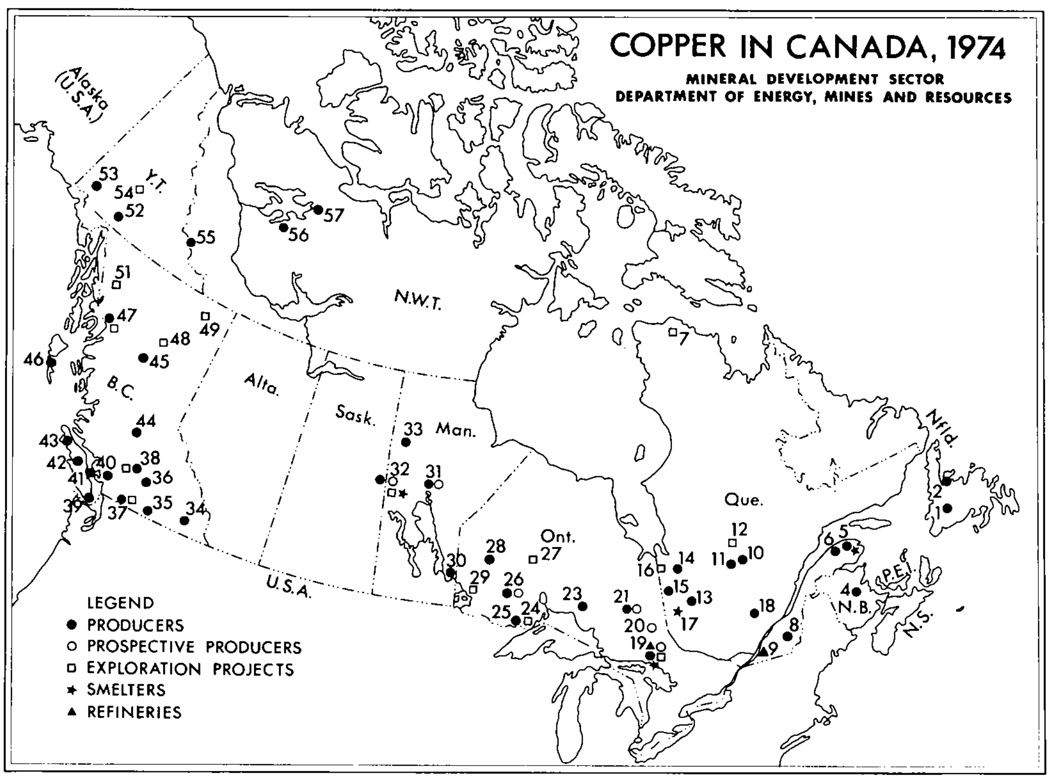
Falconbridge Nickel Mines Limited, Wesfrob Mine, Tasu Harbour, Q.C.I.	5,800 (3,000)	0.282 (0.41)	— —	— —	— —	939,313 (762,978)	2,172 (2,824)	The development of the underground mine will proceed during 1975. The mine also produced 912,000 metric tons of iron concentrates in 1974.
Giant Mascot Mines Limited, Giant Nickel Mine, Hope	1,800 (1,800)	0.21 (0.24)	— —	0.68 (0.58)	— —	157,181 (352,758)	405 (893)	Mine closed August 30, 1974.
Gibraltar Mines Ltd. (N.P.L.), McLeese Lake, Caribou District	40,000 (40,000)	0.40 (0.48)	— —	— —	— —	13,397,264 (15,082,231)	45,123 (60,900)	The Gibraltar East Stage I open pit was completed and mining of the Granite Lake Stage I open pit was begun during 1974. Ore mined in 1974 had an average molybdenum grade of 0.017% MoS_2.
The Granby Mining Company Limited, Granisle Mine, Babine Lake	13,000 (13,000)	0.446 (0.47)	— —	— —	— (0.09)	4,780,857 (4,565,105)	19,100 (17,874)	
Phoenix Copper Division, Greenwood	2,750 (2,750)	0.446 (0.50)	— —	— —	0.134 (0.18)	1,012,426 (1,003,815)	3,666 (4,087)	Concentrates sold to Japan in 1974, but will be shipped to Montana in 1975.
Granduc Operating Company, Granduc Mine, Stewart	8,000 (8,000)	1.23 (1.25)	— —	— —	0.216 —	2,708,731 (2,797,949)	31,879 (33,533)	Production to be reduced by 50% in 1975 due to lower metal prices.
Lornex Mining Corporation Ltd., Lornex Mine Highland Valley	45,000 (38,000)	0.457 (0.42)	— —	— —	— —	16,445,460 (13,986,958)	51,996 (52,992)	A major increase in ore reserves occurred in 1974. The company had an undelivered inventory of 44 million lbs of copper and 850 thousand lbs of molybdenum in concentrate at the end of 1974. The mining rate will be lower in 1975.

Table 3. (concl'd)

Company and Location	Mill or Mine Capacity[1]	Grade of Ore: Copper	Grade of Ore: Zinc	Grade of Ore: Nickel	Grade of Ore: Silver	Ore Produced	Contained Copper Produced	Remarks
	(tons ore/day)	(%)	(%)	(%)	(oz/ton)	(tons)	(tons)	
British Columbia (concl'd)								
Noranda Mines Limited, Bell Copper Division, Babine Lake	10,000 (11,300)	0.524 (0.59)	— —	— —	— —	4,500,998 (4,114,000)	19,817 (17,023)	
Placid Oil Company, Bull River Mine, Cranbrook	750 (750)	. . (2.4)	— —	— —	— (0.71)	100,904 (206,812)	1,495 (3,607)	The Bull River Mine was closed June 10, 1974 for an indefinite period.
Similkameen Mining Company Limited, Ingerbelle Pit, Princeton	15,000 (15,000)	0.48 (0.45)	— —	— —	— —	5,086,000 (5,356,829)	21,000 (20,570)	Construction of a 7,000-tons-a-day mill expansion has been started.
Texada Mines Ltd., Vanada	4,500 (5,000)	0.292 (0.31)	— —	— —	0.049 (0.05)	925,000 (1,090,000)	1,398 (2,224)	
Utah Mines Ltd., Island Copper Mine, Coal Harbour, V.I.	38,000 (33,000)	0.47 (0.50)	— —	— —	— —	11,200,000 (12,071,000)	43,850 (52,300)	
Western Mines Limited, Lynx and Myra Mines, Buttle Lake, V.I.	1,100 (1,000)	1.28 —	8.05 —	— —	4.52 —	297,290 (354,240)	3,521 (4,643)	The 2,700-foot Price tunnel was completed in 1974.
Yukon Territory								
Whitehorse Copper Mines Ltd., Little Chief Mine, Whitehorse	2,000 (2,400)	1.84 (1.83)	— —	— —	0.346 —	618,000 (700,054)	10,406 (11,782)	Orebody extension discovered during 1974.

Northwest Territories								
Canada Tungsten Mining Corporation Limited, Tungsten	600 (600)	0.17 —	— —	— —	— —	170,614 (164,900)	82 (99)	Production began from the underground E-zone. Average grade of tungsten in ore mined was 1.46% WO_3.
Echo Bay Mines Ltd., Port Radium	150 (150)	.. (1.25)	— —	— —	.. (84.0)	20,768 (37,393)	205[2] (430)	
Terra Mining and Exploration Limited, Camsell River Mine, Great Slave Lake	175 (175)	0.30 (0.7)	— —	— —	24.02 (35.4)	45,684 (41,116)	238 (250)	Two new ore veins discovered at depth during 1974.

Sources: Company reports and technical press.
[1] Mill capacity in short tons of ore a day. [2] Derived from deliveries, not reported directly.
. . Not available; — Nil; tpd Tons per day.



Producers

(numbers correspond to those on the map)

1. American Smelting and Refining Company
2. Consolidated Rambler Mines Limited
   Green Bay Mining Company Limited
4. Anaconda Canada Limited (Caribou mine)
   Brunswick Mining and Smelting Corporation Limited (No.6 and No.12 mines)
   Heath Steele Mines Limited
   Nigadoo River Mines Limited
5. Gaspé Copper Mines, Limited
6. Madeleine Mines Ltd.
8. Sullivan Mining Group Ltd. (Cupra, d'Estrie, Clinton Mines)
   Bouzan Joint Venture
10. Campbell Chibougamau Mines Ltd. (Cedar Bay, Henderson, Main, Grandroy mines)
    Icon Sullivan Joint Venture
    Patino Mines (Québec) Limited (Copper Rand, Copper Cliff, Portage mines)
11. Falconbridge Copper Limited, Opemiska Division (Perry, Springer mines)
13. Louvem Mining Company Inc.
14. Joutel Copper Mines Limited
    Mattagami Lake Mines Limited
    Orchan Mines Limited (Orchan, Garon Lake mines)
15. Normetal Mines Limited
17. Falconbridge Copper Limited, Lake Dufault Division (Norbec, Millenbach mines)
    Noranda Mines Limited (Horne Mine)
18. Société Minière d'Exploration Somex Ltée.
19. Falconbridge Nickel Mines Limited (East, Falconbridge, Fecunis, Hardy, Longvack South, North, Onaping, Strathcona mines)
    The International Nickel Company of Canada, Limited (Clarabelle, Coleman, Copper Cliff North, Copper Cliff South, Creighton, Frood Stobie, Garson, Kirkwood, Levack, Little Stobie, MacLennan, Victoria, Crean Hill Mines)
20. Kanichee Mining Incorporated
21. Ecstall Mining Limited (Kidd Creek mine)
    Pamour Porcupine Mines, Limited
23. Noranda Mines Limited, Geco Division
    Willroy Mines Limited (Willecho, Willroy mines)
25. The International Nickel Company of Canada, Limited (Shebandowan)
26. Sturgeon Lake Mines Limited
    Mattabi Mines Limited

Producers (concl'd)

28. Selco Mining Corporation Limited, South Bay Division
30. Dumbarton Mines Limited
31. Falconbridge Nickel Mines Limited (Mainbridge mine)
    The International Nickel Company of Canada, Limited (Birchtree, Pipe and Thompson mines)
32. Hudson Bay Mining and Smelting Co., Limited (Centennial mine, Anderson, Chisel, Dickstone, Flin Flon, Ghost, Osborne, Schist, Stall, White Lake mines)
33. Sherritt Gordon Mines, Limited (Farley, Fox and Ruttan mines)
35. The Granby Mining Company Limited, Phoenix Copper Division
36. Brenda Mines Ltd.
37. Giant Mascot Mines Limited
    Similkameen Mining Company Limited (Ingerbelle and Similkameen deposits)
38. Bethlehem Copper Corporation (Huestis, Iona and Jersey mines)
    Lornex Mining Corporation Ltd.
    Craigmont Mines Limited
39. Jordan River Mines Ltd. (Sunro mine)
40. Anaconda Britannia Mines Ltd. (Britannia mine)
41. Texada Mines Ltd.
42. Western Mines Limited (Lynx, Myra mines)
43. Utah Mines Ltd. (Island Copper mine)
44. Gibraltar Mines Ltd.
45. The Granby Mining Company Limited (Granisle mine)
    Noranda Mines Limited, Bell Copper Division
46. Falconbridge Nickel Mines Limited (Wesfrob mine)
47. Granduc Operating Company
52. Whitehorse Copper Mines Ltd. (Little Chief mine)
55. Canada Tungsten Mining Corporation Limited
56. Terra Mining and Exploration Limited
57. Echo Bay Mines Ltd.

Prospective producers

4. Heath Steele Mines Limited (Little River Mine)
10. Patino Mines (Québec) Limited (Lemoine ML, Jaculet)
14. Orchan Mines Limited (Norita mine)
19. Falconbridge Nickel Mines Limited (Lockerby, Thayer Lindsay mine)
    The International Nickel Company of Canada Limited (Murray, Totten mines)
21. Ecstall Mining Limited
27. Union Minière Explorations and Mining Corporation Limited (Thierry mine)
31. The International Nickel Company of Canada Limited (Soab mine)
32. Hudson Bay Mining and Smelting Co., Limited (Centennial, Western mines)
44. Cuisson Lake Mines Ltd.

Exploration projects

7. New Quebec Raglan Mines Limited
12. Selco Mining Corporation Limited and Muscocho Explorations Limited
14. Phelps Dodge Corporation of Canada, Limited
16. Selco Mining Corporation/Moore McCormack Resources Inc. (Detour Project)
17. Copperfields Mining Corporation and Iso Mines Limited
    New Insco Mines Ltd. and others
    Falconbridge Copper Limited (Lake Dufault Division)
19. Falconbridge Nickel Mines Limited (Fraser, Onex mines)
    The International Nickel Company of Canada, Limited (Cryderman, Whistle mine)
24. Great Lakes Nickel Limited
32. Hudson Bay Mining and Smelting Co., Limited (Hudvam, Rail, Reed, Wim mines)
    Stall Lake Mines Limited
    Freeport Canadian Exploration Company and Beth-Canada Mining Company (Reed Lake property)
37. Adonis Mines Ltd.
    Giant Mascot Mines Limited (Giant Copper (Canada) mine)
38. Afton Mines Ltd.
    Bethlehem Copper Corporation (J-A, Maggie, Lake and Iona zones)
    Highmont Mining Corp. Ltd.
    Leemac Mines Ltd.
    Valley Copper Mines Limited
47. Citex Mines Ltd.
48. Falconbridge Nickel Mines Limited
49. Davis-Keays Mining Co. Ltd.
51. Liard Copper Mines Ltd.
    Stikine Copper Limited
54. Silver Standard Mines Limited and Asarco Exploration Company of Canada, Limited
    United Keno Hill Mines Limited — Falconbridge Nickel Mines Limited — Canadian Superior Exploration Limited

Smelters

5. Gaspé Copper Mines, Limited
17. Noranda Mines Limited
19. Falconbridge Nickel Mines Limited
    The International Nickel Company of Canada, Limited
32. Hudson Bay Mining and Smelting Co., Limited

Refineries

9. Canadian Copper Refiners Limited
19. The International Nickel Company of Canada, Limited

Table 4. Prospective[1] copper producers

Company and Location	Mill Capacity[2] and Ore Grade	Year Production Expected	Destination of Copper Concentrates	Remarks
	(%)			
New Brunswick				
Heath Steele Mines Limited, Little River mine, Newcastle	— Cu, Pb, Zn	1977	Murdochville	Sinking new shaft, expanding mill from 3,000 to 4,000 tpd, reopening "A" pit in 1976.
Quebec				
Orchan Mines Limited, Norita Mine, Matagami	— Cu (0.70) Zn (7.60)	1976	Noranda	900 tpd to be trucked to Orchan mill.
Patino Mines (Québec) Limited, Lemoine M.L.	— Cu (4.5) Zn (10.8)	1976	Noranda	
Ontario				
Ecstall Mining Limited, Timmins	— Cu, Pb, Zn	1978	Timmins	Building copper smelter and refinery and expanding mine production to 5 million tpy by 1978.
Falconbridge Nickel Mines Limited, Lockerby mine, Falconbridge	— Cu (. .) Ni (. .)	1975	Falconbridge	Production expected to reach one third of capacity in the final quarter of 1975.
Thayer Lindsley mine, Falconbridge	— Cu (. .) Ni (. .)	. .	Falconbridge	
The International Nickel Company of Canada, Limited,	— Cu (. .) Ni (. .)			
Murray mine		. .	Copper Cliff	on standby
Totten mine		. .	Copper Cliff	on standby
Union Minière Explorations and Mining Corporation, Limited, Thierry	Cu (1.73)	1976	Noranda	Production expected in second half of 1976.
Manitoba				
Hudson Bay Mining and Smelting Co., Limited, Centennial mine, Flin Flon	— Cu (2.06) Zn (2.60)	1975	Flin Flon	Access by decline completed in 1974, shaft sinking began in Jan. 1975.
Westarm mine, Schist Lake	Cu (4.63)	1976	Flin Flon	Shaft sinking began in April, 1975.

Table 4. (concl'd)

Company and Location	Mill Capacity[2] and Ore Grade	Year Production Expected	Destination of Copper Concentrates	Remarks
	(%)			
Manitoba (concl'd)				
The International Nickel Company of Canada, Limited Soab mine, Thompson	— Cu (. .) Ni (. .)	. .	Copper Cliff	on standby
British Columbia				
Cuisson Lake Mines Ltd., Cariboo district	— Cu (0.386)	1975	Japan	Gibraltar Mines Ltd. to mine and mill the orebody

[1] Only mines with announced production plans. [2] Mill capacity in tpd of ore.
— Nil; . . Not available.

Table 5. Copper exploration projects

Company and Location	Indicated Ore Tonnage	Grade of Ore	Remarks
	(tons)	(%)	
Quebec			
Phelps Dodge Corporation of Canada, Limited, Gasset Lake property, Matagami	1,500,000	Cu (1.0) Zn (4.0)	
Falconbridge Copper Limited, Lake Dufault Division Noranda	—	Cu (—)	New orebody discovered in 1974.
Selco Mining Corporation Limited, and Muscocho Explorations Limited, Frotet Lake	1,463,835	Cu (1.73) Zn (2.96)	
Selco Mining Corporation Limited, and Picklands Mather, Broullion Township	—	Cu (—) Zn (—)	Deposits with relatively high zinc and copper grades discovered. Exploration continuing.
Noranda Mines Limited, Magusi River property Noranda	4,100,000	Cu (1.2) Zn (3.6)	Partly amenable to open-pit mining.
New Quebec Raglan Mines Limited, Wakeham Bay	16,050,000	Cu (0.71) Ni (2.58)	Inactive during 1974.
Ontario			
Falconbridge Nickel Mines Limited,	—		
Onaping Mine,		—	New ore zones discovered at depth.
Thayer Lindsley Mine,		—	Development deferred.
Onex mine (Fraser),		—	Development deferred.
Craig Mine			

Table 5. (cont'd)

Company and Location	Indicated Ore Tonnage	Grade of Ore	Remarks
	(tons)	(%)	
Great Lakes Nickel Limited Pardee Township	32,800,000	Cu (0.36) Ni (0.20)	Mining plans deferred.
The International Nickel Company of Canada, Limited, Cryderman mine, Whistle mine, Sudbury area	— —	— —	
Manitoba			
Freeport Canadian Exploration Company and Beth-Canada Mining Company Snow Lake Reed Lake property	1,000,000	Cu (2) Zn (4)	Drilling and geophysical work in progress.
Hudson Bay Mining and Smelting Co., Limited Flin Flon and Snow Lake			
Hudvam mine	400,000	Cu (1.50) Zn (1.70)	
Lost Lake deposit	247,000	Cu (1.45)	
Rail Lake mine	325,000	Cu (3.00)	
Reed Lake mine	1,500,000	Cu (2.09)	
Wim mine	1,090,000	Cu (2.91)	
Stall Lake Mines Limited Snow Lake	672,000	Cu (5.38) Zn (2.28)	
British Columbia			
Adonis Mines Ltd., Summers Creek, Princeton	41,000,000 16,000,000 6,400,000	Cu (0.48) Cu (0.56) Cu (0.47)	South Zone Adit Zone West Zone
Afton Mines Ltd., Kamloops	34,000,000	Cu (1.0)	
Bethlehem Copper Corporation J/A zone,	286,280,000	Cu (0.43) Mo (0.017)	Proven reserves.
Lake zone,	190,000,000	Cu (0.48)	Proven reserves.
Maggie zone, Highland Valley area	200,000,000	Cu (0.40)	Drill indicated. (Cu equivalent)
Davis-Keays Mining Co. Ltd., Fort Nelson	1,375,000	Cu (3.38)	
Falconbridge Nickel Mines Limited, Sustut Peak	—	Cu (1.25)	Amenable to open-pit mining.

Table 5. (concl'd)

Company and Location	Indicated Ore Tonnage	Grade of Ore	Remarks
	(tons)	(%)	
British Columbia (concl'd)			
Giant Mascot Mines Limited, Giant Nickel Mine, Hope	—	Cu (0.57) Ni (0.96)	New ore zone of limited tonnage discovered in 1974.
Highmont Mining Corp. Ltd., Highland Valley	145,000,000	Cu (0.27) MoS_2 (0.045)	
Leemac Mines Ltd., Trojan property Highland Valley	..	Cu (1.56)	
Liard Copper Mines Ltd., Schaft Creek	300,000,000	Cu (0.40) MoS_2 (0.036)	
Stikine Copper Limited Stikine River area	59,000,000 79,000,000	Cu (1.20) Cu (1.00)	
Valley Copper Mines Limited Highland Valley	600,000 tons a vertical foot	Cu (0.48)	
Yukon Territory			
Silver Standard Mines Limited and Asarco Exploration Company of Canada, Limited, Minto property, Carmacks	5,200,000	Cu (1.8)	Property developed to the feasibility study stage in 1974.
United Keno Hill Mines Limited, Falconbridge Nickel Mines Limited and Canadian Superior Exploration	..	Cu (..)	

World consumption

Comparative data for the consumption of refined copper by country in 1973 and 1974 are shown in Table 12. World consumption of refined copper declined to 9.0 million tons in 1974 from 9.5 million tons in 1973. Japan recorded a decline of 31 per cent and the United States recorded a decline of 12 per cent. The Communist countries and Canada recorded increases in refined copper consumption.

Prices

The price of copper wirebar on the LME reached record levels in 1974.

The cash price opened the year at 91 cents a pound (U.S.) and rose steadily to a high of $1.49 on April 1. Monthly average prices also peaked in April and declined steadily thereafter, except for an increase in September back to 92 cents a pound, from 82 cents a pound in August. Monthly average prices declined further after September, to a low of 58½ cents a pound in December.

Canadian producer prices for copper opened at 74 cents a pound, in early 1974 and, under the usual dominant influence of United States producer prices, rose only slowly to a high of 82½ cents a pound in the July–August period. The price was lowered in mid-September to 79½ cents a pound and two further price decreases occurred in October and November. The Canadian producer price ended the year at 74 cents a pound.

United States producer prices, still affected by "Phase IV" price controls remained frozen at 68.15 to 69.25 cents a pound during the first four months of 1974. On May 1, prices were raised to 80.375 – 82.00 cents a pound. A further increase occurred early in June to 85.625 – 87.00 cents a pound, and prices then remained at that level until mid-September. Successive price decreases in the final quarter of 1974 took prices down 68.625 – 70.00 cents a pound early in January, 1975.

Table 6. Canadian copper and copper-nickel smelters, 1973

Company and Location	Product	Rated Annual Capacity	Remarks	Ore and Concentrate Treated	Blister or Anode Copper Produced
		(tons)		(tons)	(tons)
Falconbridge Nickel Mines Limited Falconbridge, Ontario	Copper-nickel matte	650,000[1]	A smelter modernization program is under way. Fluid bed roasters and electric furnaces will replace existing smelting equipment and a 1,300-short-tons-a-day sulphuric acid plant will be installed to treat roaster gases. Completion is expected in 1977. Refining of copper-nickel matte is carried out in Norway.	. .	. .
Gaspé Copper Mines, Limited, Murdochville, Que.	Copper anodes	370,000[1]	Mine and smelter expansion program was completed but had start-up problems in 1974. As part of the program, a fluid bed concentrate roaster, a 300,000-tons-a-year sulphuric acid plant and plant water recycling facility were added to facilities previously described. Smelter is fed with Gaspé and custom concentrates and precipitate from copper leaching operations.	343,300 of which 90,300 were custom concentrates	69,700
Hudson Bay Mining and Smelting Co., Limited Flin Flon Manitoba	Blister-copper cakes	575,000[1]	Roasting furnaces, 1 reverberatory furnace, 3 converters. Treats own and custom copper concentrates along with zinc plant residues in conjunction with slag-fuming furnaces.	364,173 of which 92,894 were purchased concentrate	54,778

Table 6. (concl'd)

Company and Location	Product	Rated Annual Capacity	Remarks	Ore and Concentrate Treated	Blister or Anode Copper Produced
		(tons)		(tons)	(tons)
The International Nickel Company of Canada, Limited Copper Cliff, Ont.	Blister copper, nickel sulphide and nickel sinter for company's refineries; nickel oxide sinter for market. Soluble nickel oxide for market	4,000,000[1]	Oxygen flash-smelting of copper sulphide concentrate; converters for production of blister copper. Roasters, reverberatory furnaces for smelting of copper-nickel ore and concentrate; converters for production of copper-nickel Bessemer matte. Production of matte followed by matte treatment, flotation, separation of copper and nickel-sulphides then by sintering to make sintered-nickel products for refining and marketing. Electric-furnace melting of copper sulphide and conversion of blister copper. Also custom smelting.	. .	. .
Noranda Mines Limited, Noranda, Que.	Copper anodes	1,700,000[2]	Roasting furnaces, 2 hot-charge and 1 green-charge reverberatory furnaces; 5 converters; 1 continuous reactor. Also smelts custom material. Expansion of the continuous reactor has been suspended for restudy due to cost escalation and uncertain supply of concentrates.	1,569,000 (of which 839,000 were custom concentrates)	269,000

Source: Company reports.
[1] Ores and concentrates. [2] Ores, concentrates and scrap.
. . Not available.

Table 7. Copper refineries in Canada, 1973

Company and Location	Rated Annual Capacity	Output	Remarks
	(tons)	(tons)	
Canadian Copper Refiners Limited, Montreal East, Quebec	480,000	427,000	Refines anodes from Noranda and Gaspé smelters, blister copper from Flin Flon smelter, and purchased scrap. Copper sulphate recovered by vacuum evaporation. Precious metals, selenium and tellurium recovered from anode slimes. Produces C.C.R. brand electrolytic copper wirebars, ingot bars, ingots, cathodes, cakes and billets. Semicontinuous casting of cakes and billets will begin late in 1975.
The International Nickel Company of Canada, Limited, Copper Refining Division, Copper Cliff, Ontario	212,000	183,600[1]	Refines blister copper from Copper Cliff smelter. Precious metals, selenium and tellurium are recovered from anode slimes. Recovers and electrowins copper from Copper Cliff nickel refinery residue. Produces ORC brand electrolytic copper, cathodes, wirebars, cakes, billets, ingots and ingot bars.

Source: Company reports.
[1] Deliveries, which are assumed to be equal to output.

Outlook

In spite of production and shipment cutbacks by most noncommunist world copper producers during the first half of 1975, world supply of refined copper continued to exceed refined copper consumption. It is anticipated that world economic activity will increase during the second half of 1975 led by economic recovery in Japan, the United States and Europe, and that supply and consumption will come back into balance.

World stocks of refined copper are expected to peak in the third or fourth quarter of 1975 at around 1.5 million tons. As these stocks begin to decline, producers will begin to phase mines back into production. With refined copper stocks falling and mines back at a high level of production, a firming trend in prices can be expected. This is unlikely to occur before mid-1976.

Canadian mine production is expected to decline by 11 per cent during 1975 and to recover during 1976 and 1977. Annual production of copper may not exceed the 1974 level until 1980 due to a number of mine closures and a lag in new mine development.

Table 13 contains a forecast of Canadian and world copper production and of world consumption of primary refined copper. Consumption is expected to continue to grow at the historic long-term rate of 4.5 per cent a year, and that 1976 and 1977 will be "catch

Table 8. Canada, consumption of primary copper in manufacture of semifabricated products, 1972-73

	1972	1973
	(short tons)	
Copper mill products – sheet, strip, bars, rolls, pipe, tubes, etc.	60,183	73,804
Brass mill products – plate, sheet, strip, rods, bars, rolls, pipe, tubes, etc.	23,621	20,021
Wire and rod mill products	107,540	121,299
Miscellaneous	2,131	2,164
Total	193,475	217,288

Source: Statistics Canada.

Table 9. World mine production of copper, 1973-74

	1973	1974
	(000 short tons)	
United States	1,718.0	1,593.6
U.S.S.R.	1,212.5[e]	1,245.6[e]
Chile	810.6	989.9
Canada	908.2	928.6
Zambia	779.0	769.4
Zaire	540.4	558.9
Australia	240.9	294.1
Peru	242.5	235.0
Philippine Republic	243.8	231.2
Papua New Guinea	201.5	212.5
Poland	170.8	209.4
Republic of South Africa	193.8	194.0
Yugoslavia	162.8	171.2
Mexico	88.7	93.7
Japan	100.6	90.5
Indonesia	41.8	71.2
Other communist countries	237.0[e]	251.3[e]
Other noncommunist countries	410.6	433.1
Total	8,303.5	8,573.2

Sources: *World Metal Statistics*, May 1975 and Statistics Canada.
[e] Estimated.

Table 10. World production of refined copper, 1973-74

	1973	1974
	(000 short tons)	
United States	2,312.6	2,136.6
U.S.S.R.	1,433.0[e]	1,433.0[e]
Japan	1,048.1	1,101.2
Zambia	703.8	746.0
Canada	548.5	616.3
Chile	457.2	578.7
West Germany	448.3	466.9
Belgium	405.1	376.4
Zaire	253.8	231.5
Australia	195.8	211.1
Poland	172.4	192.9
United Kingdom	188.3	176.5
Yugoslavia	151.6	165.4
Spain	135.5	160.6
Republic of South Africa	99.9	97.6
Mexico	68.2	81.9
Sweden	65.6	66.0
Bulgaria	52.9	57.3
Other communist countries	321.3[e]	323.0[e]
Other noncommunist countries	309.8	340.9
Total	9,371.7	9,559.8

Sources: *World Metal Statistics*, May 1975 and Statistics Canada.
[e] Estimated.

up" years in which consumption growth will exceed the long-term rate. Table 13 reflects the expectation that the world surplus of refined copper built up in 1974 and early 1975 will be consumed during the 1975–1978 period.

It is likely that Japanese consumption which led the world decline will also lead the recovery during 1975. Canadian consumption is expected to recover late in 1975.

Table 11. World consumption of refined copper, 1973-74

	1973	1974
	(000 short tons)	
United States	2,445.6	2,156.6
U.S.S.R.	1,212.5[e]	1,229.1[e]
Japan	1,324.7	916.0
West Germany	801.6	797.9
United Kingdom	596.6	547.7
France	449.5	413.9
Italy	325.2	328.9
Canada	273.6	297.7
Belgium	181.2	196.4
Brazil	138.1	157.1
Poland	137.8[e]	154.3[e]
Spain	149.6	149.0
Australia	134.3	128.8
Sweden	125.7	117.1
East Germany	110.2[e]	110.2[e]
Yugoslavia	88.4	109.2
Other communist countries	519.7[e]	567.7[e]
Other noncommunist countries	593.5	578.4
Total	9,607.8	8,956.0

Source: *World Metal Statistics*, May 1975.
[e] Estimated.

Table 12. World copper production and consumption, 1974

	Mine Production	Refined Production	Refined Consumption
	(000 short tons)		
United States	1,593.6	2,136.6	2,156.6
U.S.S.R.	1,245.6[e]	1,433.0[e]	1,229.1[e]
Japan	90.5	1,101.2	916.0
CIPEC	2,553.2	1,599.2	52.3
Europe	355.6	1,577.2	2,865.9
Canada	928.6	616.3	297.7
Other communist countries	460.8[e]	573.2[e]	832.2[e]
Other noncommunist countries	1,345.3	523.1	606.2
Total	8,573.2	9,559.8	8,956.0

Sources: *World Metal Statistics*, May 1975 and Statistics Canada.
[e] Estimated.

Table 13. Forecast of Canadian and world copper production and world primary refined copper consumption

	1974	1975	1976	1977	1978	1979	1980	1981
	(000 short tons)							
Mine production								
Canada	929	830	860	900	920	920	990	1,050
World	8,573	7,460	8,000	8,200	8,900	9,800	10,200	10,500
Primary smelter production								
Canada	575	607	610	630	690	755	785	785
World	8,853	8,100	8,200	8,700	9,400	10,300	10,800	11,100
Primary refinery production								
Canada	616	610	610	630	680	730	760	760
World	9,560	8,400	8,800	9,500	10,300	11,300	11,800	12,200
World consumption of primary refined copper	8,956	7,800	9,000	9,900	10,900	11,300	11,800	12,200

Source: Mineral Development Sector, Department of Energy, Mines and Resources.

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
32900-1	Copper in ores and concentrates	free	free	free
33503-1	Copper oxides	free	15%	25%
34800-1	Copper in pigs, blocks or ingots, cathodes, plates, copper matte and blister and copper scrap, per lb.	free	free	1½¢
34820-1	Copper in bars or rods, for manufacture of trolley, telegraph, telephone wires, electric wires and cables	free	5%	10%
34835-1	Electrolytic copper powder (expires Feb. 28, 1978)	free	free	10%
34845-1	Electrolytic copper wire bars, per lb (expires Feb. 28, 1976)	free	free	1½¢
35800-1	Anodes of copper	free	free	10%

United States

Item No.		GSP	GATT
602.30	Copper ores and concentrates, on Cu content	free	0.8¢ a pound
612.06	Unwrought copper, on Cu content	free	0.8¢ a pound
612.10	Copper waste and scrap, on 99.6% of Cu content	free	0.8¢ a pound

Japan

Item No.		GATT	Preferential
26.01	Copper ores and concentrates	free	free
74.01	Unwrought copper, other than cement and native copper:		
	(1) containing not more than 99.8% by weight of copper and used for smelting and refining	8.5%	free
	(2) other	8.5% for blister, other categories, 24 yen per kg	free
74.07	Tubes, pipes, blanks of copper	12%	free
74.10	Copper wire, unalloyed	12%	free

Tariffs (concl'd)

European Communities

Item No.		Conventional Rate
26.01	Copper ores and concentrates	free
74.01	Copper matte; unwrought copper (refined or not); copper waste and scrap	free
74.07	Tubes, pipes, blanks of copper	8%
74.10	Copper wire, unalloyed	8%

Sources: The Customs Tariff and Amendmonts, Department of Nationl Revenue, Customs and Excise Division, Ottawa. Tariff Schedules of the United States, Annotated (1975). T.C. Publication 706. Customs Tariff Schedules of Japan, 1973. Official Journal of the European Communities, 1974.

Fluorspar

G.H.K PEARSE

Fluorspar, or fluorite in mineralogical nomenclature, is calcium fluoride (CaF_2), an industrial mineral with a broad spectrum of uses. The most imporant uses are: for the manufacture of hydrofluoric acid and other fluorine chemicals; as a fluxing agent in various metallurgical processes, the most important being steel manufacture; for the manufacture of artificial cryolite, an essential cell ingredient in the electrolytic reduction of alumina to aluminum; in the refining of uranium ores; and in the glass and ceramic industries.

In the past decade, world fluorspar consumption has grown rapidly because of increasing demands in the steel, aluminum and chemical industries. In 1974, world consumption reached an estimated 6.0 million short tons* and, based on forecast demands by the major consuming industries, consumption is expected to reach nine million tons by 1985. Contributing to this increase will be a greater use of the basic oxygen process in steelmaking, which requires about three times as much fluorspar as a slag thinner than the more traditional basic open-hearth process. Ever-widening usage of fluorocarbons and other fluorine chemicals will continue to stimulate world demand for acid-grade material.

Production in Canada

Fluorspar is the principal source of the element fluorine. It occurs in many geological environments from low-temperature fracture fillings to high-temperature emplacements and, as a result, it is not restricted to any particular geological province in Canada. In fact, fluorspar is known to occur in all physiographic provinces with the exception of the interior plains. However, all fluorspar produced in Canada is currently mined from the Burin Peninsula in Newfoundland by one company.

Newfoundland Fluorspar Works of Aluminum Company of Canada, Limited, (Alcan), produces fluorspar from three mines, namely Director, Tarefare, and Blue Beach. The three mines are located near the village of St. Lawrence in Newfoundland. The Director mine has been in operation for 32 years. In August 1968 the Tarefare mine commenced production at about 25,000 tons a year of fluorspar concentrate. Production from the Blue Beach mine began in 1972 and the mill capacity was increased to 1,200 tons of ore a day. Concentrates from these operations are shipped to Alcan's aluminum smelter at Arvida, Quebec, where they are upgraded by flotation and converted to aluminum fluoride for the reduction of alumina to aluminum. Small tonnages have been sold to Newfoundland Steel (1968) Company Limited, from time to time, for steel slagging. Shaft-sinking operations on extensive new reserves about one mile northwest of St. Lawrence are in progress. In 1974, shipments totalled an estimated 175,000 tons, valued at $8.2 million. Fluorspar veins on Burin Peninsula are genetically related to two large stocks of alaskite. Most of this favourable area is obscured by shallow overburden, but innumerable showings and float blocks containing fluorspar are known.

Allied Chemical Canada, Ltd. imports acid-grade fluorspar for the production of hydrofluoric acid at Valleyfield, Quebec and Amherstburg, Ontario. Some of the acid is utilized in the manufacture of various fluorine chemicals. Allied Chemical operates mines in Mexico and the United States to ensure an uninterrupted supply of fluorspar.

Huntingdon Fluorspar Mines Limited, with a plant near North Brook, Ontario, imports metallurgical-grade fluorspar to make five-pound briquettes for foundry use.

International Mogul Mines Limited has done considerable geological and mineralogical assessment work on its barite–fluorite deposits east of Lake Ainslie, Cape Breton Island, Nova Scotia. Indicated ore reserves are 2.97 million tons grading 28 per cent barite and 19 per cent fluorite. Pilot plant testing, with the objective of producing an acid-grade concentrate at an acceptable rate of recovery, has yet to prove successful. From 1940 to 1949, approximately 1,400 tons of fluorspar, along with some barite, were recovered from this deposit.

Prior to the First World War, small tonnages of fluorspar were mined from vein-type deposits in the Madoc district of Ontario. As a strategic material of great importance, it showed a marked increase in production during the war. After the war, production decreased substantially, but was stimulated once again during the Second World War by government assis-

* The net or short ton (2,000 pounds) is used throughout, unless otherwise stated.

Table 1. Canada, fluorspar production, trade and consumption

	1973		1974[p]	
	(short tons)	($)	(short tons)	($)
Production (shipments)				
Newfoundland	..	4,620,382	..	8,170,000
Imports				
Mexico	100,908	5,365,000	117,877	6,856,000
United Kingdom	39,099	1,766,000	25,526	1,101,000
France	—	—	7,289	432,000
Spain	18,595	516,000	4,044	217,000
United States	10,951	700,000	2,063	181,000
Total	169,553	8,347,000	156,799	8,787,000
	1972		1973	
Consumption[1] (available data)				
Metallurgical flux[2]	43,985		35,452	
Glass and glass wool	499		403	
Enamels and frits	385		353	
Other[3]	187,259		179,529	
Total	232,128		215,737	

Source: Statistics Canada.
[1] As reported by consumers; breakdown by Mineral Development Sector. [2] Consumption as flux in the production of steel and magnesium, and use in foundries. [3] Includes consumption in the production of aluminum and chemicals and other miscellaneous uses.
[p] Preliminary; .. Not available.

tance for exploratory drilling programs and by loans on capital equipment. From 1943 to 1947 some 25,000 tons were mined. Fluorspar was mined continuously in the Madoc area up to 1961 when severe underground flooding, lack of export markets, and increased mining costs made mining uneconomic. Altogether, some 150,000 tons of fluorspar were mined in the Madoc area, production being derived from 24 separate properties. Most significant producing properties were along a prominent linear vein structure, the southern extension of which could still contain economically attractive reserves.

The Rock Candy mine, near Grand Forks, British Columbia was mined intermittently from 1918 to 1942 and is controlled by Cominco Ltd. Substantial reserves probably remain.

Some fluorine is being recovered as fluosilicic acid from the processing of phosphate rock by Erco Industries Limited (formerly Electric Reduction Company of Canada, Ltd.), at Port Maitland, Ontario, and by Cominco Ltd., at Trail, British Columbia.

Other fluorspar occurrences of interest include the Liard River, British Columbia deposits explored a few years ago by Jorex Limited and Conwest Exploration Company Limited; Consolidated Rexspar Minerals & Chemicals Limited's large uranium bearing, medium-grade fluorspar deposit adjacent to Canadian National Railways' line at Birch Island, about 60 miles north of Kamloops; and Eaglet Mines Limited's widespread low-grade mineralization near Quesnel, British Columbia.

Uses, markets and trade

The major uses of fluorspar are: as a fluxing material in metallurgical and related industries; in the chemical industry for the manufacture of hydrofluoric acid and other fluorine compounds; in the glass and ceramic industries; in the refining of uranium ores and concentrates; and in the manufacture of artificial cryolite utilized in aluminum refining. Minor quantities of clear, transparent, colourless fluorite are used in optical equipment.

Fluorspar is marketed in three grades according to end-use, although in times of shortage, high-grade material may be substituted in applications normally requiring lower-grade materials. These three grades are: acid grade containing a minimum of 97 per cent CaF_2; metallurgical grade containing 60–80 per cent CaF_2; and ceramic grade containing 88–97 per cent CaF_2.

Acid grade. Over 50 per cent of the world's fluorspar requirement is for acid grade and is used in the manufacture of hydrofluoric acid. Most of this material is beneficiated by flotation to achieve the high CaF_2 content required. In general, two to three tons of ore must be mined to produce one ton of acid-grade fluorspar concentrate, and the production of one ton of hydrofluoric acid requires two tons of acid grade concentrate and almost three tons of sulphuric acid. Hydrofluoric acid, produced according to the reaction $CaF_2 + H_2SO_4 \rightarrow CaSO_4 + 2HF$, has a variety of uses, but by far the most important, accounting for some 80 per cent, is in the aluminum and fluorocarbon industries.

About one third of all hydrofluoric acid produced is used by the aluminum industry. Hydrofluoric acid is reacted with a sodium salt and aluminum fluoride to produce artificial cryolite, an essential cell ingredient for fluxing in the electrolytic reduction of alumina to aluminum. In general, about 45 pounds of cryolite and 40 pounds of aluminum fluoride are required for the production of one ton of primary aluminum. This is equivalent to 130 to 140 pounds of acid-grade fluorspar concentrate. Allowing for increased cell efficiencies and fluorite recoveries from potlines, the above figure should be reduced to 120 pounds a ton of primary aluminum. Because fluorite is an essential raw material, many primary aluminum producers operate or participate in the operation of fluorspar mines to ensure uninterrupted and adequate supplies.

Over 40 per cent of hydrofluoric acid is consumed in the manufacture of fluorocarbons. Fluorocarbons, which are used in the manufacture of solvents, resins, plastics, films, refrigerants and aerosol propellants, are produced by reacting hydrofluoric acid with carbon tetrachloride or with chloroform.

Fluorspar is used in uranium refining. Uranium dioxide is reacted with anhydrous hydrofluoric acid to form a green salt (UF_4), which is then reacted with elemental fluorine in the form of fluorine gas to form UF_6. For each ton of uranium processed into uranium hexafluoride, one and two-third tons of fluorspar are required.

Metallurgical grade. About one half of the world's fluorspar output is consumed as a metallurgical fluxing agent, primarily in the manufacture of steel. Metallurgical-grade fluorspar is used in the steel industry to remove impurities during melting and also to improve separation of metal and slag in the furnace by increasing the fluidity of the slag. Consumption of fluorspar in the steel industry has, in recent years, increased substantially because of increased steel output and changing technology. Steelmakers have shifted increasingly from the basic open-hearth process to the basic oxygen process. The latter consumes from 10 to 15 pounds of metallurgical-grade fluorspar compared with three to five pounds in the open-hearth process. The electric furnace process consumes from eight to ten pounds of metallurgical-grade material for each ton of steel produced. The basic oxygen process substantially reduces production costs, doubles capacity per unit dollar of capital cost and reaches heat much faster than the open-hearth process. Within the next decade, older basic open-hearth furnaces should be replaced by more efficient new basic oxygen or electric furnaces. Faced with higher prices and uncertain supply conditions, the steel industry will attempt to find methods of reducing consumption of fluorspar. In addition, some major consumers have become involved in exploration for fluorspar reserves. No satisfactory substitute for fluorspar as a fluxing agent in steelmaking has been found, although research in this area is considerable and indications are that the growth of metallurgical-grade reserves is not keeping pace with requirements. Consequently, steelmakers may have to switch to higher-grade, higher-cost material, produced as flotation concentrates and converted into pellet or briquette form. World consumption in the steel industry is currently about 3.9 million tons a year. Metallurgical-grade fluorspar is also used as a flux in foundries and in the reduction of dolomite to magnesium.

Ceramic grade. Ceramic-grade fluorspar is used as an opacifier in enamels and opal glass. It is also used to a limited extent in the manufacture of clear glass as an active flux, as a contributor to the gloss, and as a decolourizer. Much of this grade of fluorspar concentrates can be used for the manufacture of hydrofluoric acid or as pellets and briquettes for steelmaking. This latter use has been provided for in this way during shortages of metallurgical-grade fluorspar.

Table 2. Canada, fluorspar production, trade and consumption, 1965-1974

	Production[1]	Exports	Imports	Consumption
		(short tons)		
1965	112,000	..	69,848	167,537
1966	79,000	12	75,324	166,275
1967	72,762	..	94,244	155,349
1968	105,000	..	115,465	178,901
1969	131,600	..	104,382	200,827
1970	136,800	..	94,682	212,949
1971	90,000[er]	..	225,093	197,449
1972	160,700[er]	..	71,910	232,128
1973	151,000[er]	..	169,553	215,737
1974[p]	180,000[e]	..	156,799	..

Source: Statistics Canada.
[1] Shipments reported in annual reports of Aluminum Ltd. for 1964-1970. Shipments 1970-74 are estimates as reported by the U.S. Bureau of Mines.
[p] Preliminary; .. Not available; [e] Estimated; [r] Revised.

Canadian consumption and trade

Most fluorspar consumed in Canada, and virtually all domestic production, is used in the manufacture of aluminum fluoride for the electrolytic reduction of alumina to aluminum.

In 1974, fluorspar imports were 156,799 tons, a drop of 7 per cent from the previous year. Imports tend to vary widely from year to year in an inverse relationship to swings in production caused primarily by strikes. However, growth in consuming industries is also an important factor. Mexico provided 75 per cent of total imports, the remainder coming from Britain, France, Spain and the United States.

Prior to 1957, much of Canadian production was exported to the United States and Europe. In 1958, exports declined abruptly because of the development of alternative low-cost deposits in Mexico by large consumers in the United States.

World review

Rapid growth in fluorspar consumption by the steel, chemical and aluminum industries coupled with a stagnant ore-reserve situation during the 1960s raised fears of a shortage towards the end of the decade. Under the impetus of tightening supply and rising prices, intensive exploration efforts in various parts of the world were successful in substantially augmenting reserves. Expanded and new facilities were brought on stream to meet the expected strong demand. However, coincident with the surge in production came a slackening in demand due to an economic slowdown in the major consuming nations, notably the United States and Japan. During the latter part of 1971 and the first half of 1972 an over-supply situation, especially of acid-grade material, developed in many areas. World production at 5.1 million tons in 1974 was a modest improvement over 1972–73 and still marginally short of the record 1971 output. The strong growth in consuming sectors in 1974 was met by withdrawals from large inventories, notably in Europe where output was deliberately cut back.

Mexico continued to rank as the world's largest supplier, production rising 14 per cent to 1.32 million short tons in 1974, a recovery to the record level of a few years ago. Fluorspar mining began in Mexico prior to The First World War. However, the industry received its greatest stimulus during The Second World War when the United States government, cut off from European sources, encouraged exploration and development in Mexico. Most production is mined in the State of San Luis Potosi in the Zaragoza area where two major producing mines are located within a mile of each other. The Las Cuevas mine, which is the largest, accounts for some 40 per cent of total Mexican metallurgical-grade output. This underground operation is an affiliate of Noranda Mines Limited. The rapid growth of fluorspar production in Mexico from 474,000 tons in 1963 has paralleled consumption increases in the United States which relies upon Mexico for most of its import requirements.

Quimica Fluor S.A.'s hydrofluoric acid plant at Matamoros is scheduled for start up in 1975. It is one of four originally proposed in 1971.

During the year the Mexican Fluorspar Institute, a producer organization, was formed. This body, backed by the government, will formulate policy on sales and prices.

The United States is the world's largest consumer and is heavily reliant on imports to meet demand. In 1974, production fell 21 per cent to 201,000 tons as a result of several mine and mill closures in late 1973. Imports from Mexico were 1,064,000 tons, 60 per cent of which was acid spar. Most output in the United States comes from the Illinois–Kentucky district and is produced by two companies, Ozark-Mahoning Company and Minerva Oil Company. The new mine and mill development of Cerro Corporation near Salem, Kentucky started up in 1974, however, mining problems prevented achievement of capacity output during the year. Other states producing fluorspar are: Montana, Colorado, Idaho, Arizona, New Mexico and Utah. Little news of developments at Lost River Mining Corporation Limited's reportedly extensive deposits near Teller, Alaska was forthcoming during the year.

In France, a new deposit is being worked in the Massif Central region. Estimated French production in 1974 was 300,000 short tons.

In 1974, Spain produced an estimated 360,000 short tons. Significant new reserves have been found in the Caravia district in Oviedo Province. Much of Spanish production is exported, mostly to the United States and West Germany.

Production in Britain was an estimated 185,000 tons in 1974, considerably down from 1973.

Italy, also a major producer, shipped an estimated 180,000 tons in 1973, a substantial reduction compared with previous years shipments.

The U.S.S.R. is the world's second largest producer of fluorspar, with an output of about 500,000 tons in 1974. Domestic supply has fallen short of requirements for some years, and imports in 1974 exceeded 250,000 tons. The People's Republic of China and North Korea together produce approximately 300,000 tons a year.

Thailand's output remained substantially below the 1971 output of 471,015 tons. As a result of cutbacks in orders principally from Japan, production in the last two years slipped to 385,000 tons. However, reserves are reportedly 12 million tons of 60 per cent CaF_2 and large deposits indicated in the upper reaches of the River Kwai have received attention. Limiting factors on production and market development include primitive mining and beneficiating techniques, and costly and difficult transportation from producing areas to points of export. Loading facilities at Bangkok also present a bottleneck to efficient ocean transport. The Thai government has taken an active interest in the industry and is moving to eliminate these drawbacks.

South Africa's output more than doubled between 1968 and 1971 to 263,000 tons. However, production since then has been around 230,000 tons.

Namibia (formerly South-West Africa), Kenya, Tunisia and Morocco are all significant producers.

Until recently, South America produced limited quantities of hand-sorted metallurgical grade fluorspar. Exploration and development is moving along rapidly in both Brazil and Argentina and output from this continent has risen to about 150,000 tons.

Table 3. World fluorspar production, 1972-74

	1972	1973	1974[e]
	(short tons)		
Mexico	1,149,039	1,196,992	1,300,000
U.S.S.R.	470,000	490,000	500,000
Spain	444,290	430,000	360,000
Thailand	412,915	377,079	380,000
France	320,000	330,000	300,000
People's Republic of China	280,000	280,000	300,000
Italy	305,244	259,630	180,000
United States	250,347	248,601	194,000
United Kingdom	219,300	220,000	185,000
Republic of South Africa	232,374	231,842	. .
Canada	179,700	151,000	180,000
Other countries	711,124	712,705	1,115,000
Total	4,974,333	4,927,849	4,994,000

Source: U.S. Bureau of Mines.
. . Not available; [e] Estimated.

Outlook

The performance of the fluorspar industry necessarily parallels development in the steel, chemical and aluminum industries, which together account for 95 per cent of fluorspar consumption.

Conversion from the open-hearth process to the basic oxygen process for steelmaking, and vigorous growth in the chemical and aluminum industries during the 1960s accelerated fluorspar consumption. A hiatus in this growth during 1971 and much of 1972 obviated a tight-supply situation, and both consumer and producer stocks, particularly of acid grade, grew substantially. Although output was little changed in 1973 and 1974, inventories were drawn down markedly.

Exploration efforts over the last few years have resulted in a welcome expansion of world fluorspar reserves to about 320 million tons averaging 30 per cent CaF_2, more than double the known reserves of 1970. In view of economic problems in the world and attendant slack demand, remaining stocks and available capacity ensures no shortage of fluorspar in the short run. However, these reserves will satisfy little more than 15 years requirements, and considerable development and expansion will be necessary over the medium-term to meet projected demand.

Expected steel output for 1980 is over one billion metric tons. Performance of the fluorine chemical and the aluminum industries in the near-term is predicated on world economic developments. In any case, consumption of fluorspar in the aluminum industry is expected to level off over the medium-term as fluorine emissions from potlines are reduced and greater efficiency in recycling is achieved. Also, recovery of fluorine from phosphate rock processing has begun and is currently being utilized in a small way in synthetic cryolite making. These negative effects on the demand for fluorspar will undoubtedly be compensated for in the long-term by accelerated use in uranium refining and developments in the chemical industry.

Fluorine, the most electronegative of all elements, reacts with almost all organic and inorganic substances and as such only the surface of its potential as a chemical has been scratched.

Prices

United States fluorspar prices, as quoted in Engineering and Mining Journal of December 1974.

(net ton fob Illinois and Kentucky, CaF_2 content, bulk)	($)
Ceramic, calcite and silica variable, CaF_2	
88-90%	77-90
95-96%	83.50-96.00
97%	87-103
In 100-lb paper bags, extra	9
Metallurgical, pellets, 70% effective CaF_2	
Acid, dry basis, 97% CaF_2	
Carloads	85.50-103
Less than carloads	85.50-103
Bags, extra	9
Pellets, 88% effective	85.00
Wet filter cake, 8-10% moisture, sold dry content–subtract approx.	3.00
Dry acid concentrates fob Wilmington, 97% CaF_2 st	102.50

Prices (concl'd)

	($)
European wet filter cake, 8-10% moisture, sold dry content, duty pd. st cif Wilmington/Philadelphia term contracts (spot material $5-10 higher)	80-90
Mexican	
Metallurgical 70% fob cars	
Mexican border	48.50
Tampico, fob vessel	50
Acid, 97% +Eagle Pass, bulk	60-70

Tariffs

Canada

Item No.		
29600-1	Fluorspar	free

United States

Item No.		($/lt)
522.21	Fluorspar, containing over 97% calcium fluoride	2.10
522.24	Fluorspar, containing not over 97% calcium fluoride	8.40

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Gold

J.J. HOGAN

Gold production in Canada in 1974 was estimated at 1,718,000 ounces* valued at $268,981,000 compared with 1,954,340 ounces in 1973 valued at $190,376,168, a decline of 12.1 per cent in volume. The average yearly afternoon fixing prices of gold on the London Gold Market converted to equivalent Canadian dollars for the years 1974 and 1973 were $155.75 and $97.35, respectively. As a result of the sharp increase in the gold price on the free market, the dollar value of gold production in 1974 reached an all-time high, the previous high of $205,789,302 being recorded in 1941. Volume of gold production in Canada has declined continuously since 1960 when 4,628,911 ounces were produced. The largest gold production in Canada for any year was in 1941 when 5,345,179 ounces were produced.

Canada has been one of the world's leading producers of gold and, since production was first officially recorded in 1858, has produced 199.4 million ounces to the end of 1974, valued at $6,895 million. Although most of the provinces and territories have contributed to total output, the largest producers, in decreasing order of output, were Ontario, Quebec, British Columbia, Yukon Territory and the Northwest Territories.

In 1974, the 22 operating lode or auriferous quartz gold mines in Canada produced 1,196,000 ounces of gold compared with 1,416,842 ounces in 1973, a decrease of 15.6 per cent. The reason for the sharp decline in lode gold production was that the sharp rise in the gold price made it possible for most of the mines to treat lower-grade ore. In Quebec, one lode gold mine exhausted its ore reserves and was closed, and another came into production. Gold derived from base-metal mining amounted to 513,000 ounces in 1974 compared with 527,694 ounces in 1973, a decrease of 2.8 per cent and accounted for 29.9 per cent of the total. A small amount of gold was recovered from the placer deposits of the Yukon Territory and British Columbia. Ontario continued to be the leading gold producing province in 1974, accounting for 46.3 per cent of the national total followed by Quebec with 25.8 per cent, British Columbia with 10.9 per cent, and the Northwest Territories with 10.3 per cent.

Increased ore reserves, made possible by the higher price, will extend the life of the gold mines, thereby playing an important role in the economy of those communities dependent on gold mining and whose economy over the years was helped through the assistance extended to such mines under the provisions of the Emergency Gold Mining Assistance Act. The expiry date of the Act is June 30, 1976, although no mines are now receiving assistance.

In 1974, the Republic of South Africa was, by far, the leading world gold producing country, followed by the U.S.S.R., Canada and the United States. Other significant gold producing countries were Ghana, Philippines, Australia and Rhodesia. Smaller producers were Colombia, Japan, Mexico and Zaire.

In its 45th annual report for the fiscal year ending March 31, 1975 the Bank for International Settlements (B.I.S.) reported gold production in the noncommunist world for 1974 at 985.0 metric tons (mt), equivalent to 31.67 million ounces compared with 1,086 mt (34.93 million ounces) in 1973, a decline of 9.3 per cent. In 1974, the Republic of South Africa accounted for 758.5 mt (24.39 million ounces), 77.0 per cent of the noncommunist world total. Canada accounted for 5.3 per cent of the noncommunist world production. Table 2 shows the U.S. Bureau of Mines world gold production estimates for the years 1972 and 1973 at 44,717,605 and 43,093,948 ounces, respectively. For these years the U.S.S.R. gold production was estimated at 6,900,000 and 7,100,000 ounces. Consolidated Gold Fields Limited, a company that holds a large interest in South African gold mining, periodically publishes a review on the world's gold industry. Recently, this company re-examined all available data on gold production in the U.S.S.R. and revised its earlier figure, for the year 1971, shown in its report *Gold 1971* by Peter D. Fells, from 6.69 million ounces to 10.77 million ounces. The largest adjustment was made to gold recovered from lode gold mines. The report *Gold 1974* by Consolidated Gold Fields shows the estimated gold production of the U.S.S.R. for the years 1973 and 1974 at 11.93 million ounces and 12.44 million, respectively.

In 1974, the Republic of South Africa sold its gold production on the world market to meet balance of

* The term "ounce" refers to the troy ounce throughout unless otherwise stated.

Table 1. Canada, production of gold, 1973-74

	1973	1974p
	(ounces)	
Newfoundland		
Base-metal mines	14,345	14,000
New Brunswick		
Base-metal mines	5,202	4,000
Quebec		
Auriferous quartz mines		
Bourlamaque–Louvicourt	141,997	124,000
Malartic	181,838	141,000
Matagami	—	36,000
Total	323,835	301,000
Base-metal mines	154,845	143,000
Total Quebec	478,680	444,000
Ontario		
Auriferous quartz mines		
Larder Lake	198,149	171,000
Porcupine	349,451	252,000
Red Lake & Patricia	296,548	295,000
Total	844,148	718,000
Base-metal mines	78,155	77,000
Total Ontario	922,303	795,000
Manitoba-Saskatchewan		
Base-metal mines	74,546	70,000
Placer operations	4	—
Total Manitoba–Saskatchewan	74,550	70,000
Alberta		
Placer operations	175	—
British Columbia		
Auriferous quartz mines	—	—
Base-metal mines	185,986	186,000
Placer operations	3,159	2,000
Total British Columbia	189,145	188,000
Yukon Territory		
Base-metal mines	14,399	19,000
Placer operations	6,466	7,000
Total Yukon	20,865	26,000
Northwest Territories		
Auriferous quartz mines	248,859	177,000
Base-metal mines	216	—
Total Northwest Territories	249,075	177,000
Canada		
Auriferous quartz mines	1,416,842	1,196,000
Base-metal mines	527,694	513,000
Placer operations	9,804	9,000
Total	1,954,340	1,718,000
Total value	$190,376,168	$268,981,000[1]
Average Value per oz.[2]	97.41	156.48

Sources: 1973 Statistics Canada; 1974, Statistics Canada and company reports. Breakdown by type of operation by the Statistics Section, Mineral Development Sector.
[1] Value not necessarily based on average gold price for 1974. [2] Average of London Gold Market afternoon fixings in Canadian funds.
p Preliminary; — Nil.

payment obligations. According to the Bank for International Settlements, the amount of gold offered by the communist countries for sale on the world market dropped from 10.61 million ounces in 1973 to 4.82 million in 1974. The report showed noncommunist world sales at 36.49 million ounces, the difference between world sales and noncommunist world production was made up by sales from communist countries and official gold stocks.

The Winnipeg Commodity Exchange opened future trading in 100-ounce gold bar contracts on June 10, 1974, to make the market accessible to more users such as smaller jewellery manufacturers, dental wholesale houses and electronic supply firms. Prior to June 10, 1974 gold futures trading was limited to 400-ounce bar contracts.

The most noteworthy event in the gold industry in 1974 was a bill signed into law on August 14, 1974, by the President of the United States making it legal for United States citizens to buy, sell or hold gold on and after December 31, 1974. Ownership of gold by private citizens, other than certain gold coins, had been prohibited for 41 years. Trading in gold began on December 31 and the initial reaction of the general public was one of caution.

Trading in gold futures was established on five commodity exchanges in the United States on December 31, 1974. The gold futures contract specifications set by the Commodity Exchange Inc. (COMEX) of New York and the International Monetary Market (IMM) of Chicago call for trading in contracts of 100 ounces each. The contract size established by the Chicago Board of Trade (CBT) was three bars, each weighing one kilogram (32.15 ounces), for a total weight of 96.45 ounces, and by the New York Mercantile Exchange (NYME) of New York and MidAmerica Commodity Exchange of Chicago was one kilogram bar.

On December 3, 1974, the Secretary of the Treasury announced that the United States government would offer for auction, in 400-ounce bars, two million ounces of gold from its official reserves. The reason given for the sale was to offset possible inflationary pressures and balance of payment problems that might result from a strong domestic demand for gold.

Canadian developments

Atlantic provinces. All gold produced in the Atlantic provinces in 1974 was derived as a byproduct of base-metal ores. Exploratory programs were carried out on some of the gold properties in the former gold producing areas in Nova Scotia.

Quebec. Metallurgical problems were encountered in treating the gold ore at the property of Agnico-Eagle Mines Limited, in Joutel Township, and production was adversely affected. Changes are being made to the milling process to improve recovery. At Camflo Mines Limited work was started in the latter part of 1974 to deepen its shaft 600 feet to a total depth of 3,350 feet from surface. This project is expected to be completed in June 1975. Also, a mill expansion program to increase mill capacity from 1,000 to 1,250 tons a day is expected to be completed in the first quarter of 1975. Chibex Limited began tune-up operations at its new concentrator in the Chibougamau district in November 1974. The plant was designed to treat 750 tons of ore a day, producing a copper concentrate and a pyrite concentrate, the pyrite concentrate being cyanided to recover the contained gold. This property was the former producing mine of Key Anacon Mines Limited. Valley Mining Corp. has management control of the operation. East Malartic Mines, Limited acquired the adjoining Barnat property and was deepening its shaft from the present depth of 2,400 feet to 3,000 feet in order to mine two low-grade porphyry ore zones. This project is expected to be completed in May 1975. To treat the extra ore from the Barnat mine, consideration is being given to increase the capacity of the East Malartic mill or to custom treat the ore at the mill of Malartic Gold Fields (Quebec) Limited. Ore reserves at the property of Marban Gold Mines Limited were exhausted and the mine was closed at the end of September 1974. This was the first lode gold producer to close following the sharp rise in the free market price of gold which began early in 1973. Sigma Mines (Quebec) Limited completed its shaft deepening program and established four new levels at 200-feet vertical intervals. The shaft bottom is 5,962 feet below the surface.

Quebec Sturgeon River Mines Limited carried out an extensive underground exploration and development program at its property in the Bachelor Lake area, northwestern Quebec. A feasibility study is under way on the economics involved in bringing the property into production at a rate of about 750 tons of ore a day.

Considerable exploration work consisting mainly of geological and geophysical surveys and surface diamond drilling was carried out on gold prospects in the Chibougamau, Val d'Or-Malartic, Cadillac and Noranda-Rouyn districts. Some prospects in the Val d'Or-Malartic district that cannot justify the capital expenditures involved in constructing their own processing facilities might be brought into production by arranging for their ore to be custom treated at the mill of Malartic Gold Fields.

Ontario. To treat an expected increase in the ore to be mined in the Timmins area, Pamour Porcupine Mines, Limited was increasing its mill capacity from 2,500 to 3,000 tons of ore a day and expected to complete the project in March 1975. Pamour was preparing an ore zone for open-pit mining. Also, the company reached an agreement with Romfield Building Company Limited and McKay Lake Gold Mines Limited, owners of the former Buffalo-Ankerite mine, whereby Pamour would extract remnants of ore remaining in the mine. The Mining Corporation of Canada, Limited took over the underground development program at the property of New Joburke Explorations Limited, located about 50 miles southwest of Timmins. During 1974, 5,130 ounces of gold was recovered from this property by the treatment of 59,100 tons of underground development and open-pit ore at the Pamour mill. Pamour has a 25 per cent interest in the property. Canadian Arrow Mines Limited made a test shipment of 14,491 tons of ore to the Pamour mill. Further tests are planned in 1975. Hollinger Mines Limited continued its underground exploration program on the optioned property of New Kelore Mines Limited which adjoins the north boundary of the Ross mine. A feasibility study is underway to determine production possibilities. The Ross mill treated 9,200 tons of ore from surface pillars at the original Hollinger mine property in Timmins. Quebec Sturgeon River Mines Limited began preliminary surface work required to sink a shaft to a depth of 500 feet to establish two levels to carry out an underground evaluation program at its property in Stock Township near Timmins. An underground diamond drilling and development program was carried out by Pursides Gold Mines Limited on the former Surluga mine and a feasibility study is being made to determine production possibilities. Rengold Mines Ltd. leased the former Renabie mine from Willroy Mines Limited and expected to have the mine in production in 1975. In the Red Lake district Cochenour Willans Gold Mines, Limited carried out an extensive surface and underground diamond-drill program on the property of Wilmar Mines Limited to test a large mineralized granodiorite zone. Drill results were erratic and, to further evaluate the zone, a mill test will be run on a bulk sample to be mined in 1975. Bulora Corporation Limited purchased the mine, mill and related assets of Madsen Red Lake Gold Mines, Limited at Red Lake, in September 1974, for $1.7 million.

Exploratory work, consisting largely of geological mapping and surface diamond drilling, was carried out in many of the mining districts. The uncertainty existing as to the level at which the price of gold will show some stability, problems relating to rapidly increasing inflation, government taxation policies and difficulty in raising venture financing have been determining factors in exploration activity.

Prairie Provinces. Virtually all gold produced in the Prairie Provinces was recovered as a byproduct from the mining of base-metal ores. Only a limited amount of exploratory work was done in some of the former gold producing districts.

British Columbia. With the exception of a small amount of gold recovered from placer deposits, gold produced in British Columbia in 1974 was recovered as a byproduct of base-metal mining, mainly from the treatment of copper ores. Bralorne Resources Limited continued its underground exploration program on the Bralorne mine, a former major gold producer in the Bridge River district. Northair Mines Ltd. carried out an underground exploration and development program at its gold-silver property at Brandywine Falls, about 70 miles north of Vancouver. The company plans to bring the property into production in 1976 at rated capacity of 300 tons of ore a day. Exploration and underground development programs were carried out in the Cariboo district, a former gold producing area. A limited amount of exploratory work was done on gold prospects in other areas of the province.

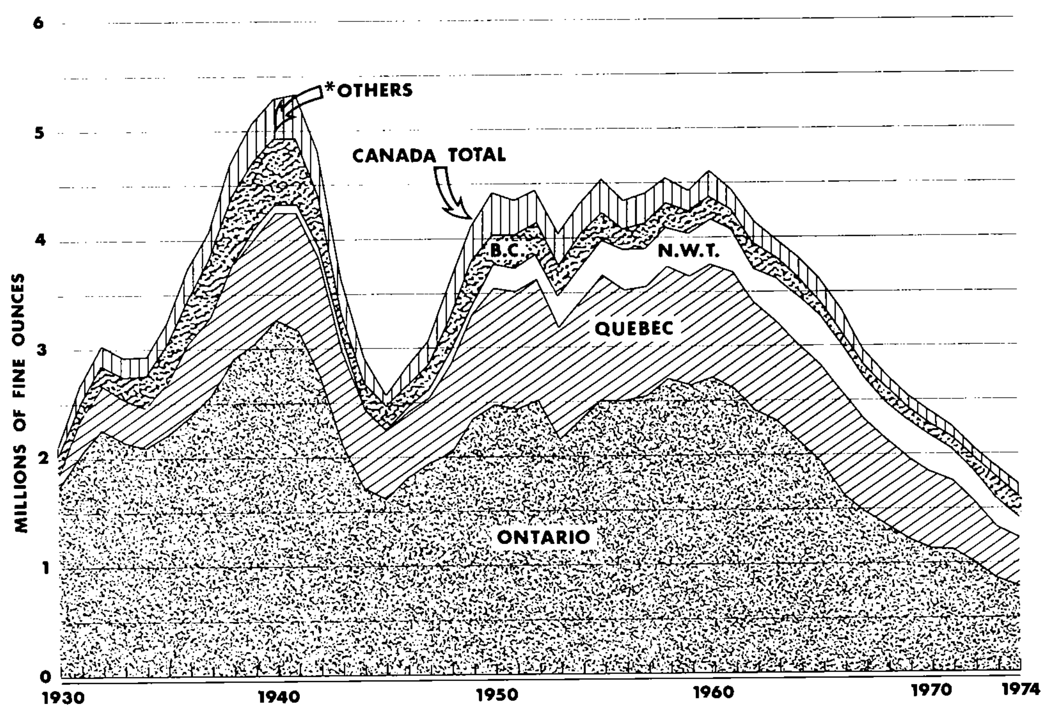
Table 2. World gold production, 1972-73

	1972	1973p
	(ounces)	
North America		
Canada	2,078,567	1,954,340
United States	1,449,943	1,175,750
Other countries	278,943	234,441
Total	3,807,453	3,364,531
South America		
Colombia	186,816	216,243
Brazil	165,531	157,216
Chile	75,946	94,571
Peru	82,885	55,637
Bolivia	19,640	35,341
Other countries	36,399	35,801
Total	567,217	594,809
Europe		
U.S.S.R.e	6,900,000	7,100,000
Yugoslavia	136,898	145,000
Romania	60,000	60,000
France	58,126	60,000
Other countries	93,587	94,658
Total	7,248,611	7,459,658
Asia		
Philippines	606,730	572,319
Japan	243,027	188,000
North Koreae	160,000	160,000
India	105,776	106,097
Other countries	104,753	144,297
Total	1,220,286	1,170,713
Africa		
Republic of South Africa	29,245,273	27,494,603
Ghana	724,051	722,531
Southern Rhodesia	502,000	500,000
Zaire	81,566	133,522
Other countries	53,447	49,266
Total	30,606,337	28,899,922
Oceania		
Australia	754,562	944,716
Papua-New Guinea	409,125	566,216
Fiji	89,670	79,983
Other countries	13,911	13,400
Total	1,267,268	1,604,315
World total	44,717,172	43,093,948

Sources: U.S. Bureau of Mines *Minerals Yearbook Preprint 1973* and Statistics Canada.
p Preliminary; e Estimated.

GOLD PRODUCTION by PROVINCES

MINERAL DEVELOPMENT SECTOR
DEPARTMENT OF ENERGY, MINES AND RESOURCES



* OTHERS = NFLD., N.S., N.B., MAN., SASK., ALTA., Y.T.
DATA SOURCE: STATISTICS CANADA

Yukon Territory. The sharp rise in the price of gold was responsible for increased activity in placer mining in the Yukon, mainly in the Dawson City district. Whitehorse Copper Mines Ltd., near Whitehorse, was the main contributor to byproduct gold production.

Northwest Territories. Cominco Ltd. is sinking a new surface shaft, at its Con property, to an initial depth of 5,800 feet in order to more efficiently mine ore from the lower workings of the mine. The company expects to complete the project in 1976. Giant Yellowknife Mines Limited began to treat ore from an open pit zone containing about 480,000 tons. In 1974, Camlaren Mines, Limited deepened its shaft 480 feet to establish two new levels at 600 and 800 feet and carried out a lateral development and underground diamond-drill program. The company was analyzing development results with a view to installing a low-tonnage milling plant.

Foreign developments

Republic of South Africa. In 1974, gold production in the Republic of South Africa was estimated at 24.7 million ounces compared with 27.4 million ounces in 1973. The main reasons responsible for the decline in output were: higher gold prices which enabled the mine operators to treat lower grade ore; a decline in high grade ore reserves in some of the mines and a shortage of labour. The South African mines were confronted with a series of labour problems during the year. The mines are highly labour intensive and rely to a large extent on expatriate labour, Malawi and Mocambique being the two most important sources. A major setback to the labour pool was the banning of labour recruitment from Malawi by the government of that country. Dissension between some of the different African groups employed at some mines disrupted operations. To offset the labour shortage the Chamber of Mines of South Africa increased its efforts to recruit labour from

Table 3. Canada, gold production 1965-74

	Auriferous Quartz Mines		Placer Operations		Base-metal Ores		Total	
	(ounces)	(%)	(ounces)	(%)	(ounces)	(%)	(ounces)	(%)
1965	2,958,874	82.1	44,598	1.2	602,559	16.7	3,606,031	100
1966	2,676,381	80.6	43,369	1.3	599,724	18.1	3,319,474	100
1967	2,426,137	81.2	9,411	0.3	550,720	18.5	2,986,268	100
1968	2,208,184	80.5	9,564	0.4	525,273	19.1	2,743,021	100
1969	2,030,680	79.8	8,725	0.3	505,704	19.9	2,545,109	100
1970	1,883,764	78.2	7,359	0.3	517,451	21.5	2,408,574	100
1971	1,766,634	78.2	4,988	0.2	489,108	21.6	2,260,730	100
1972	1,598,460	76.9	4,454	0.2	475,653	22.9	2,078,567	100
1973	1,416,842	72.5	9,804	0.5	527,694	27.0	1,954,340	100
1974^p	1,196,000	69.6	9,000	0.5	513,000	29.9	1,718,000	100

Sources: Statistics Canada. Breakdown classification by Statistics Section, Mineral Development Sector.
^{p} Preliminary.

Table 4. Canada, gold production, average value per ounce and relationship to total value of all mineral production, 1965-74

	Total Production	Total Value	Average Value per Ounce	Gold as Percentage of Total Value of Mineral Production
	(ounces)	($ Cdn.)	($ Cdn.)	(%)
1965	3,606,031	136,051,943	37.73	3.7
1966	3,319,474	125,177,364	37.71	3.1
1967	2,986,268	112,731,618	37.75	2.6
1968	2,743,021	103,439,321	37.71	2.2
1969	2,545,109	95,925,158	37.69	2.0
1970	2,408,574	88,057,464	36.56	1.5
1971	2,260,730	79,903,241	35.34	1.3
1972	2,078,567	119,742,087	57.61	1.9
1973	1,954,340	190,376,168	97.41	2.3
1974^p	1,718,000	268,981,000[1]	156.48	2.3

Source: Statistics Canada.
[1] Value not necessarily based on average gold price for 1974.
^{p} Preliminary.

within the country. Wages paid to the African miners were substantially increased during the year and, reportedly, are now competitive with those paid by industry in other parts of the country. The companies have been forced to use the available labour more efficiently and will turn to increased mechanization, especially in those applications in which equipment has already been developed. The geological nature of the ore deposits and the narrow width of the ore zones precludes the use of much of the mechanical equipment now available for stoping and new equipment is being developed. The significant increase in the wage rates was largely responsible for mining costs in 1974 being about 25 per cent above those of the previous year. Rising operating costs were a strong incentive for increasing productivity through mechanization.

United States. Gold production in the United States was estimated at 1.12 million ounces in 1974 by the U.S. Bureau of Mines, a decline of almost 5 per cent from 1973. Mining of lower-grade ore at the gold mines, shortage of labour and a labour strike at the copper mines were responsible for the lower production of gold. Lode gold mines accounted for about 53 per cent of the total output. The major lode gold producers were Homestake Mining Company in South Dakota and Carlin Gold Mining Company and Cortez Gold Mines in Nevada. Copper ores accounted for most of the byproduct gold production, Kennecott Copper Corporation being the main contributor. There was increased activity in gold exploration, especially in Nevada, as a result of the relatively high price of gold. Much of the effort has been directed towards open-pit prospects because of the success with this type of operation in Nevada.

Dominican Republic. Late deliveries of equipment and supplies delayed bringing the 8,000-ton-a-day Pueblo Oiezo gold–silver open-pit mine of Rosario Dominicana S.A. into production in 1974. Production is now expected to begin in the first half of 1975. The operation is a joint venture with Rosario Resources Corporation in charge, and U.R. Simplet Co., both of the United States, each owning 40 per cent of the company, with the remaining 20 per cent being held by the Dominican Republic through its central bank. The mine will be the second largest gold producer in the western hemisphere when operating at plant capacity. Output is estimated to be about 350,000 ounces a year.

Costa Rica. Esperanza Mines Corporation, wholly-owned subsidiary of Bulora Corporation Limited, a Canadian company, brought its Libana gold mine into production in 1974. The mill was designed to treat 200 tons of ore a day, but initially will operate at 100 tons daily.

Bolivia. Camino Gold Mines Limited, a Canadian company, carried out an extensive exploration program on a placer gold deposit in the Tipuani Valley district.

Colombia. In 1974, Pato Consolidated Gold Dredging, Limited, a British Columbia incorporated company, sold its mining and related interests in Colombia to Mineros Colombianos S.A., a private Colombian company, at a reported price of $16 million. Pato held a large acreage of placer ground in Colombia and operated four gold dredges. International Mining Corporation of New York controls 67.4 per cent of Pato Consolidated. Mineros Colombianos also purchased the gold properties in Colombia of Compania Minera Choco Pacifico S.A., a wholly-owned subsidiary of International Mining.

U.S.S.R. Accurate data on gold production in the U.S.S.R. is not available. Gold is recovered from placer deposits, lode mines and as a byproduct from base-metal mines. Gold production in the US.S.R. is expected to increase in 1974.

Prices

The price of gold on the open market in 1974 continued the sharp upward trend which began in 1972. The price quoted on the London Gold Market at the beginning of 1974 was $114.75 (U.S.) an ounce, the low for the year. World wide inflationary pressures, which were increased by a sharp rise in oil prices by the major oil exporting countries, the continuing unsettled situation in the world's monetary arrangements, the unsettled political situation in many parts of the world and speculative buying of gold were responsible for a sharp rise in the gold price over a short period. A price of $178.00 (U.S.) an ounce was recorded on the London Gold Market on February 27, 1974. The gold price remained at a comparatively high level from March to May, then levelled off and remained stable from June to October. With the exception of July, when the average gold price for the month declined to $142.63 (U.S.) an ounce, the monthly average gold price varied between $151.71 and $158.60 (U.S.) an ounce. In November the gold price began to increase sharply because of the continuing uncertainty in the world economy and monetary affairs and the expectations of a strong demand for gold by U.S. citizens when they could officially buy, sell or hold gold. The gold price reached a high of $197.50 an ounce for 1974 on December 30. The average afternoon fixing price on the London Gold Market for 1974 was US $159.26 an ounce.

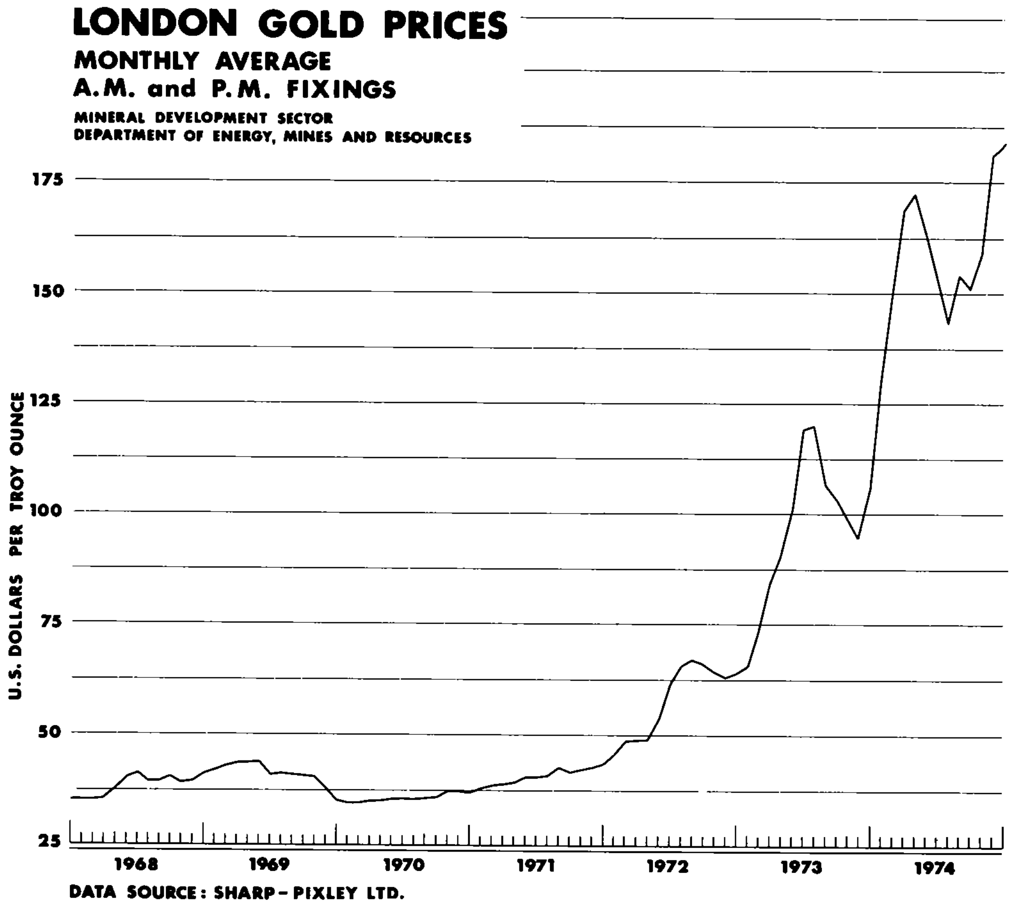
At the meeting of the Committee of the Board of Governors of the International Monetary Fund on Reform of the International Monetary System and Related Issues (the Committee of 20), held in Washington, D.C. on June 12-13, 1974, it was agreed to establish a new method of valuing the special drawing rights (SDR). The valuation of the SDR, for an interim period, was based on a "basket" of currencies of those 16 countries which had a share in the world exports of goods and services in excess of one per cent on average over the five-year period 1968–72. The mix of the different currencies was broadly weighted in proportion to each country's share in international transactions. The United States dollar was assigned a weight of 33 per cent and the Canadian dollar 6 per cent. The weights assigned to some of the other major trading nations were: West Germany, 12.5 per cent; United Kingdom, 9 per cent; France, 7.5 per cent; Japan, 7.5 per cent; and Italy, 6 per cent. The SDR rate was to be calculated daily based on the exchange rates of the "basket" of currencies. The value of an SDR on July 1, 1974 was $1.20601 (U.S.). No action was taken on the role of gold in a revised world monetary system.

Table 5. Average annual price of gold, 1970-74

	London Free Market[1]		Royal Canadian Mint[2]
	($ U.S.)	(equiv. $ Cdn.)	($ Cdn.)
1970	35.941	37.522	36.56
1971	40.806	41.206	35.34
1972	58.161	57.608	36.60
1973	97.394	97.412	38.86
1974p	159.259	156.477	41.18

[1] Annual averages of London Free Market afternoon fixing price. [2] Annual averages of the Royal Canadian Mint weekly published buying prices.

Prior to the meeting, the finance ministers of the noncommunist world's ten leading industrialized nations agreed that official gold reserves could be used as collateral for international loans among the member



nations at near market-related prices. The countries involved in any loan arrangements would have to decide on a mutually acceptable gold price. Toward the end of August 1974, Italy took advantage of this arrangement and borrowed $2 billion from Germany. The collateral value of the gold used to secure the loan was not stated but was believed to be in the range of $119 to $121 (U.S.) an ounce.

At a conference in Martinique in December 1974, President Ford of the United States and President Giscard d'Estaing of France agreed that any government could revalue its gold holdings on the basis of current market gold prices.

The normal commodity demand–supply relationship that exists for other metals does not apply to gold because of its unique dual role, a metal included in the world's monetary reserves and a metal consumed by industry. Therefore it is difficult to forecast gold prices, even on a short-term basis. The unsettled situation in the world's economy and in monetary arrangements further complicate price projections. A factor of major importance in the pricing of gold will be the eventual role gold will play in any new monetary arrangements. Gold held in the world's official reserves are large. At the end of 1974 they were 1.1794 billion ounces compared with 1.1808 billion ounces at the end of 1973. Gold reserves held by each country is shown in Table 7. This huge reserve, whether maintained as part of the official monetary reserves or phased out of monetary arrangements and made available for industrial use or for speculative purposes, will play a very important role in the future pricing system.

Uses and consumption

Gold has been used traditionally as a monetary reserve by governments and central banks in the settlement of

(text continued on page 209)

Table 6. Principal gold (mine) producers in Canada, 1974 and (1973)

Company and Location	Mill or Mine Capacity	Grade of Ore Produced: Gold	Silver	Copper	Combined Lead and Zinc	Ore Treated	Gold Produced	Remarks
	tons of ore/day	oz/ton	oz/ton	%	%	tons	oz	
Newfoundland								
American Smelting and Refining Company (Buchans Unit), Buchans	1,250 (1,250)	0.024 (0.024)	3.25 (3.45)	1.01 (1.00)	17.52 (17.99)	264,000 (124,000)	5,106 (2,526)	
Consolidated Rambler Mines Limited, Baie Verte	1,200 (1,200)	0.06 (0.043)	0.57 (0.331)	3.16 (2.45)	— (—)	215,541 (292,011)	9,047 (9,158)	Production from East mine suspended; Boundary shaft advanced 1,650 ft. during year.
New Brunswick								
Heath Steele Mines Limited, Newcastle	3,100 (3,100)	0.018 (0.017)	1.98 (1.83)	1.04 (0.86)	6.11 (6.54)	1,085,495 (1,077,816)	5,770 (6,397)	Sinking No. 5 production shaft to 3,000 ft. Mill capacity to be increased to 4,000 tons a day.
Quebec								
Agnico-Eagle Mines Limited, Joutel	1,000 (1,000)	0.250 (—)	. . (. .)	— (—)	— (—)	194,702 (—)	31,079 (—)	Metallurgical problems responsible for mill operating below capacity.
Camflo Mines Limited, Malartic	1,000 (1,000)	0.216 (0.251)	. . (. .)	— (—)	— (—)	377,521 (389,622)	81,589 (98,228)	Deepening of main shaft by 600 ft. to 3,340 ft., mill capacity being increased from 1,000 to 1,250 tons a day.
Campbell Chibougamau Mines Ltd., Main, Cedar Bay and Henderson mines, Chibougamau	4,000 (4,000)	0.024 (0.029)	0.220 (0.244)	1.03 (1.30)	— (—)	960,552 (1,186,842)	19,088 (28,780)	Developing Gwillim Lake gold property.
East Malartic Mines, Limited, Malartic	1,800 (1,800)	0.099 (0.118)	. . (. .)	— (—)	— (—)	516,711 (560,942)	49,248 (63,417)	Acquired adjoining Barnat mine.

Table 6 (cont'd)

Company and Location	Mill or Mine Capacity	Grade of Ore Produced: Gold	Silver	Copper	Combined Lead and Zinc	Ore Treated	Gold Produced	Remarks
	tons of ore/day	oz/ton	oz/ton	%	%	tons	oz	
Quebec (cont'd)								
Falconbridge Copper Limited, Lake Dufault Division, Millenbach and Norbec Mines, Noranda-Rouyn	1,500 (1,500)	0.019 (. .)	0.99 (1.41)	2.38 (3.65)	3.54 (4.41)	553,187 (555,292)	7,566 (13,058)	Norbic mine closed at year end; to explore new ore zone.
Falconbridge Copper Limited, Opemiska Division, Perry, Springer and Cooke mine, Chapais	3,000 (3,000)	. . (. .)	0.32 (0.34)	1.85 (2.14)	— (—)	927,059 (1,062,818)	8,796 (11,884)	Preparing Cooke mine for production – reserves average 0.30 ounces of gold a ton.
Lamaque Mining Company Limited, Val d'Or	2,100 (2,100)	0.113 (0.113)	. . (. .)	— (—)	— (—)	527,000 (598,120)	55,850 (63,117)	Fiscal year ending September 30, 1974, increased expenditures on mine exploration.
Marban Gold Mines Limited, Malartic	355[1] (459)[1]	0.110 (0.112)	. . (. .)	— (—)	— (—)	96,133 (167,700)	10,347 (18,510)	Ore exhausted, mine closed in September. Ore custom treated at Malartic Gold Field mill.
Noranda Mines Limited, Horne Division, Noranda	3,200 (3,200)	0.158 (0.145)	0.59 (0.56)	2.8 (2.51)	— (—)	390,000 (485,783)	40,761 (53,790)	Sufficient reserves to maintain operation into 1976. Development of Chadbourne gold deposit proceeding on schedule.
Patino Mines (Quebec) Limited, Chibougamau	2,800 (2,800)	0.043 (0.035)	0.200 (0.186)	1.56 (1.61)	— (—)	859,332 (973,395)	29,486 (27,901)	Preparing the Lemoine deposit for production.
Sigma Mines (Quebec) Limited, Val d'Or	1,400 (1,400)	0.153 (0.158)	. . (. .)	— (—)	— (—)	498,410 (521,006)	73,019 (78,203)	Shaft deepening program completed – 4 new levels established. Depth of shaft 5,962 ft.

Ontario								
Bulora Corporation Limited, Madsen Red Lake Division, Red Lake	800 (800)	0.257 (0.244)	. . (. .)	— (—)	— (—)	90,127[2] (126,070)	22,195[2] (29,163)	Purchased Madsen Red Lake Gold Mines property in Red Lake district, effective sale date Sept. 15, 1974.
Campbell Red Lake Mines Limited, Red Lake	800 (800)	0.743 (0.708)	. . (. .)	— (—)	— (—)	289,833 (303,796)	197,369 (196,190)	Preparations underway for installation of crusher below 27 level (4,000 ft.).
Dickenson Mines Limited, Red Lake	470 (470)	0.388 (0.409)	. . (. .)	— (—)	— (—)	105,563 (105,805)	37,640 (39,947)	
Dome Mines Limited, South Porcupine	1,900 (1,900)	0.178 (0.224)	. . (. .)	— (—)	— (—)	701,600 (682,200)	121,032 (148,512)	High gold price enabled treatment of lower-grade ore.
Falconbridge Nickel Mines Limited, Ontario mines Sudbury district	12,100 (12,100)	. . (. .)	. . (. .)	. . (. .)	— (—)	4,337,000 (4,292,900)	. . (. .)	
Hollinger Mines Limited, Ross mine, Holtyre	450 (450)	. . (0.133)	. . (. .)	. . (. .)	— (—)	115,000 (144,600)	. . (19,264)	Milled 9,200 tons from surface pillars at original Hollinger mine.
International Nickel Company of Canada, Limited (The), Sudbury & Shebandowan districts, Ontario and Thompson Manitoba	85,900 (85,900)	. . (. .)	. . (. .)	0.97 (0.98)	— (—)	22,000,000 (19,410,303)	. . (. .)	
Kerr Addison Mines Limited, Virginiatown	760[1] (811)[1]	0.40 (0.44)	. . (. .)	— (—)	— (—)	277,000 (296,000)	108,820 (127,650)	Reinstatement of 485,000 tons averaging 0.23 oz. gold a ton into reserves.
Mattabi Mines Limited, Sturgeon Lake	3,000 (3,000)	. . (. .)	4.31 (5.31)	0.91 (1.10)	9.72 (12.43)	1,138,965 (1,111,765)	5,467 (7,410)	
Pamour Porcupine Mines, Limited Nos. 1, 2 & 3 mines, Pamour	2,500 (2,500)	0.115 (0.151)	. . (. .)	— (—)	— (—)	859,525 (877,331)	91,571 (126,654)	Mill capacity being increased to 3,000 tons a day.

Table 6 (cont'd)

Company and Location	Mill or Mine Capacity	Grade of Ore Produced: Gold	Grade of Ore Produced: Silver	Grade of Ore Produced: Copper	Grade of Ore Produced: Combined Lead and Zinc	Ore Treated	Gold Produced	Remarks
	tons of ore/day	oz/ton	oz/ton	%	%	tons	oz	
Ontario (cont'd)								
Pamour Porcupine Mines, Limited Schumacher Division (gold) Schumacher	1,500 (1,500)	0.201 (0.277)	.. (..)	— (—)	— (—)	214,130 (237,800)	39,508 (61,542)	Gold sector of mine.
Pamour Porcupine Mines, Limited, Schumacher Division (copper), Schumacher	2,000 (2,000)	0.023 (0.027)	0.105 (..)	0.628 (0.63)	— (—)	706,940 (777,670)	12,183 (15,838)	Copper sector of mine.
Robin Red Lake Mines Limited, Red Lake	124[1] (119)[1]	0.730 (0.795)	.. (..)	— (—)	— (—)	45,446 (43,481)	30,454 (32,004)	Ore mined and milled by Dickenson.
Willroy Mines Limited, Macassa Division, Kirkland Lake	500 (500)	0.508 (0.537)	.. (..)	— (—)	— (—)	90,186 (98,976)	43,611 (50,529)	Mill operating at one-half capacity.
Manitoba – Saskatchewan								
Hudson Bay Mining and Smelting Co., Limited, Flin Flon and Snow Lake districts	8,500 (8,500)	0.035 (0.042)	0.63 (0.747)	2.34 (2.45)	3.34 (3.61)	1,574,948 (1,815,027)	50,342 (62,892)	Preparing Centennial mine for production.
Sherritt Gordon Mines, Limited, Fox Mine, Lynn Lake	3,000 (3,000)	.. (..)	.. (..)	2.10 (2.01)	1.98 (2.07)	1,008,000 (963,416)	.. (..)	Gold sales in 1974 from all Sherritt Gordon operations was 29,000 ounces.
Sherritt Gordon Mines, Limited Ruttan mine	10,000 (10,000)	.. (..)	.. (..)	1.07 (1.14)	1.68 (2.01)	3,358,000 (1,871,000)	.. (..)	

British Columbia								
Granby Mining Company Limited, The, Granisle mine, Babine Lake	13,000 (13,000)	. . (. .)	. . (0.09)	0.46 (0.472)	— (—)	4,853,434 (4,565,105)	18,369 (17,083)	Fiscal year ending Sept. 30, 1974.
Granby Mining Company Limited, The, Phoenix mine, Greenwood	2,750 (2,750)	0.017 (0.024)	0.134 (0.177)	0.44 (0.56)	— (—)	995,751 (994,136)	10,003 (17,020)	Fiscal year ending Sept. 30, 1974.
Granduc Operating Company, Stewart	8,000 (8,000)	0.004 (. .)	0.216 (. .)	1.23 (1.25)	— (—)	2,708,731 (2,797,949)	9,803 (9,811)	Production to be reduced by over 50% because of economic problems.
Noranda Mines Limited, Bell Copper Division, Babine Lake	10,000 (10,000)	. . (. .)	. . (. .)	0.524 (0.58)	— (—)	4,500,998 (4,114,000)	28,700 (25,200)	
Similkameen Mining Company Limited, Ingerbelle pit, Princeton	15,000 (15,000)	. . (. .)	. . (. .)	0.48 (0.45)	— (—)	5,086,000 (5,356,829)	29,100 (28,100)	Concentrator being expanded by 7,000 tons a day.
Utah Mines Ltd., Island Copper mine, Coal Harbour, Vancouver Island	38,000 (33,000)	. . (. .)	. . (. .)	0.47 (0.50)	— (—)	11,200,000 (12,071,000)	45,000 (44,000)	Gold shipments shown.
Western Mines Limited, Buttle Lake, Vancouver Island	1,100 (1,100)	0.09 (. .)	4.52 (4.60)	1.28 (1.39)	9.53 (9.57)	297,290 (354,240)	23,189 (26,122)	Completed price adit.
Yukon Territory								
Whitehorse Copper Mines Ltd. Little Chief mine, Whitehorse	2,400 (2,400)	0.028 (. .)	0.346 (. .)	1.84 (1.83)	— (—)	617,841 (700,054)	17,731 (13,888)	Ball mill installed for tertiary grinding.
Northwest Territories								
Cominco Ltd., Con and Rycon mines Yellowknife	500 (500)	0.60 (0.56)	. . (. .)	— (—)	— (—)	145,000 (168,696)	82,650*e* (91,400)	New shaft, with initial depth to 5,800 ft. level, advanced to 2,500 ft. elevation at the end of 1974.

Table 6 (concl'd)

Company and Location	Mill or Mine Capacity	Grade of Ore Produced Gold	Silver	Copper	Combined Lead and Zinc	Ore Treated	Gold Produced	Remarks
	tons of ore/day	oz/ton	oz/ton	%	%	tons	oz	
Northwest Territories (cont'd)								
Giant Yellowknife Mines Limited, Yellowknife	1,000 (1,000)	0.32 (0.426)	. . (. .)	— (—)	— (—)	254,918 (271,350)	71,095 (102,321)	Started mining ore from open pit.
Lolor Mines Limited, Yellowknife	70[1] (158)[1]	0.286 (0.458)	. . (. .)	— (—)	— (—)	25,460 (57,737)	6,367 (23,469)	Ore mined and milled by Giant.
Supercrest Mines Limited, Yellowknife	131[1] (165)[1]	0.578 (0.608)	. . (. .)	— (—)	— (—)	47,721 (60,373)	24,052 (32,503)	Ore mined and milled by Giant.

Sources: Company reports and Bureau De Le Statistique Du Québec.
[1] Average daily tonnage milled. [2] Eight and one-half months' production.
[e] Estimated; — Nil; . . Not available.

international balances but, since August 1971, when the President of the United States temporarily suspended the convertibility of U.S. dollars into gold, it has not been used for this purpose. The use of gold as a monetary unit will depend on the role assigned to it, if any, by the authorities responsible for the reform of the world monetary arrangements.

The major uses of gold are in the jewellery trade, the electronics industry, dentistry, coinage, and in the making of medallions. In jewellery products, because of the high gold price, the trend is towards the fabrication of items having a lower carat gold content. In the industrial field, emphasis has been placed on the development of technology leading to a more efficient use of gold, such as thinner film in gold plating, selective and spot gold plating and duplex plating with a high-carat surface on a low-carat base.

The sharp rise in the world price of gold and a significant decrease in business activity affected gold consumption in 1974 and, with the exception of gold coinage, all major industrial applications showed a substantial reduction in gold consumption in 1974 compared with 1973. The sharpest drop was in consumption in the jewellery trade which was estimated to be more than 40 per cent below the 15.8 million ounces used in 1973. The review *Gold 1975* by Consolidated Gold Fields showed that the world consumption of gold in the electronics industry dropped from 4.19 million ounces in 1973 to 2.96 million ounces in 1974. Corresponding figures for dentistry for the years 1973 and 1974 were 2.41 million and 1.98 million ounces, respectively. A continuation of the depressed economic situation, combined with the high price of gold should result in a further decline in gold consumption in the above applications in 1975. Gold usage in the minting of official gold coins in 1974 increased sharply and was estimated at 9.17 million ounces compared with 1.74 million ounces in 1973.

The Consolidated Gold Fields report shows the total supply of gold available to the free market in 1974 and 1973 was 40.32 and 45.01 million ounces, respectively. It was estimated that the offtake of gold for speculation, investment and hoarding was 18.13 million ounces in 1974.

The United States is a large consumer of gold for industrial purposes and the United States Treasury Department announced that gold for these applications fell to 4.6 million ounces in 1974 from 6.7 million ounces in 1973, a drop of over 30 per cent and the lowest consumption figure in ten years.

In 1974 there was a strong demand for newly-minted gold coins with a low premium over their gold content. In its annual review for the year 1974 Samuel Montagu & Co. Limited reported that the South African mint consumed 3.22 million ounces of gold in 1974 in striking Krugerrands, a gold coin containing an ounce of gold. The Austrian and Mexican mints used 2.25 and 2.15 million ounces of gold, respectively, in fabricating gold coins of their realms. The Royal Mint in the United Kingdom used about 0.45 million ounces in striking a new issue of Queen Elizabeth sovereigns, each coin containing 0.2354 ounce of gold. Hungary used 0.48 million ounces of gold for minting its gold coins.

The major outlets for the Krugerrand were the United Kingdom and Germany. Residents of the United Kingdom are prohibited from holding gold bullion but can trade in gold coins.

In December 1973, legislation was passed in the United States allowing citizens of that country to purchase gold coins minted prior to 1960, including restrikes of these coins in subsequent years. It was estimated that the gold content of coins imported into the United States in 1974 was about 3.2 million ounces, the coins being chiefly of Mexican and Austrian origin. The purchases of these coins satisfied some of the latent demand for ownership of gold by United States citizens.

Table 7. Gold reserves of central banks and governments, December 31, 1974

Country	Value in millions of dollars; gold valued at $42.22 U.S. per fine ounce	Ounces (fine) in millions of ounces
United States	11,652	276.0
Germany (Fed. Rep. of)	4,966	117.6
France	4,262	100.9
Switzerland	3,513	83.2
Italy	3,483	82.5
Netherlands	2,294	54.3
Belgium	1,781	42.2
Portugal	1,180	27.9
Canada	927	22.0
Japan	891	21.1
United Kingdom	886	21.0
Austria	882	20.9
South Africa	771	18.3
Spain	602	14.3
Others	4,977	117.9
International Monetary Fund	6,478	153.4
Bank for International Settlements	250	5.9
Estimated total, world[1]	49,795	1,179.4

Sources: Value from *Federal Reserve Bulletin* (U.S.) April 1975; number of ounces calculated by Mineral Development Sector, Department of Energy, Mines and Resources.
[1] Excludes holdings of the U.S.S.R., other Eastern European Countries and the People's Republic of China.

Outlook

Gold production in Canada in the short-term will continue its downward trend. The lode gold mine producers will take advantage of the relatively high gold price and mine lower-grade ore, thereby helping to increase their ore reserves. Production by prospective new producers will not be sufficient to offset lower production from the producing mines. Byproduct gold production from base-metal ores is expected to decrease by at least 10 per cent because of lower base-metal output because of a decline in world business activity.

In the short-term outlook gold production in the noncommunist world is expected to be lower. The Republic of South Africa is by far the leading gold producer in the world, and its gold output has a very strong impact on gold production in the noncommunist world. Production in South Africa should decline because the higher gold price enables the mine producers to treat lower-grade ore. Three new mines are under development, but it will be a few years before these properties contribute to the country's gold output. With the exception of the gold property of Rosario Dominicana, which is expected to be in production in 1975, there are no major developments underway that would significantly add to the world gold output. Gold recovered from base-metal ores will also decline because of the decreased production of base metals.

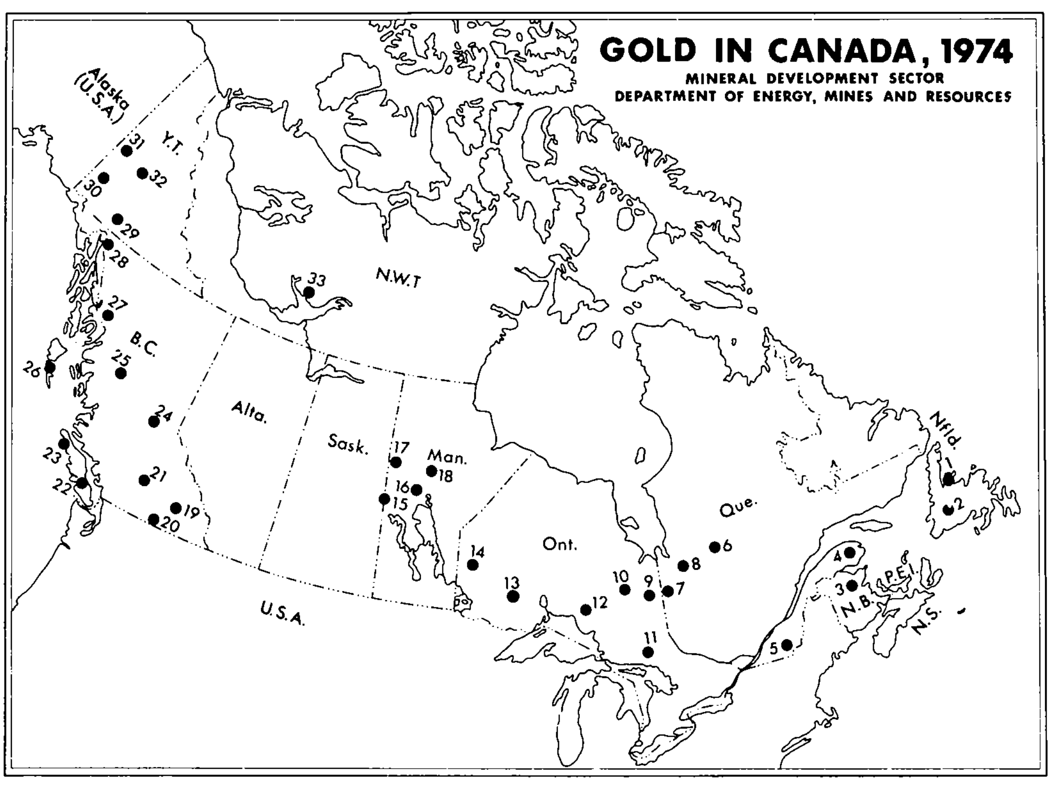
Gold Producers 1974

(numbers refer to numbers on the map)

Newfoundland
(1) Consolidated Rambler Mines Limited (a)
(2) American Smelting and Refining Company (Buchans Unit) (a)

New Brunswick
(3) Heath Steele Mines Limited (a)

Quebec
(4) Gaspé Copper Mines, Limited (a)
(5) Sullivan Mining Group Ltd. (a)
(6) Chibougamau district
Campbell Chibougamau Mines Ltd. (a)
Falconbridge Copper Limited (Opemiska Division) (a)
Patino Mines (Quebec) Limited (Copper Rand



Division) (a)
Valley Mining Corp. (Chibex Limited mine) (a & b)
(7) Noranda-Rouyn district
Falconbridge Copper Limited (Lake Dufault Division) (a)
Noranda Mines Limited (a)
Duparquet district
Kerr Addison Mines Limited (Normetal) (a)
Malartic district
Camflo Mines Limited (b)
East Malartic Mines, Limited (b)
Marban Gold Mines Limited (b)
Bourlamaque-Louvicourt district
Lamaque Mining Company Limited (b)
Manitou-Barvue Mines Limited (a)
Sigma Mines (Quebec) Limited (b)
(8) Matagami district
Agnico-Eagle Mines Limited (b)
Mattagami Lake Mines Limited (b)
Orchan Mines Limited (b)

Ontario
(9) Larder Lake Mining Division
Hollinger Mines Limited (Ross) (b)
Kerr Addison Mines Limited (b)
Willroy Mines Limited (Macassa Division) (b)
(10) Porcupine Mining Division
Dome Mines Limited (b)
Pamour Porcupine Mines, Limited (Nos. 1, 2 & 3 mines) (b)
Pamour Porcupine Mines, Limited (Schumacher Division-McIntyre Mine) (a & b)
(11) Sudbury Mining Division
Falconbridge Nickel Mines Limited (a)
The International Nickel Company of Canada, Limited (a)
(12) Thunder Bay Mining Division
Noranda Mines Limited (Geco Mine) (a)
(13) Patricia Mining Division
Falconbridge Copper Limited (Sturgeon Lake Division) (a)
Mattabi Mines Limited (a)
(14) Red Lake Mining Division
Bulora Corporation Limited (Madsen Red Lake Division) (b)
Campbell Red Lake Mines Limited (b)
Dickenson Mines Limited (b)
Robin Red Lake Mines Limited (b)

Manitoba
(15) Hudson Bay Mining and Smelting Co., Limited (Flin Flon) (a)
(16) Hudson Bay Mining and Smelting Co., Limited (Snow Lake) (a)
(17) Sherritt Gordon Mines, Limited (Fox Lake & Ruttan mines) (a)
(18) The International Nickel Company of Canada, Limited (Thompson) (a)

Saskatchewan
(15) Hudson Bay Mining and Smelting Co., Limited (a)

British Columbia
(19) Cominco Ltd. (a)
(20) The Granby Mining Company Limited (Phoenix Division) (a)
(21) Brenda Mines Limited (a)
Similkameen Mining Company Limited (a)
(22) Western Mines Limited (a)
(23) Utah Mines Ltd. (Island Copper Mine) (a)
(24) Small placer operations (c)
(25) The Grandby Mining Company Limited (Granisle Division) (a)
Noranda Mines Limited (Bell Copper) (a)
(26) Wesfrob Mines Limited (a)
(27) Granduc Operating Company (a)
(28) Small placer operations (c)

Yukon Territory
(29) Whitehorse Copper Mines Ltd. (a)
(30) Small placer operations (c)
(31) Small placer operations (c)
(32) Small placer operations (c)

Northwest Territories
(33) Cominco Ltd. (Con mine) (b)
Giant Yellowknife Mines Limited (b)
Lolor Mines Limited (b)
Rycon Mines Limited (b)
Supercrest Mines Limited (b)

(a) Base metal; (b) Auriferous quartz; (c) Placer

Gypsum and Anhydrite

D.H. STONEHOUSE

Gypsum is a hydrous calcium sulphate ($CaSO_4.2H_2O$) which, when calcined at temperatures ranging from 250° to 400°F, releases three quarters of its chemically combined water. The resulting hemihydrate of calcium sulphate, commonly referred to as plaster of paris, when mixed with water, can be moulded, shaped or spread and subsequently dried, or set, to form a hard plaster product. Gypsum is the main mineral constituent in gypsum wallboard, lath and tile. Anhydrite, the anhydrous calcium sulphate ($CaSO_4$), is commonly associated geologically with gypsum.

Crude gypsum is crushed, pulverized and calcined to form stucco, which is mixed with water and aggregate (sand, vermiculite or expanded perlite) and applied over wood, metal or gypsum lath to form interior wall finishes. Gypsum board, lath and sheathing are formed by introducing a slurry of stucco, water, foam, pulp and starch between two sheets of absorbent paper, which results in a continuous "sandwich" of wet board. As the stucco hardens, the board is cut to predetermined lengths, dried, bundled and stacked for shipment.

Crude gypsum is also used in the manufacture of portland cement where it acts as a retarder, to control set. It is used as a filler in paint and paper manufacture, as a substitute for saltcake in glass manufacture and as a soil conditioner.

Production of gypsum in Canada is closely related to activity in the building construction industry, particularly to activity in the residential building sector, in both Canada and the eastern United States. About 75 per cent of Canadian gypsum production is exported to the United States. It is not surprising, therefore, that as a direct result of the economic recession in the United States, which was harshly felt throughout the construction industry, exports of crude gypsum from Canada were reduced in 1974 by 9.4 per cent. Most of the gypsum for export is quarried in Nova Scotia by Canadian subsidiaries of United States gypsum products manufacturers. Although most of the output from other provinces is used regionally, nearly all of the Nova Scotia production is exported in large "in-company" shipments to the eastern United States.

Total construction in Canada in 1974 is estimated to have reached a value of over $23 billion, 60 per cent of which is credited to the building construction sector. Traditionally, one half of building construction expenditures are in the residential category where, in 1974, housing starts were down by 17 per cent to 222,123 units.

Production of gypsum wallboard, lath and sheathing increased slightly in 1974. Plaster production decreased by over 16,000 tons to 105,483 tons, reflecting the effects of work stoppages at a number of gypsum products plants. The problem of material shortages within the construction industry carried through mid-year as suupliers and contractors were evidently reluctant to enter agreements which could be seriously affected by inflationary pressures. A high level of uncertainty prevailed in the construction industry, marked by hesitant and cautious commitments.

Canadian industry and developments

Atlantic provinces. During 1974, five companies produced crude gypsum in Nova Scotia, two in New Brunswick and one in Newfoundland. Regional consumption of raw gypsum was small compared with the quantity exported to the United States from the Atlantic provinces. Three cement manufacturing plants, two gypsum wallboard manufacturing plants and one plant producing plaster of paris, together used only about 100,000 tons. Crude gypsum from Nova Scotia is used by Quebec wallboard plants and by Quebec and Ontario cement producers, each supplying regional construction industries.

Fundy Gypsum Company Limited, a subsidiary of United States Gypsum Company, Chicago, mines gypsum by open-pit methods at Wentworth and at Miller Creek near Windsor, Nova Scotia, for export to the United States. Crushed and beneficiated crude gypsum is shipped to company-owned processing plants through the port of Hantsport, Nova Scotia.

National Gypsum (Canada) Ltd. produces gypsum from a quarry near Milford, Nova Scotia, and exports most of it through the port of Halifax to east coast United States plants operated by the parent company, National Gypsum Company of Buffalo, New York. Unit-trains of 40 cars each are used to haul gypsum from the quarry site 30 miles to Dartmouth. Company-owned, self-unloading ore carriers of up to 30,000 tons capacity are loaded at rates of up to 5,000 tons an hour through facilities on Bedford Basin. Shipments by water are made to Quebec for use in the manufacture of gypsum products and cement, and by truck to

Brookfield, Nova Scotia for use in cement manufacture.

Georgia-Pacific Corporation, Bestwall Gypsum Division, mines gypsum from a quarry near River Denys, Inverness County, Nova Scotia. Crushed rock is transferred by rail to open storage at Point Tupper, 20 miles from the quarry, and loaded on chartered vessels through a conveyor and reclaim tunnel system. Shipments are exported mainly to the Georgia-Pacific plant at Wilmington, Delaware.

Little Narrows Gypsum Company Limited, another subsidiary of United States Gypsum Company, produces gypsum from a quarry at Little Narrows, Victoria County, Nova Scotia, for shipments to the

Table 1. Canada, gypsum production and trade 1973-74

	1973		1974p	
	(short tons)	$	(short tons)	$
Production (shipments)				
Crude gypsum				
Nova Scotia	6,178,255	14,448,797	6,100,000	14,518,000
Ontario	754,330	2,393,625	825,000	2,760,000
British Columbia	365,249	1,114,009	449,000	2,052,000
Newfoundland	808,833	2,324,614	552,000	1,883,000
Manitoba	190,231	519,804	218,000	657,000
New Brunswick	92,274	265,960	91,000	300,000
Total	8,389,172	21,066,809	8,235,000	22,170,000
Imports				
Crude gypsum				
United States	7,289	64,000	42,398	418,000
Mexico	84,084	327,000	19,417	77,000
United Kingdom	41	5,000	179	17,000
Hong Kong	—	—	12	1,000
Argentina	877	1,000	—	—
Total	92,291	397,000	62,006	513,000
Plaster of paris and wall plaster				
United States	20,830	1,270,000	16,356	1,202,000
United Kingdom	340	18,000	496	31,000
West Germany	10	1,000	12	2,000
Other countries	48	1,000	2	1,000
Total	21,228	1,290,000	16,866	1,236,000
Gypsum lath, wallboard and basic products	Sq. ft.		Sq. ft.	
United States	82,760,137	3,458,000	148,414,378	6,216,000
Other countries	3,200	...	—	—
Total	82,763,337	3,458,000	148,414,378	6,216,000
Total imports gypsum and gypsum products		5,145,000		7,965,000
Exports				
Crude gypsum				
United States	6,259,025	13,987,000	5,685,005	13,771,000
Bahamas	83,644	125,000	60,715	122,000
West Germany	139	3,000	—	—
Total	6,342,808	14,115,000	5,745,720	13,893,000

Source: Statistics Canada
p Preliminary; — Nil; ... Less than one thousand dollars.

United States, Quebec and Ontario, through company ship-loading facilities near the plant site.

Domtar Construction Materials Ltd. operates a calcining plant at Windsor, Nova Scotia, for the production of plaster of paris. Gypsum for the plant is supplied from a quarry at MacKay Settlement, under contract with D. MacDonald.

Many other gypsum occurences are known in the central and northern mainland of Nova Scotia and on Cape Breton Island.

Gypsum is mined at Flat Bay Station, Newfoundland, 60 miles southwest of Corner Brook, by The Flintkote Company of Canada Limited, mostly for export to company plants in the United States. Raw gypsum is supplied to the Corner Brook plant of Atlantic Gypsum Limited for the manufacture of gypsum wallboard products and plaster of paris, and to the cement plant operated by North Star Cement Limited, also at Corner Brook. Exports are made through the port of St. George's from an open stockpile supplied by an aerial cable tramway carrying rock from Flat Bay, six miles from the shipping site. Other gypsum occurrences are known in the southwestern lowlands, west of the Long Range Mountains.

In New Brunswick, two companies quarry gypsum. Canadian Gypsum Company, Limited, a subsidiary of United States Gypsum Company, produces gypsum for use in the manufacture of plaster and wallboard in the company-owned plant at Hillsborough. Canada Cement Lafarge Ltd. obtains gypsum from the Havelock area, west of Moncton, for use in the manufacture of portland cement at Havelock.

Other gypsum occurrences in the southeastern counties of New Brunswick have been recorded. On the Magdalen Islands in Quebec many gypsum outcrops occur.

Ontario. Two underground gypsum mines are operated in southwestern Ontario to produce raw material for three gypsum products plants and a number of cement manufacturing plants. Domtar Construction Materials Ltd. mines gypsum at Caledonia, near Hamilton, from an 8-foot seam 75 feet below the surface. Crude gypsum is shipped to other consumers as well as being supplied to the company's wallboard plant at the mine site, where a full range of gypsum building products is manufactured.

At Hagersville, southwest of Caledonia, Canadian Gypsum Company, Limited, a subsidiary of United States Gypsum Company, Chicago, produces crude gypsum by room-and-pillar mining methods from a 4-foot seam, reached through a 95-foot vertical shaft. Gypsum rock is shipped in crude form. It is used also by the company in the production of wallboard and plaster in a plant adjacent to the mine shaft.

Gypsum has been proven at depths down to 200 feet in other parts of southwestern Ontario and under 10 to 30 feet of overburden in the Moose River area south of James Bay.

Western provinces. Crude gypsum is produced from one underground mine and one surface operation in Manitoba and from one surface operation in British Columbia. Gypsum products plants, situated in areas exhibiting major development trends, are supplied from Canadian producers of gypsum rock. Imports, mostly from Mexico, supply a number of cement producers.

Domtar Construction Materials Ltd. obtains crude gypsum from its quarry at Gypsumville, 150 miles northwest of Winnipeg, Manitoba. The company's gypsum products plant at Winnipeg uses crude from this source as well as gypsum from Silver Plains mined by Westroc Industries Limited.

Westroc Industries Limited mines gypsum from a deposit 140 feet beneath the surface near Silver Plains, 30 miles south of Winnipeg. Crushed and screened product is used by the company's gypsum products plant in Winnipeg and quantities are shipped to BACM Industries Limited's gypsum products plant at Saskatoon as well as to cement manufacturers in Winnipeg, Regina and Saskatoon.

Western Gypsum Ltd., a subsidiary of Westroc Industries Limited, operates an open-pit mine near Windermere in the southeastern part of British Columbia, supplying raw gypsum to its products plant at Calgary and Vancouver, to the Calgary and Vancouver plants of Domtar Construction Materials Ltd., to the Edmonton plant of BACM Industries Limited and to cement manufacturers in the Vancouver area, Kamloops, Exshaw and Edmonton.

Crude gypsum from Windermere is exported to cement manufacturers in northwestern United States.

Gypsum occurs in Wood Buffalo National Park, in Jasper National Park, along the Peace River between Peace Point and Little Rapids, and north of Fort Fitzgerald in Alberta; on Featherstonhaugh Creek, near Mayook, Canal Flats, Loos, and Falkland in British Columbia; on the shores of Great Slave Lake, the Mackenzie, Great Bear and Slave rivers in the Northwest Territories; and on several Arctic islands.

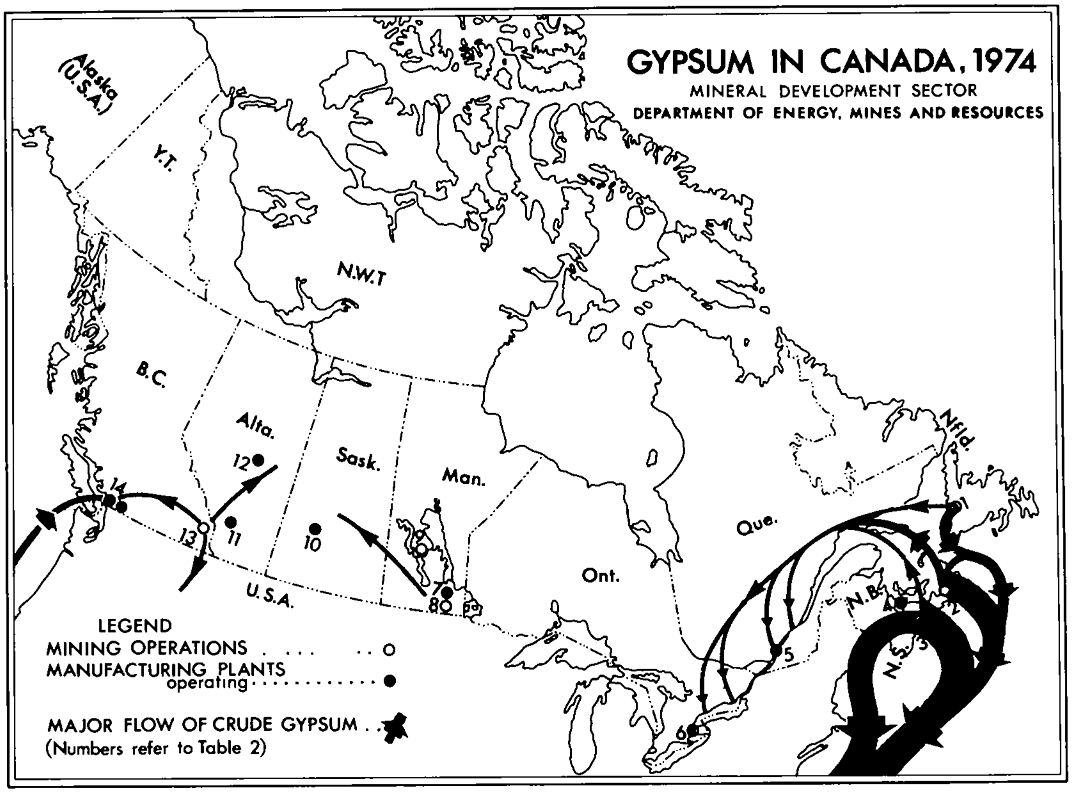


Table 2. Canada, summary of gypsum and gypsum products operation, 1974

Company	Location	Remarks
	(numbers refer to numbers on map)	
Newfoundland		
1. The Flintkote Company of Canada Limited	Flat Bay	Open-pit mining of gypsum
Atlantic Gypsum Limited	Corner Brook	Gypsum products manufacture
Nova Scotia		
2. Little Narrows Gypsum Company Limited	Little Narrows	Open-pit mining of gypsum and anhydrite
Georgia-Pacific Corporation Bestwall Gypsum Division	River Denys	Open-pit mining of gypsum
3. Fundy Gypsum Company Limited	Wentworth and Miller Creek	Open-pit mining of gypsum and anhydrite
National Gypsum (Canada) Ltd.	Milford	Open-pit mining of gypsum
Domtar Construction Materials Ltd.	MacKay Settlement	Open-pit mining of gypsum
	Windsor	Gypsum plaster manufacture

Table 2 (cont'd)

Company	Location	Remarks
New Brunswick		
4. Canadian Gypsum Company, Limited	Hillsborough	Open-pit mining of gypsum and gypsum products manufacture
Canada Cement Lafarge Ltd.	Havelock	Open-pit mining of gypsum used in cement manufacture
Quebec		
5. Canadian Gypsum Company, Limited	Montreal	Gypsum products manufacture
Canadian Gypsum Company, Limited	St-Jérôme	Gypsum products manufacture
Domtar Construction Materials Ltd.	Montreal	Gypsum products manufacture
Westroc Industries Limited	Ste-Cathérine d'Alexandrie	Gypsum products manufacture
Ontario		
6. Canadian Gypsum Company, Limited	Hagersville	Underground mining of gypsum and gypsum products manufacture
Domtar Construction Materials Ltd.	Caledonia	Underground mining of gypsum and gypsum products manufacture
Westroc Industries Limited	Clarkson	Gypsum products manufacture
Manitoba		
7. Domtar Construction Materials Ltd.	Winnipeg	Gypsum products manufacture
Westroc Industries Limited	Winnipeg	Gypsum products manufacture
8. Westroc Industries Limited	Silver Plains	Underground mining of gypsum
9. Domtar Construction Materials Ltd.	Gypsumville	Open-pit mining of gypsum
Saskatchewan		
10. BACM Industries Limited	Saskatoon	Gypsum products manufacture
Alberta		
11. Domtar Construction Materials Ltd.	Calgary	Gypsum products manufacture
Westroc Industries Limited	Calgary	Gypsum products manufacture
12. BACM Industries Limited	Edmonton	Gypsum products manufacture

Table 2 (concl'd)

Company	Location	Remarks
British Columbia		
13. Western Gypsum Ltd.	Windermere	Open-pit mining of gypsum
14. Westroc Industries Limited	Vancouver	Gypsum products manufacture
Domtar Construcion Materials Ltd.	Vancouver	Gypsum products manufacture
BACM Industries Limited	Vancouver	Gypsum products manufacture

Markets, trade and outlook

The long-established gypsum industry in Nova Scotia exists because efficient, large-volume transportation facilities and favourable mining conditions and costs enable successful competition with inland United States operations. Canadian exports of crude gypsum are mainly to the eastern United States and are dependent on the building construction industry there. With reduced activity in this industry during 1974 the demand for gypsum products was also reduced. Long-range forecasts, which last year predicted an annual rate of increase in demand for gypsum at 4 per cent, have been adjusted to suggest a 2 per cent annual rate of increase through 1980.

Some raw gypsum is moved from the Atlantic provinces to Montreal and Toronto regions for use in gypsum products manufacture and in cement production. Raw gypsum is rail-hauled from near Winnipeg, Manitoba to Calgary, Alberta and to Saskatoon, Saskatchewan, and from Windermere, British Columbia to Calgary, Edmonton and Vancouver for gypsum products manufacture. Raw gypsum is imported on the west coast from Mexico, mainly for cement manufacture. Minor amounts of crude gypsum are shipped to the mid-United States for agricultural use, and quantities are exported to the northwestern United States from British Columbia, mainly for use by cement manufacturers.

Gypsum products are not shipped great distances because freight and handling costs represent a major part of the price to the consumer for items that are relatively low-priced and readily available at many locations. Although gypsum products are usually manufactured close to the consumer, with modern containerized shipments becoming more popular and with the trend to trade off economic and environmental factors, the establishment of wallboard plants at the raw material source could become attractive.

Construction expenditures in both Canada and the United States are expected to increase. Construction of homes, apartments, schools and offices will continue and the need for gypsum-based building products will rise steadily. Although new construction materials are being introduced, gypsum wallboard will remain popular because of price and ease of installation. The

Table 3. World production of gypsum, 1973-74

	1973	1974[e]
	(thousand short tons)	
United States	13,558	12,443
Canada	8,389	8,235
France	6,790	6,800
Spain	4,520	4,500
United Kingdom	4,066	4,000
Other Free World	21,792	22,000
Communist Countries (except Yugoslavia)	7,990	8,000
World total	67,105	65,978

Sources: United States Bureau of Mines Commodity Data Summaries, January 1975 and for Canada, Statistics Canada.
[e] Estimated.

Table 4. Canada, gypsum production, trade and consumption, 1965-74

	Production[1]	Imports[2]	Exports[2]	Apparent Consumption[3]
	(short tons)			
1965	6,305,629	75,433	4,746,628	1,634,424
1966	5,976,164	85,913	4,672,518	1,389,559
1967	5,175,384	69,112	3,896,134	1,348,362
1968	5,926,940	69,062	4,463,605	1,532,397
1969	6,373,648	81,799	4,871,184	1,584,263
1970	6,318,523	38,880	4,853,304	1,504,099
1971	6,702,100	105,783	5,034,974	1,772,090
1972	8,099,480	62,383	5,962,973	2,198,890
1973	8,389,172	92,291	6,342,808	2,138,655
1974[p]	8,235,000	62,006	5,745,720	2,551,286

Source: Statistics Canada.
[1] Producers' shipments, crude gypsum. [2] Includes crude and ground, but not calcined. [3] Production plus imports minus exports.
[p] Preliminary.

Table 5. Canada, production of gypsum products, 1973-74

Item	1973	1974
	(square feet)	
Wallboard	1,279,042,523	1,294,843,189
Lath	109,311,140	95,382,330
Sheathing	41,367,376	40,158,164
	(short tons)	
Plaster	121,826	105,483

Source: Statistics Canada.

present structure of the gypsum industry in Canada is unlikely to change greatly in the near future. Building materials plants have sufficient capacities to meet the short-term, regional demand for products and the ability to adapt to new building techniques.

One new gypsum products plant went on stream in Canada during 1974 — that of BACM Industries Limited, Truroc Gypsum Products Ltd. in Vancouver. The new plant has a capacity of 100 million square feet of gypsum wallboard a year.

Canadian Standards Association standards A 82.20 and A 82.35 relate to gypsum and gypsum products.

World review

Gypsum occurs in abundance throughout the world but, because its use is dependent on the building construction industry, developments are generally limited to the industrialized countries. Reserves are generally considered "adequate".

The United States is the world's largest single producer and, together with Canada, brings North American production to over 30 per cent of world output. European production is about 46 per cent of the world total, France being the largest producer. Asian producers account for about 9 per cent of the world total; the four major producers being Iran, India, People's Republic of China and Japan. Central America, South America, Africa and Oceania each produce significant amounts, with Mexico contributing by far the greatest tonnage of any country in this group.

Interest in byproduct gypsum continued at a slow pace although the production of wallboard, plaster and plaster-based blocks or panels from the waste gypsum that results during the manufacture of phosphoric acid from phosphate rock can still be attractive under the proper set of conditions. American Cyanamid Company announced intentions to construct a plant at Savannah Georgia to recover byproduct gypsum from its ilmenite plant sludge wastes at a cost of $16 million.

Production of sulphuric acid and coproduct cement from gypsum and anhydrite has been practiced in European countries for a number of years. If current projections of sulphur supply and demand imbalance by the 1980s are accurate, use of both natural and byproduct gypsum for sulphuric acid production could become significant.

ANHYDRITE

Production and trade statistics for anhydrite are included with gypsum statistics. Anhydrite is produced

Table 6. Canada, house construction by province

	Starts			Completions			Under Construction		
	1973	1974	% diff.	1973	1974	% diff.	1973	1974	% diff.
Newfoundland	4,831	4,911	+ 2	4,478	4,446	− 1	3,737	4,173	+12
Prince Edward Island	2,122	1,334	−37	1,789	1,664	− 7	1,192	860	−28
Nova Scotia	7,734	6,008	−22	5,534	6,604	+19	7,117	6,349	−11
New Brunswick	7,235	5,861	−19	7,036	6,812	− 3	4,534	3,550	−22
Total (Atlantic Provinces)	21,922	18,114	−17	18,837	19,526	+ 4	16,580	14,932	−10
Quebec	59,550	51,642	−13	55,260	58,596	+ 6	39,280	31,487	−20
Ontario	110,536	85,503	−23	98,262	104,360	+ 6	98,566	78,517	−20
Manitoba	11,531	8,752	−24	10,727	12,164	+13	9,088	5,668	−38
Saskatchewan	6,386	7,684	+20	5,421	6,487	+20	3,876	5,001	+29
Alberta	20,977	19,008	− 9	23,470	21,570	− 8	12,734	9,940	−22
Total (Prairie Provinces)	38,894	35,444	− 9	39,618	40,221	+ 2	25,698	20,609	−20
British Columbia	37,627	31,420	−16	34,604	34,540		27,112	22,861	−16
Total Canada	268,529	222,123	−17	246,581	257,243	+ 4	207,236	168,406	−19

Source: Statistics Canada

by Fundy Gypsum Company Limited at Wentworth, Nova Scotia, and by Little Narrows Gypsum Company Limited at Little Narrows, Nova Scotia. According to the Nova Scotia Annual Report on Mines, production of anhydrite in 1974 was 280,725 tons. Most of this was shipped to the United States for use in portland cement manufacture and as a peanut crop fertilizer. Cement plants in Quebec and Ontario also used some Nova Scotia anhydrite.

Tariffs

Canada

Item No.		British Preferential Tariff	Most Favoured Nation	General
29200-1	Gypsum, crude	free	free	free
29300-1	Plaster of paris, or gypsum calcined, and prepared wall plaster, the weight of the package to be included in the weight for duty per 100 pounds	free	6¢	$12\frac{1}{2}$¢
29400-1	Gypsum, ground not calcined	free	free	15%
28410-1	Gypsum tile	15%	15%	25%

United States

Item No.		
512.21	Gypsum, crude	free
		On and after Jan. 1, 1972
512.24	Gypsum, ground calcined	59¢ per long ton
245.70	Gypsum or plastic building boards and lath	6%

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Indium

J.J. HOGAN

Indium occurs as a minor constituent of certain ores of zinc, lead, tin, tungsten and iron. It is commonly associated with sphalerite, the most abundant zinc mineral. Indium becomes concentrated in zinc residues and smelter slags derived from zinc and lead smelting operations. It is recovered at only a few of the world's zinc and lead smelters.

Cominco Ltd. is the only Canadian producer of indium and is one of the world's largest producers of the metal. Its output in 1974 was 259,000 ounces* compared with 681,000 ounces in 1973 and 462,000 ounces in 1972. A labour strike at Cominco's metallurgical plant was largely responsible for the decline in production.

Indium is also produced in the United States, Japan, Belgium, Peru, U.S.S.R. and West Germany, but statistics on output and consumption in these countries are not generally available.

Production

Indium was first recovered at Trail, British Columbia in 1941, though the presence of indium in the lead–zinc–silver ores of Cominco's Sullivan mine at Kimberley, British Columbia, had been known for many years. In 1942, 437 ounces were produced by laboratory methods. After a decade of intensive research and development, production began in 1952 on a commercial scale. At present, the potential annual production at Trail is one million ounces (about 35 short tons).

Indium enters the Trail metallurgical plants in the zinc concentrates. In the electrolytic zinc process, indium remains in the zinc calcine during roasting and in the insoluble residue during leaching. The residue is then delivered to the lead smelter for recovery of contained lead and residual zinc. In the lead blast furnaces, the indium enters lead bullion and blast furnace slag in about equal proportions. From the slag, it is recovered along with zinc and lead during slag-fuming. The fume is leached for recovery of zinc, and indium again remains in the residue, which is retreated in the lead smelter. From the lead bullion, indium is removed in bullion dross. The dross is retreated for recovery of copper matte and lead and, in this process, a slag is recovered which contains lead and tin together with 2.5 to 3.0 per cent indium.

The dross retreatment slag is reduced electrothermally to produce a bullion containing lead, tin, indium and antimony, which is treated electrolytically to yield a high (20 to 25 per cent) indium anode slime. The anode slime is then treated chemically to give a crude (99 per cent) indium metal, which is refined electrolytically to produce a standard grade (99.97 per cent) or a high-purity grade (approximately 99.999 to 99.9999 per cent) indium. The metal is cast in ingots varying in size from 10 ounces to 10 kilograms. Also produced are various alloys and chemical compounds of indium, such as indium antimonide, and a variety of fabricated forms such as discs, wire, ribbon, foil and sheet, powder, and spherical pellets.

Properties and uses

Indium is a silvery-white metal that resembles tin in its physical and chemical properties. Its chief characteristics are extreme softness, low melting point and high boiling point. The metal has a melting point of 156°C; boiling point of 2,000°C; and atomic weight of 114.8. Its specific gravity at 20°C is 7.31 which is about the same as that of iron.

Indium forms alloys with precious metals and many of the base metals, improving their performance in certain special applications. Its first major use, and still an important outlet, was in high-speed silver–lead bearings in which the addition of indium increases the strength, and corrosion resistance of the surfaces of the bearings. Bearings of this type are used in aircraft piston engines, diesel engines and several types of automobile engines. The standard grade of indium is used in this application.

Indium is used in low-melting-point alloys containing bismuth, lead, tin and cadmium; e.g., a bismuth–tin–cadmium–lead–indium alloy containing 19.1 per cent indium used as a heat fuse melts at 47°C. Indium is used in glass-sealing alloys containing about equal amounts of tin and indium; in certain solder alloys in which resistance to alkaline corrosion is required; and in gold dental alloys.

Indium is one of several metals that find application in various semiconductor devices. In these, high-purity indium, alloyed in the form of discs or spheres

* The term "ounce" refers to the troy ounce throughout unless otherwise stated.

into each side of a germanium wafer, modifies the properties of the germanium. Indium is especially suitable for this purpose because it alloys readily with germanium at low temperatures and, being a soft metal, does not cause strains on contracting after alloying.

Discovered in 1863, but in commercial use only since 1927 when it was first used as a nontarnish coating on silverware, indium and its compounds are relatively new materials whose potential applications are still being explored. Uses have been found in electrical contacts, resistors, thermistors, photoconductors, small lightweight batteries, and infra-red detectors. Indium can be used as an indicator in atomic reactors because artificial radioactivity is easily induced in indium by neutrons of low energy (about 1.5 electron-volt). Indium foil was used as a neutron indicator in the uranium–graphite piles of the first atomic bomb project. Silver–cadmium–indium alloys are now used for reactor control rods. Indium compounds added to lubricants have a beneficial anticorrosive effect. Indium also has possible applications in decorative plating of jewellery and tableware.

Foreign trade

Statistics on foreign trade are not available for indium. United States imports in 1974 were estimated at 545,000 ounces, and obtained from: Canada, 42 per cent; U.S.S.R., 15 per cent; Peru, 12 per cent; Netherlands, 9 per cent; and other countries, 22 per cent.

Prices

The price of indium as quoted by *Metals Week* was $2.00 (U.S.) an ounce at the beginning of 1974. Increases of 50 cents an ounce took place in February and April. Asarco Incorporated increased the price from $3.00 to $5.50 an ounce, effective May 13, 1974, and it remained at this level for the balance of the year.

Tariffs

Canada – not specifically enumerated in Canadian tariffs

United States

Item No.	Rate of Duty January 1, 1975
	%
628.45–Metal, unwrought, waste and scrap	5
628.50–Metal, wrought	9

Source: Tariff schedules of the United States Annotated (1975) T.C. Publication 706.

Iron Ore

ROGER J. GOODMAN

The Canadian iron ore industry is characterized by a vertically integrated market structure of producing iron ore mines and parent steel companies. Mines in Canada are predominantly controlled by United States steel companies and managing agents and, to a lesser extent, Canadian steel companies. By mid-1975, of the total installed productive capacity in the Canadian iron ore industry 76.5 per cent will be American owned, 22.9 per cent Canadian owned and 0.6 per cent Italian owned. The Quebec-Labrador region remained the pre-eminent iron ore producing region in Canada in 1974, and accounted for about 73 per cent or 34.4 million tons* of overall Canadian shipments. The pre-eminence of the region is assured in the long-term, and by mid-1975 the Quebec-Labrador region will process about 81 per cent of installed productive capacity.

Canadian iron ore producers mine low- to medium-grade iron ores grading 19 – 55 per cent iron. Consequently, in 1974, over 86 per cent of Canadian ores mined required varying degrees of beneficiation to produce a marketable product. Measured iron ore reserves in Canada have been estimated at 11.8 billion tons, grading 28.4 per cent iron, with a potential iron ore resource base of 154.6 billion tons of ore, grading 34.1 per cent iron; a quantity sufficient to last well into the twenty-first century at present consumption rates.

In 1974 iron ore production, valued at $719 million, ranked fifth in terms of value in the Canadian mineral industry, comprising 6.2 per cent of the aggregate value of mineral production, which was $11.6 billion. During 1974, capital expenditures by the iron ore industry were estimated at $169.3 million, or 8.1 per cent of total capital expenditures of $2.1 billion disbursed by the entire Canadian mineral industry. Estimated repair expenditures of $119.6 million comprised 19.0 per cent of total repair expenditures of $629 million incurred by the entire Canadian mineral industry. Direct employment in the iron ore industry amounted to 13,000 people in 1974, and value added by the iron ore industry was an estimated $540 million or 0.36 per cent of the Gross National Product in 1974.

Export shipments were 36.86 million tons in 1974 compared with 37.07 million tons in 1973, while imports declined to 2.30 million tons compared with 2.65 million tons in 1973. Canadian consumption of iron ore was 12.93 million tons in 1974, as demand by the domestic steel industry remained at a high level.

Production and shipments

The continued strong demand for steel, low inventories of iron ore and steel, and a year free of major labour strikes resulted in shipments of 47.22 million tons in 1974, only 0.16 million ton below the level attained in the preceding record-breaking year. Iron ore shipments would have been appreciably higher had not protracted technical and labour shortage problems caused production at the Iron Ore Company of Canada's expanded operations at Carol Lake and Sept-Îles to fall well below expectations. Exports in 1974 were about 36.86 million tons, only marginally below the unprecedented level of 37.07 million tons attained in 1973. Domestic demand remained high, with shipments to domestic producers of 10.38 million tons, almost identical with shipments of 10.39 million tons in the preceding year.

Iron ore continued to be produced by 15 companies or joint venture enterprises at 16 locations, with nine mine operations in Ontario and two each in Quebec, Newfoundland (Labrador) and British Columbia. One of the Ontario locations is The International Nickel Company of Canada, Limited's pellet plant at Copper Cliff, where iron is recovered as a byproduct of nickel mining.

Newfoundland (Labrador) remained the leading provincial producer in 1974 with iron ore mine shipments attaining 22.11 million tons, an increase of 1.5 per cent compared with the 21.78 million tons shipped in 1973. Quebec shipments also increased by about 1 per cent to 12.59 million tons in 1974, from 12.47 million tons in 1973. Ontario shipments declined about 4.8 per cent from 11.71 million tons in 1973 to 11.15 million tons in 1974. Shipments from the two iron ore producers in British Columbia decreased 2.4 per cent from 1.40 million tons in 1973 to 1.36 million tons in 1974.

Developments

The Canadian iron ore industry has undergone large scale expansion programs throughout the seventies and as a result, production capacity will increase from 46 million tons of iron ore products in 1970 to approximately 78 million tons by 1976. Almost the entire expansion of the iron ore industry has been in the Quebec-Labrador region.

The Iron Ore Company of Canada (IOC) completed a major three-year expansion program in mid-1973,

* The gross or long ton (2,240 pounds) is used throughout unless otherwise stated.

and currently possesses an annual rated production capacity of about 34 million tons of iron ore products at Schefferville, Carol Lake and Sept-Îles. At the Carol Lake concentrating-pelletizing complex near Labrador City, the pelletizing plant was reconstructed, and a 12-million-ton-a-year concentrator expansion was undertaken to increase concentrate production to about 22 million tons a year. The concentrator currently ranks as one of the world's largest iron ore beneficiation plants. Despite completion of the concentrator expansion facilities by mid-1973, however, production remained well below rated capacity throughout 1974. Major problems were encountered with labour turnover and shortages, notably among skilled maintenance personnel. IOC remains optimistic that full-rated capacity can be achieved in early 1976. The Sept-Îles pelletizing plant was also completed in 1973, but start up has been severely hampered by mechanical difficulties, shortages of key replacement components, and unexpected problems experienced with the metallurgical feed of "treat ore" from Schefferville. Production at Sept-Îles attained almost two million tons of pellets in 1974, with attainment of the rated capacity of 6 million tons annually unlikely to be achieved prior to 1976.

Total cost of the Carol Lake expansion and the Sept-Îles pelletizing facility was an estimated $400 million. The problems which continue to plague the new operations were mainly responsible for a loss of $48 million by IOC in 1974.

The major expansion programs embarked upon by Quebec Cartier Mining Company (QCM) were approaching completion by the end of 1974. The Fire Lake iron ore property came on stream in March 1975 at an initial rated capacity of 1.2 million tons a year in 1975, increasing to 5 million tons a year by 1976. The Fire Lake property is situated approximately half-way between Gagnon and Mount Wright, and only a few miles from the Mount Wright railway. The Fire Lake orebody is approximately one mile long from east to west and up to half a mile wide. The main ore zone is composed of relatively coarse-grained, friable specular hematite, with estimated total reserves of 400 million tons of iron ore grading 33.5 per cent iron. Crude ore from the Fire Lake property will be railed to the Lac Jeannine concentrator, 51 miles to the south-southwest. Output from the Lac Jeannine concentrator will be reduced gradually from the rate of 8.81 million tons achieved in 1973 to 5 million tons a year in 1977, when only Fire Lake crude ore will be processed, as reserves at the Lac Jeannine mine become depleted. During its 16 years of operation from 1961 to 1977, the Lac Jeannine mine will have mined in excess of 320 million tons of crude ore averaging 30 per cent iron, to produce almost 140 million tons of 66 per cent iron concentrate.

Table 1. Canada, iron ore production and trade, 1973-74

	1973		1974p	
	(long tons)[1]	($)	(long tons)[1]	($)
Production (mine shipments)				
Newfoundland	21,783,543	314,838,603	22,113,000	372,424,000
Ontario	11,093,141	152,468,574	10,551,000	172,188,000
Quebec	12,473,892	125,892,911	12,593,000	161,180,000
British Columbia	1,397,738	12,906,063	1,364,000	13,244,000
Total	46,748,314	606,106,151	46,621,000	719,036,000
Byproduct iron ore[2]	624,000	..	598,000	..
Imports				
United States	2,137,603	32,121,000	1,636,550	25,854,000
Brazil	476,285	6,952,000	527,329	9,469,000
Sweden	33,025	575,000	101,300	2,253,000
South Africa	—	—	31,165	532,000
Total	2,646,913	39,648,000	2,296,344	38,108,000
Exports				
Iron ore, direct shipping				
United States	4,821,961	49,281,000	4,022,920	51,263,000
Italy	806,879	7,929,000	841,214	10,721,000
United Kingdom	1,165,144	11,711,000	902,990	8,590,000
Belgium and Luxembourg	123,015	933,000	415,181	5,338,000
Japan	370,703	2,854,000	185,232	2,593,000
France	32,641	333,000	139,959	1,803,000
Spain	—	—	47,210	944,000
Total	7,320,343	73,041,000	6,554,706	81,252,000

Table 1. (concl'd)

	1973		1974p	
	(long tons)[1]	($)	(long tons)[1]	($)
Exports (cont'd)				
Iron ore concentrates				
United States	3,544,302	40,948,000	3,299,829	44,205,000
Japan	3,251,228	27,208,000	3,907,714	31,388,000
United Kingdom	2,449,302	19,868,000	2,894,135	27,403,000
West Germany	1,736,019	14,223,000	1,828,171	17,767,000
Netherlands	1,815,799	14,252,000	1,770,842	15,631,000
Italy	188,930	1,455,000	566,337	5,403,000
France	457,082	3,793,000	444,474	4,114,000
Spain	85,687	712,000	190,153	2,036,000
Finland	179,059	1,477,000	91,137	970,000
Portugal	35,638	329,000	72,623	738,000
Belgium and Luxembourg	20,810	172,000	57,031	615,000
Australia	3,815	47,000	19,563	276,000
Austria	—	—	23,542	250,000
Bahamas	11,300	93,000	11,200	145,000
Total	13,778,971	124,577,000	15,176,751	150,941,000
Iron ore agglomerated				
United States	12,590,522	207,721,000	11,687,669	238,503,000
United Kingdom	1,188,842	19,880,000	958,760	19,648,000
Italy	860,558	14,199,000	670,456	13,371,000
Netherlands	376,921	6,305,000	597,382	12,493,000
Spain	396,040	6,465,000	387,150	8,189,000
West Germany	125,490	2,068,000	255,966	5,197,000
Japan	—	—	80,429	1,794,000
Belgium and Luxembourg	82,550	1,360,000	—	—
Total	15,620,923	257,998,000	14,637,812	299,195,000
Iron ore not elsewhere specified				
United States	352,461	6,380,000	487,168	11,164,000
Total exports all classes				
United States	21,309,246	304,330,000	19,497,586	345,135,000
United Kingdom	4,803,288	51,459,000	4,755,885	55,641,000
Japan	3,621,931	30,062,000	4,173,375	35,775,000
Italy	1,856,367	23,583,000	2,078,007	29,495,000
Netherlands	2,192,720	20,557,000	2,368,224	28,124,000
West Germany	1,861,509	16,291,000	2,084,137	22,964,000
Spain	481,727	7,177,000	624,513	11,169,000
Belgium and Luxembourg	226,375	2,465,000	472,212	5,953,000
France	489,723	4,126,000	584,433	5,917,000
Finland	179,059	1,477,000	91,137	970,000
Portugal	35,638	329,000	72,623	738,000
Australia	3,815	47,000	19,563	276,000
Austria	—	—	23,542	250,000
Bahamas	11,300	93,000	11,200	145,000
Total	37,072,698	461,996,000	36,856,437	542,552,000

Source: Statistics Canada.
[1] Dry long tons for production (shipments) by province; wet long tons for imports and exports. [2] Total shipments of byproduct iron ore compiled by Mineral Development Sector from data supplied by companies. Total iron ore shipments include shipments of byproduct iron ore.
p Preliminary. — Nil. . . Not available.

Along with the development of the Fire Lake iron ore deposit was a joint venture agreement between QCM and Sidbec-Dosco Limited to construct a pelletizing facility at Port Cartier, using Fire Lake concentrate produced at the Lac Jeannine concentrator. The six-million-ton-a-year pelletizing plant, capable of producing 65 per cent iron pellets was expected to cost in excess of $300 million. QCM announced in September 1974, however, that escalating costs and continual labour disruptions in the Quebec construction industry would necessitate the project being held in abeyance. A definite decision is still pending, and may be influenced by the outcome of the Cliche Commission study into violence and unrest in the Quebec labour industry, and subsequent government action.

Development work continued unabated in 1974 on QCM's other mammoth project at Mount Wright, 70 miles northeast of Gagnon, Quebec. At Mount Wright, a large specular hematite deposit is being developed for open-pit mining. It is approximately 4 miles long by 4,000 feet wide and 1,000 feet deep, with an average grade of 31.4 per cent iron. The mine will have a rated annual capacity of about 40 million tons of ore, and is expected to have a life-span of 75 – 100 years. Included in the Mount Wright development is the construction of a concentrator and related facilities with a minimum production capacity of 18.4 million tons of high-grade iron ore concentrate, with provision being made for an ultimate annual capacity of 24 million tons of concentrate. An 88-mile railway extension was completed in August 1974 to connect Mount Wright with the shipping terminal in Port Cartier. At year-end, over 80 per cent of the Mount Wright development had been completed, with final completion of the entire Mount Wright project scheduled for late July 1975. Mining operations at Mount Wright commenced on a limited scale in October 1974, and the company intends to stockpile the broken ore in readiness for the completion of the crushing and concentrator facilities in late 1975.

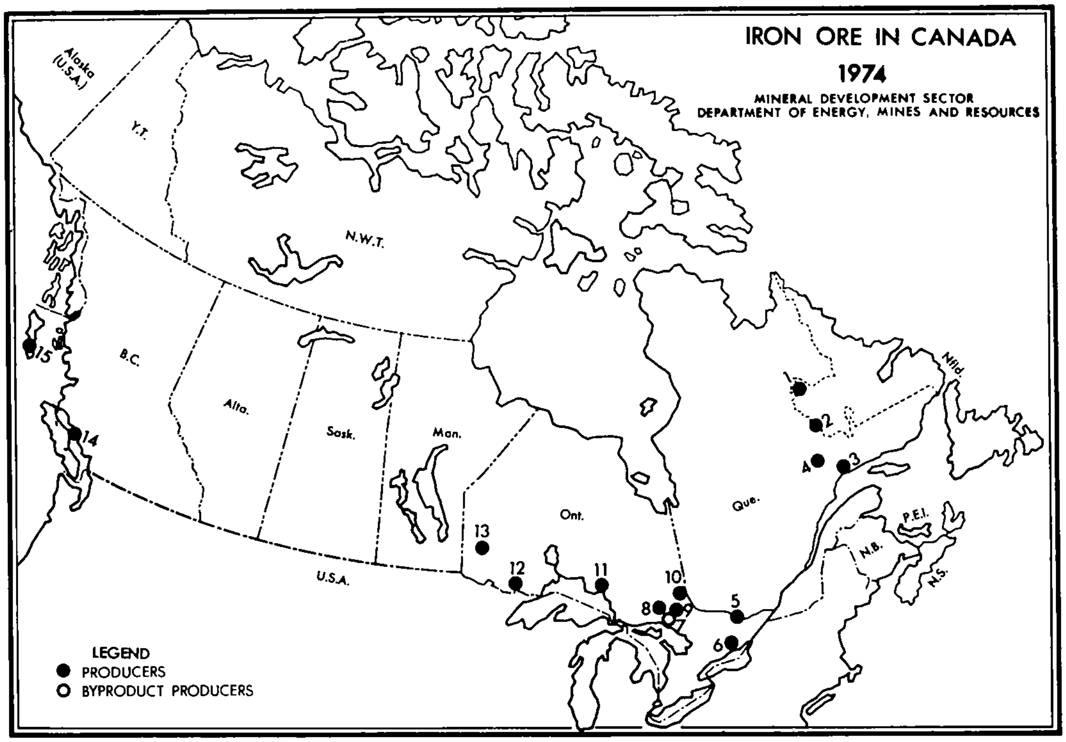
The Mount Wright scheme includes the construction of a new community, known as Fermont, to provide living accommodations for the employees of the Mount Wright iron ore project. The total cost of the project including the new community was originally estimated at almost $400 million, but costs are now expected to approach $700 million, excluding opportunity costs induced by production delays, and associated revenue losses caused by the labour problems in the Quebec construction industry.

Campbell Chibougamau Mines Ltd. continues to conduct intensive feasibility studies on its Magnetite Bay iron deposits, (Ferchib project), located on the north shore of Lake Chibougamau, 12 miles east of the town of Chibougamau. Two magnetite zones have been delineated with total proven reserves of 270 million tons of 27.6 per cent iron. Further reserves of 230 million tons of ore have also been indicated, which could yield potential tonnages of more than 500 million tons of low-grade magnetite. The magnetite deposits have a low titania content (< 1 per cent) and pilot plant tests have yielded concentrates grading 66.3 per cent iron and a silica content of 2.5 per cent. The concentrate is capable of producing high-quality pellets grading 65.2 per cent iron, containing only 2 per cent silica.

The basic infrastructure for mine development already exists for the Ferchib project, owing to the proximity of the Chibougamau base metal mines. Thus, the bulk of the housing, community and transportation facilities are already provided, necessitating simple inexpensive upgrading of this infrastructure to handle the increased capacity created by the project. Freight mileage from Chibougamau to tide water at Port Alfred on the Saguenay River is approximately 250 miles. The existing Canadian National Railways line would merely need upgrading, and two 16-miles branch lines would have to be constructed, one at the Chibougamau end and one at the Port Alfred end.

The Quebec government is currently undertaking a study, however, embracing a more ambitious regional development scheme for the area. This would entail the development of the Albanel iron deposits, 90 miles north of Chibougamau in addition to the Ferchib project. Such a development scheme would necessitate the installation of a complete new railway line from Albanel and Chibougamau to Port Alfred, capable of transporting in excess of 10 million tons of iron ore concentrate or pellets annually. The scheme would also include development of adequate shipping facilities at Port Alfred.

In Ontario, the Lake St. Joseph magnetite deposits owned by Steep Rock Iron Mines Limited are located 180 miles north of Atikokan, the site of the company's current iron ore mining operation. At Lake St. Joseph, two magnetite orebodies have been delineated, containing about 613 million tons of iron ore grading 23 per cent iron. The magnetite is one of the few sources in central North America of raw material of sufficiently high quality to meet the requirements of direct reduced feed for electric furnace steel production. Detailed feasibility studies have been conducted on the deposit, and recommended the production of 4 million tons annually of a magnetite superconcentrate grading 70 – 71 per cent iron. The superconcentrate would be converted to 4.15 million tons of iron pellets grading about 68 per cent iron, of which 3.18 million tons would be shipped in the form of oxide pellets; with the residual oxide pellets being further processed by a direct reduction process to 700,000 tons of sponge iron containing 92 per cent iron. The 92 per cent sponge iron would make an excellent substitute for scrap iron which, in the past, has been periodically in tight supply and high priced.



PRODUCERS
(numbers refer to numbers on map)

1. Iron Ore Company of Canada, Knob Lake division (Schefferville)
2. Iron Ore Company of Canada, Carol division, (Labrador City)
2. Scully Mine of Wabush Mines (Wabush)
3. Iron Ore Company of Canada, Sept-Îles division (Sept-Îles)
3. Pointe Noire Division of Wabush Mines (Pointe Noire)
4. Quebec Cartier Mining Company (Gagnon)
5. Hilton Mines Ltd. (Shawville)
6. Marmoraton Mining Company, Division of Bethlehem Chile Iron Mines Company (Marmora)
8. National Steel Corporation of Canada, Limited (Capreol)
9. Sherman Mine of Dominion Foundries and Steel, Limited (Temagami)
10. Adams Mine of Dominion Foundries and Steel, Limited (Kirkland Lake)
11. Algoma Ore Division of The Algoma Steel Corporation, Limited (Wawa)
12. Caland Ore Company Limited (Atikokan), Steep Rock Iron Mines Limited (Atikokan)
13. The Griffith Mine (Bruce Lake)
14. Texada Mines Ltd. (Texada Is.)
15. Wesfrob Mines Limited (Moresby Is.)

BYPRODUCT PRODUCERS

7. The International Nickel Company of Canada, Limited (Copper Cliff)

Table 2. Canada, iron ore producers, 1973 and 1974

Company and Property Location	Participating Companies	Material Minded and/or Treated 1974	Product Shipped 1974	Shipment 1973	Shipment 1974
		(% Fe natural)	(% Fe dry/wet)	('000 wet long tons)	
Adams Mine: Boston Twp., near Kirkland Lake, Ont.	Dominion Foundries and Steel, Ltd.; managed by Cliffs of Canada Limited, a wholly-owned subsidiary of The Cleveland-Cliffs Iron Company	Magnetite from open-pit mine (21)	Pellets (66/65)	1,174	1,142
Algoma Ore Division of The Algoma Steel Corp., Ltd.; mines and sinter plant near Wawa, Ont.	Wholly owned	Siderite from open-pit and underground mine (33)	Siderite sinter (48/48)	2,046	2,077[1]
Caland Ore Co. Ltd.; east arm of Steep Rock Lake, near Atikokan, Ont.	Inland Steel Co.	Hematite and goethite from open-pit mine (54)	Pellets (64/64)	1,178	1,034
			Concentrate (59/56)	928	930
			Direct Shipping (60/55)[2]	—	—
Griffith Mine, The; Bruce Lake, 35 miles south of Red Lake, Ont.	The Steel Co. of Canada, Ltd.; managed by Pickands Mather & Co.	Magnetite from open-pit mine (23)	Pellets (67/67)	1,506	1,569
Hilton Mines Ltd.; near Shawville, Quebec, 40 miles NW of Ottawa	The Steel Co. of Canada, Ltd., 50%; Jones & Laughlin Steel Corp., 25%; Pickands Mather & Co. (managing agent), 25%	Magnetite from open-pit mine (22)	Pellets (67/67)	870	930

Table 2 (cont'd)

Company and Property Location	Participating Companies	Material Mined and/or Treated 1974	Product Shipped 1974	Shipments 1973	Shipments 1974
		(% Fe natural)	(% Fe dry/wet)	('000 wet long tons)	
Iron Ore Company of Canada 1. Schefferville, Quebec-Labrador operation	Labrador Mining and Exploration Ltd., 4.73%; Hollinger Mines Ltd., 10.17%; The Hanna Mining Co. (managing agent), 26.37%;	Hematite-goethite-limonite from open-pit mines (54)	Direct-shipping ore (59/54)	7,211	6,568
2. Carol Lake, Labrador operation	Bethlehem Steel Corp. 18.80% Armco Steel Corp., 5.87% Lykes-Youngstown Corp., 5.87%;	Specular hematite and magnetite from open-pit mines (39)	Pellets (64/64) Conc. (63/62)	9,721 3,060	7,572 4,443
3. Sept-Îles, Que.,[3] Pellet opération	National Steel Corp., 17.62%; Republic Steel Corp., 5.87%; Wheeling-Pittsburgh Steel Corp., 4.70%	Hematite-goethite-limonite from open-pit mines, Schefferville area Treat-Ore (50)	Pellets (63/61) Conc. (61/59)	372 22	1,885 —
Marmoraton Mining Co., Division of Bethlehem Chile Iron Mines, Company, near Marmora, Ont.	Bethlehem Steel Corp.	Magnetite from open-pit mine (43)	Pellets (65/65)	481	520
National Steel Corporation of Canada, Ltd., Moose Mountain Mine; Sudbury area, 20 miles north of Capreol, Ont.	National Steel Corp. (The Hanna Mining Co. is the managing agent)	Magnetite from open-pit mine (34)	Pellets (63/62)	725	686
Quebec Cartier Mining Company; Gagnon, Quebec	United States Steel Corp.	Specular hematite from open-pit mine (35)	Specular hematite conc. (66/64)	8,805	8,450

Table 2. (cont'd)

Company and Property Location	Participating Companies	Material Mined and/or Treated 1974	Product Shipped 1974	Shipment 1973	Shipment 1974
		(% Fe natural)	(% Fe dry/wet)	('000 wet long tons)	
Sherman Mine; near Temagami, Ont.	Dominion Foundries and Steel, Limited, 90% Tetapaga Mining Company (wholly-owned subsidiary of the Cleveland-Cliffs Iron Company), 10%. The operation and management of the mine is by Cliffs of Canada Limited, also a wholly-owned subsidiary of The Cleveland-Cliffs Iron Company	Magnetite from open-pit mines (22)	Pellets (66/65)	1,305	1,029
Steep Rock Iron Mines Ltd.; Steep Rock Lake, N. of Atikokan, Ont.	Publicly-owned company	Hematite-goethite from open-pit mine (50)	Conc. (58/54) Pellets (62/62)	9 1,417	12 1,341
Texada Mines Ltd.; Texada Island, B.C.	Kaiser Aluminum and Chemical Corp.	Magnetite and chalcopyrite from underground mine (31)	Magnetite concentrate (64/60)	486	326
Wabush Mines; Scully Mine includes mine and concentrator at Wabush, Labrador; Pointe Noire Division includes pelletizing plant at Pointe Noire, Que.	The Steel Co. of Canada Ltd., 25.6%; Dominion Foundries and Steel, Ltd., 16.4%; Youngstown Sheet and Tube Company, 15.6%; Inland Steel Co., 10.2%; Interlake, Inc., 10.2%; Wheeling-Pittsburgh Steel Corp., 10.2%; Finsider of Italy, 6.6%; and Pickands Mather & Co., (managing agent), 5.2%	Specular hematite and some magnetite from open-pit mine (35)	Pellets (66/64) Conc. (66/64)	5,371 66	5,445 18

Table 2. (concl'd).

Company and Property Location	Participating Companies	Material Mined and/or Treated 1974	Product Shipped 1974	Shipments 1973	Shipments 1974
		(% Fe natural)	(% Fe dry/wet)	('000 wet long tons)	
Wesfrob Mines Limited; Tasu Harbour, Moresby Is., Queen Charlotte Is., B.C.	Falconbridge Nickel Mines Limited	Magnetite and chalcopyrite from open-pit mines (40)	Pellet-feed concentrate (69/63)	496	617
			Sinter-feed concentrate (61/58)	461	413
Byproduct Producers					
The International Nickel Co. of Canada, Ltd.; Copper Cliff, Ont.	Publicly-owned company	Pyrrhotite flotation concentrates (57) treated	Pellets (66/65)	624	598
Quebec Iron and Titanium Corp.; mine at Lac Tio, Que.; electric smelter at Sorel, Quebec	Kennecott Copper Corp.; Gulf & Western Industries[4] Inc. (New Jersey Zinc Co.)	Ilmenite-hematite ore (40% Fe, 35% TiO_2) from open-pit mine at Lac Tio, beneficiated and calcined at Sorel	Ilmenite calcine. Electric smelted to TiO_2slag and various grades of desulphurized pig iron or remelt iron	579[4]	553[4]

Sources: Company reports, personal communication.
[1] Includes 80,832 tons of regular sinter; 1,993,623 tons of superfluxed sinter; 2,227 tons of crude ore shipped as food supplement to livestock industry. [2] Excludes 115,084 tons of direct shipping ore sent to Steep Rock Iron Mines Ltd. [3] Commenced operations in 1973. [4] Pig iron.
— Nil.

The ore would be mined by conventional opencast methods, and concentrated at the mine site. The ore would then be conveyed by railway or slurry pipeline to Savant Lake, where the superconcentrate would be converted into iron pellets and sponge iron. Steep Rock Iron Mines Limited is engaged in negotiations with the provincial government of Ontario pertaining to government assistance with the construction of a railway from Savant Lake to the mine site. Steep Rock Iron Mines is also attempting to arrange satisfactory financing for the project compatible with its desire to retain a 30 per cent equity position in a consortium venture that currently includes Dominion Foundries and Steel, Limited (Dofasco) and The Algoma Steel Corporation, Limited (Algoma) as potential major participants.

The Steel Company of Canada, Limited (Stelco) is constructing a SL/RN direct reduction kiln at its wholly-owned Griffith Mine, located at Bruce Lake, northwestern Ontario. The kiln will produce 93 per cent metallized sponge iron at a rated capacity of 400,000 tons annually, and will be used as a charge for Stelco's electric steelmaking furnace shops at Edmonton, Alberta and Contrecoeur, Quebec. Total cost of the project is estimated at $35 million, with production planned for mid-1975.

The three major integrated steelmakers in Ontario — Stelco, Dofasco and Algoma — have recently tended to meet substantial future iron ore requirements from United States producers. Algoma and Stelco have taken equity positions in the Tilden iron ore project in Michigan, which commenced production in December 1974. The mine has a rated annual capacity of 4.0 million tons of pellets, of which Algoma will receive 1.2 million tons a year, and Stelco will receive 0.5 million ton a year commencing in 1974. In addition, Stelco has assumed equity positions in two other taconite projects in Minnesota. Its participation in the Eveleth Taconite Co. mine in the Mesabi Range of Minnesota will provide Stelco with an additional annual supply of 1 million tons of pellets a year commencing in 1976. A 10 per cent interest in the Hibbing Taconite Co., Minnesota will provide an additional annual supply of 0.55 million ton of pellets commencing in 1977. Dofasco is also involved in the expansion plans of the Eveleth Taconite Co. and will receive 0.60 million ton of pellets annually when production commences in 1976.

The reasons for the exodus of Canadian capital into the United States mining ventures include: the lower operating costs associated with taconite production in the United States; favourable taxation legislation; and incentives prevailing through the Domestic International Sales Corporations legislation.

Trade

Total Canadian export shipments in 1974 were 36.86 million tons, about 0.5 per cent below 1973 export shipment of 37.07 million tons. The United States remained the largest consumer of Canadian iron ore exports with 19.50 million tons, followed by Europe with 13.16 million tons and Japan with 4.17 million tons. Of total Canadian exports to the European Community, Britain was the largest importer with 4.76 million tons, followed by the Netherlands with 2.37 million tons, West Germany with 2.08 million tons, and Italy with 2.08 million tons.

The trend to increasing imports into Canada, that commenced in 1973, was reversed in 1974, with imports falling from 2.65 million tons in 1973 to 2.30 million tons in 1974. The decrease in iron ore imports, however, was due to shipping problems encountered during the year in the Great Lakes — St. Lawrence Seaway, and imports are expected to continue an upward trend during the next few years.

Imports from the United States accounted for 71.3 per cent of total iron ore imports in 1974. Other minor iron ore imports from Brazil, Sweden and South Africa were utilized at the direct reduction facility and electric steelmaking complex of Sidbec-Dosco Limited, Contrecoeur, Quebec, where the ores were mixed with domestic pellet feed material, prior to insertion into the reduction facility. Sydney Steel Corporation, Sydney, Nova Scotia also imported small quantities of Brazilian lump ore as a supplement to iron ore supplied by IOC.

Consumption

Canadian consumption of iron ore in 1974 was 12.93 million tons, some 0.36 million ton below the 1973 level of 13.29 million tons. These values exclude iron ore pellets consumed in the direct reduction facility of Sidbec-Dosco Limited, Contrecoeur, Quebec, which amounted to 0.36 million ton in 1974. Of total consumption of 12.93 million tons, 10.47 million tons was of domestic origin, 2.21 million tons from the United States and 0.25 million ton from other foreign sources.

Receipts at steel plants, however, as reported by the American Iron Ore Association, see Table 4, were slightly less at 12.47 million tons; stockage at lake site port caused the discrepancy between mine shipments and receipts at steel plants. Consumption of iron ore at 12.93 million tons, thus, exceeded combined domestic and import receipts of 12.47 million tons by 0.46 million ton, and an equivalent downward adjustment in the iron ore inventory occurred at iron and steel plant sites. The shortfall in receipts at iron and steel plant sites was largely due to a decrease in imports from the United States, caused by shipping problems experienced in the Great Lakes — St. Lawrence Seaway network.

Labour

The iron ore industry in Canada provided permanent employment for approximately 13,000 personnel in 1974, of which 8,800 personnel were employed by the three major mining corporations in the Quebec-

Table 3. Production and capacity of pig iron and crude steel at Canadian iron and steel plants, 1973-74

	1973	1974p
	(short tons)	
Pig iron		
Production	10,510,994	10,386,306
Capacity at December 31	11,145,000	11,700,000
Steel ingots and castings		
Production	14,755,379	15,017,278
Capacity at December 31	17,940,800	18,838,500

Source: Statistics Canada.
p Preliminary.

Labrador region. These values exclude labour utilized in the construction and development of the Mount Wright iron ore project of Quebec Cartier Mining Company, which, because of the contractual and temporary nature of the vocation is difficult to assess accurately.

Labour shortages, especially among skilled maintenance personnel, and the large labour turnover continued to plague the Canadian iron ore industry in 1974, more especially in the Quebec—Labrador region. At one Quebec—Labrador establishment, labour turnover apparently exceeded 100 per cent in 1974, despite highly competitive wage rates and attractive fringe benefits compared with many industries in the manufacturing sector. To counteract prevailing prohibitive labour turnovers, with concomitant loss in production efficiency, major iron ore companies are attempting more innovative approaches, aimed at resolving, or at least alleviating the labour supply dilemma. Such new concepts as increased acceptance of females into male-dominated vocations, as well as the use of contractual foreign labour from European countries are being attempted, to instill a higher degree of labour stability into the labour force. Incremental inducements in terms of improved working and living conditions, enhanced fringe benefits, and generous escalator clauses are now commonplace among major iron ore establishments. Furthermore, major wage contract negotiations are poised for the beginning of 1975, and major salary increases are expected in order to meet labour union demands, and to stimulate greater labour stability in the iron ore industry.

Caland Ore Company Limited is one company that has been attempting to implement more innovative concepts in labour relations in recent years. In 1974, the dearth of crucial operating personnel in the mining and pelletizing operations led to the hiring of 30 women to fill positions, previously regarded sacrosanct to the male domain. Furthermore, Caland continued its novel correction without punishment (CWP) scheme, first initiated in January 1972. This program ministers counselling and guidance services to personnel experiencing behavioural or disciplinary problems. The success of the program can be assessed from the drastic curtailment of grievances from about 30 annually, prior to 1972, to one in 1974.

Table 4. Receipts, consumption and stocks of iron ore at Canadian iron and steel plants, 1973-74

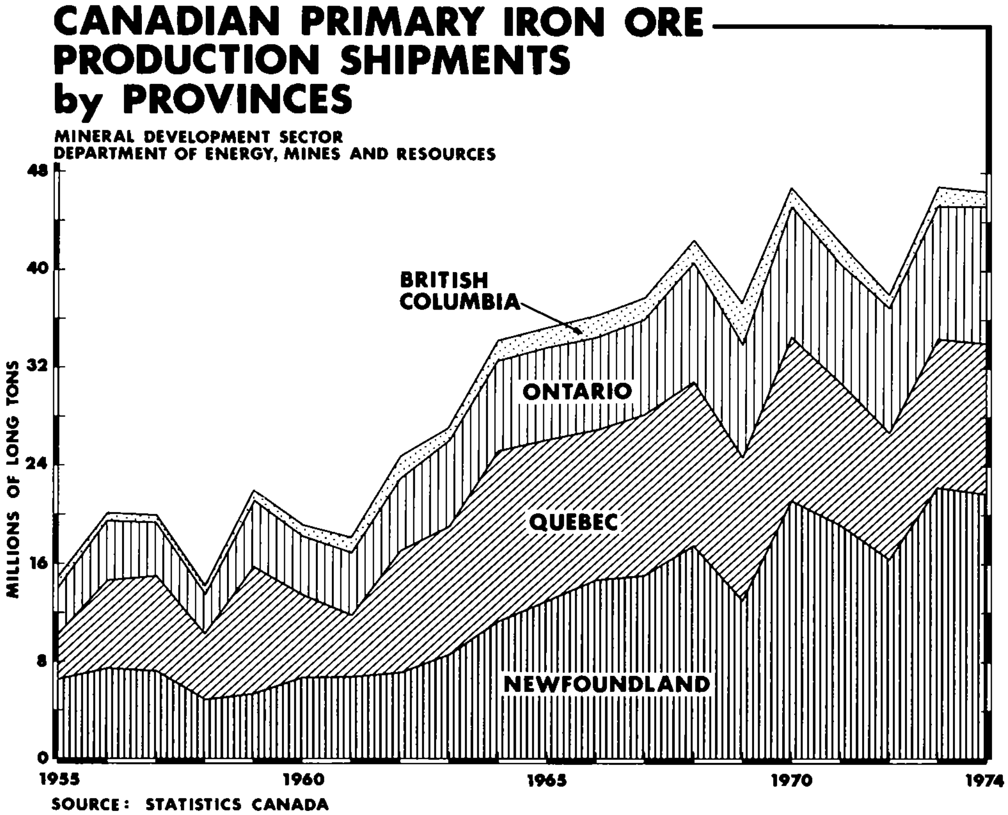
	1973	1974p
	(long tons)	
Receipts imported	2,731,772	2,090,670[1]
Receipts from domestic source	10,388,613	10,376,552[2]
Total receipts at iron and steel plants	13,120,385	12,467,222
Consumption of iron ore	13,285,745	12,929,531[3]
Stocks of ore at iron and steel plants, December 31	3,882,225	3,386,881
Change from previous year	-149,494	-495,344

Source: American Iron Ore Association, compiled from company submissions.
[1] Compared with 2,296,344 tons in Table 1. [2] Compared with domestic shipments of 10,761,397 tons compiled by Statistics Canada. [3] Compared with 13,075,033 tons compiled by Statistics Canada for blast furnace consumption.
p Preliminary.

Improvements in the sociological infrastructure of remote areas are probably a prerequisite to any incremental improvement in labour stability. In this respect, Quebec Cartier Mining Company have endeavoured to counteract the psychological barrier of remoteness at its Mount Wright iron ore project, by constructing the innovative model town of Fermont. The new town includes luxurious living accommodation, as well as a full range of social and welfare amenities. As a further substantial inducement to attract labour, Quebec Cartier Mining Company is selling the new houses at a price of about 25 – 30 per cent of their true market value.

Transportation

In 1974, total iron ore shipments through the Great Lakes — St. Lawrence Seaway were 87.6 million tons,



or some 7.5 per cent below the 1973 shipments of 94.5 million tons. Shipments from Canadian ports declined by 9.2 per cent, from 20.7 million tons attained in 1973 to 18.8 million tons in 1974. A decline of 6.8 per cent was experienced in iron ore shipments emanating from United States ports, from 73.8 million tons in 1973 to 68.8 million tons in 1974.

Freight rates prevailing in the Great Lakes — St. Lawrence Seaway have increased only moderately in recent years. Escalating operating costs, however, are likely to stimulate marked freight rate increases of about 50 per cent for the transportation of iron ore in the upcoming 1975 shipping season. The first ever all-winter navigational access through the Soo Locks at Sault Ste. Marie, Michigan, occurred in 1974–75.

The unprecedented demand for ocean-going shipping experienced in 1973, continued into the first half of 1974, with freight rates remaining at a high level. As world economic activity took a marked downward plunge in mid-1974, however, freight rates also plummeted. The initial result of declining freight rates was a decreased demand in the tanker freight market, due to high petroleum prices inducing lower consumption patterns. Confronted by a large surplus of redundant tonnage, tankers were refitted for dry cargoes, which, in turn, swamped the dry-cargo market. This initiated the plummeting freight rates in the latter half of 1974; a trend that continued unabated into 1975. The price of bulk carriers conveying iron ore from eastern Canadian ports to western European ports provides an interesting illustration. In April 1974, a 70,000-ton ship was chartered on a single voyage basis at $8.50 per ton of iron ore. In March 1975, a 100,000-ton ship was chartered on a single voyage basis at $2.00 per ton of iron ore. Low ocean freight rates will undoubtedly continue throughout 1975, as world economic activity remains depressed, and, if prudent consumption of petroleum becomes necessary, the shipping industry may experience a period of prolonged overcapacity, and depressed levels of freight rates.

The use of combination bulk carriers (OBO's) is expected to be amplified in future years, as consumers of freight tonnage continue to search for additional backhaul and combination freight routes, aspiring at

Table 5. Canadian consumption of iron bearing materials at iron-steel plants,[1] 1974

	In Sinter Plants[2]	In Direct Reduction Plants	In Iron and Steel Furnaces: Pig Iron Furnaces	Steel Furnaces	Total in Furnaces
			(long tons)		
Iron ore					
Crude and concentrates	221,183	—	405,100	58,036	463,136
Pellets	137,843	364,432[5]	9,871,112	68,492	9,939,604
Sinter	48,103	—	2,066,520	—	2,066,520
Subtotal	407,129	364,432	12,342,732	126,528	12,469,260
Sinter produced at steel plant	—	—	1,164,579[3]	—	1,164,579
Total	407,129	364,432	13,507,311	126,528	13,633,839[4]
% Fe	58.08	68.00[e]	61.24	65.30	61.28
Other iron-bearing materials					
Flue dust	190,302	—	—	—	—
Scale, reduced pellets, etc.	574,581	—	349,818	311	350,129
Total	764,883	—	349,818	311	350,129
% Fe	51.56	—	31.01	60.00	31.04

Source: Company data supplied to Mineral Development Sector.
[1] All integrated producers; excludes Quebec Iron and Titanium Corp. [2] Sinter plants located at steel works consume new iron ore "screenings" as well as other iron-bearing materials. [3] Sinter produced mainly from 407,129 tons of "new iron ore" and 764,883 tons of other iron-bearing materials. [4] Including any sintered iron-bearing materials. Total iron ore consumption of "new iron ore" is an estimated 13.240 million tons, comprising 12.469 million tons of iron ore in furnaces, 0.364 million ton of pellets in direct reduction plants and 0.407 million ton of iron ore fines in sinter plants. [5] Includes pellets and crude ore.
— Nil. [e] Estimated.

the overall reduction of unit cost transportation especially to more distant markets.

World supply and demand

Despite the world economic recession by the end of 1974, world steel production attained 710 million metric tons in 1974, compared with 695 million metric tons in the preceding year. The growth rate of 2 per cent, however, was substantially below the 10 per cent achieved in 1973. Steel demand remained buoyant in the European Community with production increasing from 150.1 million tons in 1973 to 155.7 million tons in 1974, an effective growth rate of 3.7 per cent. By year-end, however, the effects of stagflation were beginning to manifest themselves in the American and Japanese steel industries, with production falling below the record-breaking levels of 1973. Japanese steel output declined by 2.1 million tons, from 119.3 million tons attained in 1973, to 117.2 million tons in 1974, and American output declined by 2.3 million tons, from 137.6 million tons in 1973, to 135.3 million tons in 1974. A significant growth rate of 3 per cent was maintained in the steel industry of the USSR, as steel production increased from 131.5 million tons in 1973 to 135.3 million tons in 1974. Significant growth in steel production was also recorded by the steel industries in Austria, Brazil, Mexico, South Korea, Sweden, Spain and most Eastern European countries in 1974.

The world iron ore industry exhibited a proportional rate of growth to that portrayed by the world steel industry in 1974. Iron ore production increased from 828 million metric tons in 1973 to an estimated 851 million metric tons in 1974. Consequently, iron ore remained in quite tight supply in 1974, especially with respect to specific grades and types of iron ore products. Demand for iron ore pellets remained strong in 1974, propagated in part by an increasing desire on behalf of European steelmakers to utilize pellets as a fundamental blast furnace feed material.

The USSR remained the major iron ore producer with 223 million metric tons in 1974, followed by Australia, the United States, France, Brazil, Canada, Sweden and India. Amongst major iron ore producers, only Australia, Brazil and Sweden showed a substantial increase in 1974 production over the preceding year. The relatively stable output levels of the United States and Canada reflected a slackening of demand in the United States steel industry, and that of India mainly reflected an easing of demand by the Japanese steel industry. In terms of iron ore trade Australia retained its inimitable position as the world's major iron ore exporting nation with exports of 85 million tons in 1974, of which 67.9 million tons was destined for the Japanese consumer market. Other major iron ore exporters in 1974 were Brazil with 59 million tons, USSR with 40 million tons, Canada with 38 million tons, Sweden with 32 million tons, and Liberia with 25 million tons. The trend to increasing world trade of iron ore continued in 1974, mainly as a result of continued depletion of indigenous European sources of iron ore.

The Association of Iron Ore Exporting Countries

In recent years there have been continued endeavours to institutionalize major iron ore exporting nations into a formal organization, aspiring at achieving more stable and equitable arrangements for nonreplenishable iron ore exports. An informal group of iron ore producers was formed in 1968, when representatives of Brazil, Chile, India, Liberia, Peru and Venezuela met in Caracas; hence the term Caracas Group was often used for the original informal group. After a brief interlude under the auspices of UNCTAD, an enlarged and independent Iron Ore Producers Group was established in February 1973 with full membership being pursued by the original Caracas Group members, supplemented by Algeria, Gabon, Mauritania and the Philippines, with Australia, Canada and Sweden as participating observers. In mid-1974, a working group drew up a working document and a set of draft statutes outlining an organization called The Association of Iron Ore Exporting Countries (AIOEC). The Association was formally inaugurated on April 3, 1975 at Geneva, with membership participants including Algeria, Australia, Brazil, Chile, India, Liberia, Mauritania, Peru, the Philippines, Sierra Leone, Sweden, Tunisia and Venezuela. Canada declined any form of participation, at that time, due to its avowed preference for joint producer—consumer organizations.

Official Canadian policy does not preclude eventual membership participation however if the Association encompasses consuming countries as participatory members. The evolution of such a trend could ultimately lead to the development of a genuine commodity agreement for the production, marketing and consumption of iron ore.

Table 6. World iron ore shipments, 1973-74

	1973	1974p
	(000 metric tons)	
USSR	216,104	223,200
USA	89,692	83,050
Australia	85,887	96,797
Brazil	55,019	74,979
France	54,228	54,266
Canada	48,132	47,977
China	45,000	46,000
Sweden	33,307	34,469
India	34,426	33,800
Venezuela	21,946	25,952
Liberia	25,329	25,370
Eastern Europe	14,495	14,650
Mauritania	10,288	11,616
South Africa	10,955	11,553
Peru	9,582	10,549
Chile	9,463	10,455
Spain	7,466	8,998
Angola	6,205	5,276
Others	57,376	32,143
Total	834,900	851,100

Sources: Mineral Development Sector; *Metal Bulletin* and others.
p Preliminary

As currently formulated, the Association will act solely as a consultative vehicle, and has avowed not to resort to radical measures of cartel organizations. The current members of the Association control approximately 33 per cent of world iron ore production, but over 70 per cent of world iron ore trade. It is in respect of its virtual monopoly of iron ore entering international trade that the development of the association will be regarded with significant self-interest by European and Japanese consuming nations, who rely on member nations to procure their iron ore requirements.

World developments

According to a recent International Iron and Steel Institute study, world steel consumption should increase to 935 million metric tons by 1980 and 1,144 million metric tons by 1985. To meet the demand of an expanding world steel industry, it is estimated that 1,350 million metric tons of iron ore will be required by 1985. The attainment of this goal will be governed largely by the successful implementation of major iron ore projects, currently, at the preliminary, or advanced stages of development. The complexities and scale of

Table 7. Lake Erie base prices of selected ores, 1964-75

	1964-69	1970	1971-72	1973[1]	1973[2]	1974[3]	1975[4]
	($ U.S. per long ton)						
Mesabi Non-Bessemer	10.55	10.80	11.17	11.71	11.91	15.06	17.28
Mesabi Bessemer (+ phos. premium)	10.70	10.95	11.32	11.86	12.06	15.04	17.53
Old Range Non-Bessemer	10.80	11.05	11.42	11.96	12.16	15.14	—
Old Range Bessemer	10.95	11.20	11.57	12.11	12.31	15.29	—
High Phosphorous	10.55	10.80	10.80	—	—	—	—
Pellets (per long ton natural unit)[5]	0.252[6]	0.266	0.280	0.291	0.300[7]	0.380[8]	0.446

[1] Increase effective January 1, 1973. [2] Increase effective March 1973. [3] Increase effective August 1974. [4] Increase effective January 1975. [5] Equals 1% of a ton i.e. 22.4 pounds for a long ton unit. An iron ore containing 60% Fe therefore has 60 units. [6] Price applicable for years 1962 to 1969. [7] Increases effective March 1973 and October 1973. [8] Increases effective May 1974, June 1974, August 1974 and December 1974.
— Nil.

political and financial arrangements, pre-engineering studies, and installation of the requisite transportation and port infrastructure, necessitates a 5- to 10-year period to bring major contemporaneous iron ore projects to fulfillment.

Australia. Major expansion plans in Australia will continue to emanate from Western Australia, predominantly from the Pilbara region, with production capacity projected to expand from a current 97 million metric tons to 165 million metric tons in 1985. The four major iron ore producers in the Pilbara region — Mount Newman Mining Ltd., Goldsworthy Mining Pty. Ltd., Hamersley Iron Pty. Ltd., and Cliffs Robe River Associates — are currently embarking upon major expansion plans. In addition to the large expansion plans of these current producers, new developments in the Marra Mamba iron formations are likely to become increasingly important in the 1980s.

Brazil. Iron ore production in Brazil is likely to continue its phenomenal growth over the next ten years, with production capacity projected to expand from a current 75 million metric tons to 160–170 million metric tons by the mid-1980s. The most significant project in Brazil is the development of the vast Carajas iron ore deposits in the state of Para. The deposits, reportedly containing at least 2 billion metric tons of high-grade ore, are being developed by Amazonia Mineraçao S.A., a joint venture corporation owned 51 per cent by Cia Vale do Rio Doce (CVRD) and 49 per cent by United States Steel Corporation. The total capital cost of the project will exceed $2 billion, including the requisite extensive transportation and port infrastructure. Initial production at an annual rated capacity of 5 million metric tons is expected in 1980, with capacity being increased to 50 million metric tons in 1985–86.

Brazil is also embarking upon a major expansion program destined to raise pelletizing capacity from a current 6 million metric tons per annum to 25–30 million metric tons per annum by 1978.

Chile. The state-owned steel firm, Cia de Acero del Pacifico (CAP), which monopolizes iron ore production in Chile, has announced plans recently to develop a new iron ore mine, pelletizing plant and railway in the Huasco Valley, approximately 400 miles north of Santiago. The development will eventually add 3.5 million metric tons of pellets per annum to CAP's current production, with initial start up scheduled for 1976.

Guinea. The Swedish state-owned mining company, Luossavaara-Kiirunavaara A.B. is currently conducting studies on the Nimba iron ore deposits in northern Guinea. Eventual production at a rated annual capacity of 15 million metric tons of iron ore is expected, possibly by the mid-eighties.

Ivory Coast. Initial development has commenced on the Mount Klahayo project with tentative plans including a 12 million ton per annum iron ore mine, concentrating and pelletizing complex, and a 186 mile railway to a major port on the Atlantic coast. The Mount Klahayo iron ore project is a consortium venture of British, Dutch, French and Japanese steel companies, in conjunction with Pickands Mather International and the government of Ivory Coast.

India. Privately operated mines currently account for about 54 per cent of total iron ore production in India, but there was increased speculation in 1974 that the Indian government was planning complete nationalization of the Indian iron ore industry. As yet no firm decision has been announced, however, on the prospective nationalization.

Chowgule and Co. Pvt. Ltd. were recently granted government permission to construct a second iron ore pelletizing plant with an annual rated capacity of 2 million tons of iron ore pellets at Goa. The plant, which will be completed in 1977, has been financed by Japanese loans, with the entire output contracted for Japanese steelmakers. Chowgule have also recently asked Nippon Kokan Kaisha, the second largest Japanese steel producer, to conduct a feasibility study on the Bababudan iron ore deposits and pelletizing project in Northern India. Chowgule anticipates eventual production of 7–8 million tons of pellets annually from the Bababudan deposits.

Liberia. Three major iron ore projects are currently being investigated in Liberia — the Wologisi, the Putu Mountains, and the Bie Mountains iron ore deposits. No definite production schedules have been formulated with respect to the three prospective developments in Liberia, but it is feasible all three could be incremental suppliers of a total of 20 million tons of iron ore to world markets by the mid-1980s.

United States. The iron ore industry in the United States is, currently, experiencing a period of sustained growth, particularly in the Lake Superior taconite ranges. This is expected to decrease United States dependence on imported iron ores in the medium-term. The Tilden mine in Michigan, which is managed by The Cleveland-Cliffs Iron Company, commenced production in December 1974 at an annual rated capacity of 4 million tons of pellets, of which 1.7 million tons will be exported to Canadian steel producers. Cleveland-Cliffs Iron Company is also nearing completion of its expansion plans at the Empire mine in Michigan which will increase annual capacity by almost 2 million tons annually.

In Minnesota, annual production capacity is projected to increase by about 12 million tons over the next two years, when the new projects of Hibbing Taconite Co. and Inland Steel Company are completed, and expansion plans at the Eveleth Taconite Co. are fully implemented.

In southern Alaska, the United States Steel Corp. and a consortium of Japanese steel companies continue to evaluate feasibility studies conducted on the Klukwan iron ore deposits. Present proven ore reserves are estimated at 71 million tons of 14.8 per cent iron ore and 1.5 per cent titanium, but potential ore reserves are thought to exceed 3 billion tons of low-grade iron ore. Imminent production of the Klukwan iron deposits will be partly dependent on the ability of participating companies to comply with rigid environmental standards imposed by the regulatory agencies in Alaska.

Venezuela. The two major iron ore producers in Venezuela, owned respectively by United States Steel Corp. and Bethlehem Steel Corporation, were nationalized in 1974. Under the nationalization agreement, transfer of assets was effective December 31, 1974, but the American corporations would continue to operate the mines during a one-year transition period. The Venezuelan government also acceded to a continuation of iron ore shipments to American steel producers for a further contractual period of three years. After such time, further shipments would be guaranteed only if such shipments were deemed in excess to requirements of an expanding domestic steel industry.

Iron ore markets and pricing policies

There are four major international trading markets for iron ore — United States, Western Europe, Eastern Europe and Japan. Canada sells iron ore to all the major consuming markets, except Eastern Europe, which relies on the U.S.S.R. as the predominant source for its iron ore material. In 1974 export shipments to the United States comprised 52.9 per cent of total Canadian exports; shipments to Western Europe represented 35.7 per cent and, shipments to Japan 11.3 per cent.

International iron ore fob prices increased substantially in 1974, due to escalating operating costs induced by world-wide inflation. Iron ore production costs were accelerated by increased fuel costs and forceful demands by labour for substantial wage increases, based on inherent inflation expectations. These increases propagated a wave of renegotiated long-term contracts, especially with Japanese consumers, with the Japanese compelled to grant appreciable increases in iron ore product prices accruing to exporting nations. International iron ore cif prices also increased in 1974, but to a lesser degree than fob prices. This was caused by the higher fob prices being, in part, offset by declining freight rates in the latter part of 1974; a trend which continued into 1975.

United States market. It has been customary for prices of United States domestic iron ore shipments and the bulk of its iron ore imports to be established at the commencement of each year according to a reference price schedule called the Lake Erie base price. This price schedule is applicable to domestic shipments within the United States, imports from Canada, Brazil, and Venezuela, and most Canadian ore shipments delivered to Canadian steel producers. The prices of various iron ore products are normally established on January 1 annually, with a merchant ore company — The Hanna Mining Company — acting as the price leader. Since the price increases reflect escalating costs of labour, supplies, fuel and transportation, these price increases are adopted by other merchant ore companies and producers operating under comparable inflationary cost pressures. In recent years, Hanna Mining Company has increasingly departed from its

Table 8. Fob prices of selected Japanese iron ore imports, 1974-75

Country	Company	Annual Tonnage	Product Type	Price	Effective Date
				($US per long ton)	
Angola	Cia Mineira do Lobito S.A.	2,400,000	Lumps	11.53	October 1974
			Fines	9.66	October 1974
Brazil	Cia Vale do Rio Doce S.A. (CVRD)	17,000,000	Lumps	13.80	April 1975
			Fines	10.70	April 1975
			Sinter-feed	12.00	April 1975
	Mineraçao Brasileiras Reunidas S.A. (MBR)	7,000,000	Lumps	11.60	November 1974
			Sinter-feed	9.80	November 1974
			Pellets	12.10	November 1974
Canada	Iron Ore Company of Canada	5,000,000	Fines	. .	. .[1]
	Texada Mines Ltd.	400,000	Sinter-fines	10.82	January 1975
	Wesfrob Mines Ltd.	400,000	Sinter-fines	10.55	January 1975
Chile	Cia de Acero del Pacifico S.A. (CAP)	8,600,000	Lumps	10.24-10.40	September 1974
			Fines	8.02-8.21	September 1974
			Run-of-mines	10.18	September 1974
India	Chowgule and Co. Pvt. Ltd.	550,000	Pellets	19.13	April 1975
Mauritania	Societé Anonyme des Mines de Fer de Mauritanie (MIFERMA)	2,000,000	Lumps	13.20	April 1973[1]
		200,000	Fines	5.70	April 1973[1]
New Zealand	Marcona Corp. (Waipipi Iron sand)	1,200,000	Iron sand	5.95	September 1974
	New Zealand Steel Co. (Taharoa iron sand)	1,200,000	Iron sand	5.95	September 1974
Peru	Marcona Corp.	. .	Pellets	13.15[2]	September 1974
			Sinter-feed	6.80-10.07[2]	September 1974
			Slurry	8.60[2]	September 1974
South Africa	South African Iron & Steel Industrial Corp. (ISCOR)	400,000	Lumps	12.61	October 1974
Swaziland	Swaziland Iron Ore Development Co. (SIODC)	2,000,000	Lumps	14.00	April 1975
			Fines	8.00	April 1975
U.S.S.R.	VO Soyuzpromexport (Krivoi Rog iron ore)	1,000,000	Low-grade fines	6.75	September 1974
			Concentrate fines	7.55	September 1974

Source: *Japan Commerce Daily* and others.
[1] Contracts under renegotiation. [2] Calculated from cif price, assuming freight cost of $5.75 per ton.
. . Not available.

customary procedure of price increases on January 1; in part, Hanna's departure from tradition was induced by constraints on price increases imposed by the U.S. governments' price controls in 1973. The artificially restrained price levels of 1973 stimulated major price realignments in 1974, when the U.S. price controls were lifted in April 1974.

Overall, three price increases were effected in the Lake Erie base price in 1974, which raised the price of natural ore by about 45 per cent. A further 9.6 per cent increase in iron ore products was pegged by Hanna Mining Company in January 1975. As operating costs continue to escalate in 1975 iron ore prices will continue to increase, especially in view of a projected 50 per cent increase in lake freight rates in 1975.

Total shipments of iron ore received at United States steel plants in 1974, were 128.3 million tons, of which 81.8 million tons or 63.7 per cent of the total shipments received were from domestic iron ore producers. Canadian iron ore shipments comprised 17.8 million tons or 13.9 per cent of total shipments, and other foreign sources provided 28.7 million tons or 22.4 per cent of total United States iron ore shipments in 1974. Of the 28.8 million tons of iron ore from other foreign sources, Venezuela is the leading exporter, and in 1974 shipped 16.8 million tons to the United States. The price of Venezuelan direct shipping ore fob Puerto Ordaz was previously tied to the Lake Erie base price for Mesabi non-Bessemer ore, but effective March 1973, the Venezuelan government initiated a new policy of monitoring fob prices, through the Ministry of Mines and Hydrocarbons.

European market. European steel producers have tended in past years to secure a large proportion of their iron ore requirements on annual contractual arrangements, normally negotiated at the termination of the preceding year. Until 1973, over half of the total European iron ore requirements were procured through such short-term contracts. With the escalating prices of iron ore in 1974, and the expected continuation of increasing prices in the future years, there is a prevailing trend on the part of European steel producers to negotiate long-term contracts for iron ore imports, especially with non-European suppliers.

The continued growth of the European steel industry has greatly increased European demand for imported iron ore, and this trend has been accentuated by rapid depletion of indigenous iron ore deposits — notably in the United Kingdom, Italy and West Germany. Swedish sellers have, traditionally, fulfilled the role of price leader in iron ore sales within European markets, because of favourable locational economics. In recent years, increasing economies of scale imparted by ocean-going transportation has rendered iron ore supplies from more distant sources equally as competitive. Thus, Canada, Brazil, India and West African countries continue to respond to the demands of European consuming markets.

European prices paid for iron ore were generally stable in the early seventies, but the unprecedented growth of the European steel industry in 1973 began to exert strong upward pressure on iron ore prices. Because of the negotiation of short-term annual contracts, most of these increases were effectively supressed until January 1974, when extensive increases in iron ore products were negotiated. The prices of Swedish ores are set by Malmexport A.B., the joint sales agent for Luossavaara-Kiirunavaara A.B. and Granges Exploration Aktiebolag, and Malmexport demanded price increases of about 25–30 per cent in 1974. The prices of low phosphorus sinter fines increased from about 20 cents per iron unit in 1973 to 24–26 cents per iron unit cif Rotterdam in 1974, with low impurity lumps increasing to 30–32 cents per iron unit cif Rotterdam. The high prevailing freight rates at the beginning of 1974 also greatly increased the demand for Scandinavian, Canadian and West African ore, due to their preferential location to major European markets. Less competitive distant sources of iron ore, such as Australia, Brazil and India, were compelled to accept lower fob prices for iron ore in order to remain competitive with the less distant ore sources. Pellets were especially in demand in 1973, and prices increased from the 1972 level of 25–29 cent per iron unit cif Rotterdam to about 35 cents in 1973.

Increases in spot prices of iron ore products continued throughout 1974, and this was reflected in new contracts concluded at year-end, which resulted in major increases in prices for all iron ore products of about 45–50 per cent. Malmexport of Sweden announced price increases on low phosphorus sinter fines from 24–26 cents in 1974 to 34–36 cents in 1975; low impurity lumps from 30–32 cents to 40–41 cents; and, pellets from 35–37 cents to 53–55 cents per iron unit cif Rotterdam. The increases were attributed to rapidly escalating mining costs, especially for equipment and oil, the latter particularly affecting pelletizing operations.

It is of interest that, notwithstanding a declining demand for most iron ore products in early 1975 in western Europe, spot prices of pellets remained firm. The European demand for pellets, thus, appears to be developing into a long-term trend which was recently confirmed by announcements of the construction of new pelletizing facilities in the United Kingdom, the Netherlands, West Germany and Scandinavia. The belated demand for iron oxide pellets in many European countries is thought to be propagated predominantly by stricter pollution control legislation and rapid depletion of indigenous Minette-type iron ore deposits.

Japanese market. The Japanese steel industry was dependent almost exclusively on iron ore imports in 1974, with imports accounting for 99.3 per cent of total iron ore consumption. After the unprecedented growth of the Japanese steel industry in 1973, steel production actually declined by 1.9 per cent in 1974. Despite the decline in steel production, iron ore imports responded paradoxically, increasing from 135 million metric tons in 1973, to 142 million metric tons in 1974. The excess iron ore purchases were used primarily to replenish precariously low iron ore inventories resulting from the halcyon conditions of 1973. The average cif price for imported iron ore increased by 16 per cent in 1974, from U.S. $12.26 a metric ton in 1973 to U.S. $14.25 a metric ton in 1974.

The proximity of Australian iron ore sources renders it the price leader in the Japanese market. In 1974, Japan procured about 67.9 million metric tons, or 48 per cent of its total iron ore requirements from Australia. Iron ore trade was encouraged by the high grade, favourable quality and low transportation costs embodied by Australian producers. Other significant suppliers of Japanese iron ore imports were Brazil with 19.5 million metric tons and India with 17.3 million metric tons. Canada is at a disadvantage as a major supplier of iron ore to the Japanese market because of the remoteness of the large iron ore producers, located in the Quebec-Labrador region. In 1974, Canada exported only 4.2 million metric tons to Japan, emanating predominantly from the two iron ore producers in British Columbia and the Carol Lake Division of the Iron Ore Company of Canada. Canadian iron ore exports to Japan are unlikely to increase significantly in the medium-term.

The impact of cost-push inflationary forces upon most Western economies resulted in escalating operating costs for most iron ore production centres in 1974, and this necessitated renegotiation of long-term contracts between most iron ore producers and Japanese steel companies. In Australia, Japanese-integrated steelmakers and major Australian iron ore producers reached final agreement on a fob price increase of U.S. $2.25 per ton of iron ore products, effective September 1, 1974. Original assent was achieved in July 1974 on the basis of an overall increase of U.S. $1.75 a ton, but the agreement did not receive the sanction of the Australian government and, hence, Japanese steelmakers and Australian iron ore producers were compelled to renegotiate higher price increases. The eventual increase of U.S. $2.25 a metric ton represented a 22 per cent increase on the original weighted average price of U.S. $10.15 a ton of lumps, fines and pellets to $12.40 a metric ton, on an fob basis. In addition, a further increase of 7.5 per cent was agreed upon for shipments of iron ore made after April 1, 1975, as was stipulated in the original long-term contracts. From the Australian viewpoint the favourable outcome of contract renegotiations was further enhanced by a 12 per cent devaluation of the Australian dollar against the United States dollar, effected September 25, 1974. The significance of the currency realignment lies in the fact that all long-term contracts between Australian iron ore producers and Japanese steelmakers are negotiated in U.S. dollars. The unexpected windfall accruing to Australian iron ore producers may result in renewed Japanese resistance to the proposed 7.5 per cent duly agreed upon for April 1, 1975.

Table 9. Representative fob prices of Australian lump and fines according to Japanese contracts, 1966-1974

	Hamersley Lump	Hamersley Fines	Goldsworthy Lump	Goldsworthy Fines	Mt. Newman Lump	Mt. Newman Fines
	($U.S. per dry long ton, 64% Fe basis)					
1966-67	9.92	7.68	9.86	7.25	N/A	N/A
1968	9.37	7.68	9.37	7.68	9.37	7.13[1]
1969	9.37	7.63	9.37	7.68	9.37	7.13[1]
1970	9.58	7.23[1]	9.86	7.95	9.58	7.23[1]
1971	9.58	7.95	9.58	7.25[1]	9.58	7.25[1]
1972	9.38	7.68	9.38	7.68	9.38	7.68[1]
1973	10.96	8.68	10.96	8.68	10.96	8.45[1]
1974	13.21	10.93	13.21	10.93	13.21	10.70[1]

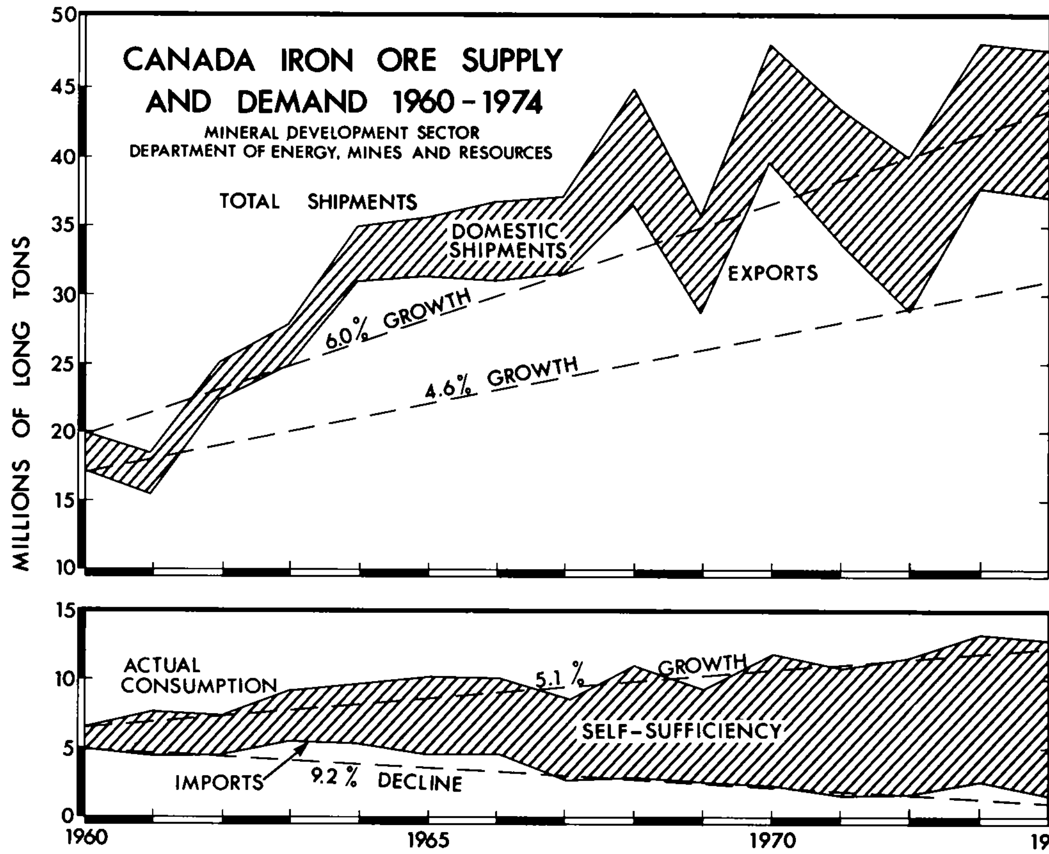
Sources: *Japan Commerce Daily* and others.
[1] 62% Fe.

Canadian iron ores entering Japan were also subject to favourable contract renegotiations in 1974. Concentrate shipments from Wesfrob Mines Limited and Texada Mines Ltd. were increased by U.S. $1.70 a long ton, for shipments commencing January 1975. A renegotiation of the Iron Ore Company of Canada's contract with Japanese steelmakers was also expected to be ratified in late 1974 or early 1975.

Other major iron ore exporting countries, such as Brazil, Chile, Peru, India, Angola, and Liberia also obtained a uniform fob increase of U.S. $2.25 a metric ton for contracts with Japanese steelmakers in 1974. See Table 7.

Future trends.

The continued growth of the Canadian iron ore industry should be assured in both the short- and the long-run, by continued firm demand by the expanding world steel industries. Canadian iron ore shipments are expected to increase from 47.2 million tons in 1974, to an estimated 75 million tons by 1980, and 140 million tons by 2000. Currently, about 80 per cent of Canadian shipments are exported, and this ratio is likely to be substantially maintained in the long run. Thus, the growth of the Canadian iron ore industry will be primarily in response to a demand for exports, notably in the United States and European markets. Total exports are expected to exhibit an annual growth rate of 6.4 per cent, increasing from 36.9 million tons in 1974, to an estimated 61 million tons by 1980. Domestic



iron ore shipments are expected to increase at a slower rate of growth, rising from 10.4 million tons in 1974 to an estimated 14 million tons by 1980.

The sustained growth of the Canadian iron ore industry, with its large reliance on the export market, assumes continued expansion of world steelmaking facilities. The world steel industry was tormented by severely depressed conditions during the latter part of 1974 and the early part of 1975, as a consequence of a marked decline in non-communist economic activity. In the medium-term, however, the world steel industry may return to an annual growth norm of about 5 – 6 per cent, which would be compatible with the IISI projection* of world raw steel consumption of 935 million metric tons by 1980. Assuming no marked global change in the current pig-iron/raw steel ratio of 0.71, pig-iron production is expected to increase from 503 million metric tons in 1974 to 664 million metric tons in 1980. This increase is equivalent to an increased demand of total iron content in iron ores of 614 million metric tons by 1980. This, translated into iron ore requirements for 1980, is approximately 1.10 million metric tons of iron ore products.

Recently confirmed and envisaged expansion of iron ore production capacity in many countries, notably Australia, Brazil, Canada, Sweden, United States and the U.S.S.R. should ensure adequate iron ore supplies in the medium-term. Certain premium products especially iron ore pellets, may remain in tight supply, however, as countries strive for increased efficiency bestowed by ameliorated blast furnace feed materials, and the requirement in many countries to eradicate undue pollution, in response to the ever more stringent environmental legislation. Futhermore, the anticipated growth in direct reduction processing may engender a strong demand for premium quality iron ore pellets, containing a high iron content and low deleterious gangue constituents, notably silica.

* International Iron and Steel Institute; Projection 85, World Steel Demand; March, 1972.

The rapid depletion of indigenous iron ores in many Western European countries and the expected continued growth of the Japanese steel industry will continue to stimulate strong growth in world iron ore trade in future years. In 1974, world iron ore trade was an estimated 365 million metric tons or 43 per cent of total world iron ore production, and this is expected to increase, by 1980, to 580 million metric tons, or 54 per cent of total world production. In 1980, Japan is expected to import about 207 million metric tons, western Europe (excluding Scandinavia) about 156 million metric tons and the United States about 75 million metric tons, or cumulatively about 75 per cent of total world iron ore trade.

In recent years, the increasing volatility of scrap iron prices, and the periodic scrap shortages have increased the search for alternate forms of metallic feed for the world steel industry. This has resulted in an increasing interest in the relative economics of direct-reduced iron as a substitute feed for scrap iron in steel furnaces. Numerous processes for the direct reduction of iron currently exist, of which only a few have proven commercial viability. Most of the present proven processes are dependent upon natural gas as a primary energy source, and in energy deficient areas, presently proven direct-reduction processes consume unacceptably high quantities of natural gas, rendering such processing obsolete even before installation. The currently proven direct-reduction processes have important implications for energy-rich nations, however, aspiring at the stimulation of a modest electric-furnace steel industry, or promoting an export merchant trade in prereduced iron products. Thus, for countries with abundant natural gas supplies, such as many Middle East countries and Venezuela, the growth of a viable direct-reduction industry utilizing natural gas should be a desirable national objective. The relative scarcity of natural gas in most western economies, however, has sparked an interest in direct reduction processes, utilizing a more abundant fuel, such as low-rank coals. Ultimately, such processes are expected to play a significant role in the development of a large direct reduction industry, especially in industrialized countries with abundant coal reserves, such as the United States, Canada and Australia. In Canada, two solid-reductant direct-reduction processes are currently approaching commercial operation — The Steel Company of Canada's SL-RN process and the Allis Chalmers Canada Ltd. Ported Kiln process. The Allis Chalmers process has the additional advantage of built-in flexibility, being capable of utilizing coal, natural gas or petroleum as fuel materials. Successful adaptation of the solid-reductant processes to commercial-scale plants could lead to a rapid expansion of the direct-reduction industry in Canada. Current installed direct-reduction capacity in Canada is restricted to one Midrex facility with annual rated capacity of 0.4 million ton, installed at the electric steelmaking facilities of Sidbec-Dosco Limited at Contrecoeur, Quebec. The Canadian direct-reduction industry however, is expected to grow to almost 2 million tons of annual capacity by 1980. On a world-scale, production capacity, which is currently at about 5 million tons of installed capacity, could attain 30 million tons or more by 1980, given satisfactory resolution of the many technical probems confronting the operation of direct-reduction processes. This growth could greatly facilitate the development of electric steelmaking processes in areas deficient in scrap.

The formal inauguration of The Association of Iron Ore Exporting Countries is not expected to radically change iron ore markets or marketing procedures in the medium-term. The mere existence of a unified front of iron ore exporting countries may exert gradual upward pressure on iron ore prices, but radical cartel-type activity of price fixing or supply curtailment is considered most unlikely. Eventually, the Association could result in a true commodity agreement for iron ore, as currently appears vogue in an emerging new global economic order. A commodity agreement could promote the more orderly development of iron ore reserves and marketing of iron ore products, precluding the deleterious pricing fluctuations and inequities, which have alternately beleaguered producers and consumers in past years.

A stabilizing form of producer-consumer cooperation would be appreciated as international trade, becomes increasingly complicated by unilateral action, nationalization and severe fluctuations in the prices of primary commodities.

Sampling steel from a basic oxygen converter.
(NFB photo/Brian King)

Iron and Steel

PAUL LAFLEUR

Canadian crude steel* production and consumption reached record levels in 1974 for the fourth consecutive year. While apparent crude steel consumption increased by 10.2 per cent from the year before to reflect burgeoning demand, production was up by only 1.8 per cent as a consequence of shortages of raw materials and other factors that restricted full utilization of capacity. The resultant shortfall in available domestic steel was filled by imports which increased by 53 per cent from the previous year. While imports established a new record, exports increased only slightly notwithstanding the possibility of obtaining higher prices for foreign sales. The imbalance between production and consumption caused steel plant stocks to be generally depleted throughout the year. Accordingly, producers allocated steel to consumers as in the previous year.

The strong average domestic demand during the year masked a weakening trend in requirements by certain sectors that intensified in the last quarter of the year. While shipments declined to the automobile and construction industries, the two largest users of steel, other sectors took up the slack and this allowed domestic shipments to increase by 4.6 per cent from 1973. The weakening trend in demand is expected to continue well into 1975 and any major recovery will depend on an upturn in construction activity and in the manufacture of automobiles.

Installed or anticipated crude steel capacity amounted to 18.3 million tons in 1974 compared with 16.0 million tons the year before. However, the effective capacity for 1974 was much lower because of constraining factors in the production process. The outstanding development during the year was the start of construction by The Steel Company of Canada, Limited of a major new steel plant at Nanticoke, Ontario that will add some 1.3 million tons of new capacity by 1978 at an estimated cost of $430 million.

Under the pressure of an expanding demand, and because of a steep rise in production costs, mainly for raw materials and wages, steel prices in Canada rose much more sharply in 1974 than in the previous year. Of tremendous importance to the steel industry in this regard, was the timely release in October 1974 of the Steel Profits Enquiry Report which "cleared" the steel industry of all inferences of profiteering either through price increases or the withholding of steel inventories.

Government and private sector economists have forecasted real growth of the Gross National Product (GNP) in 1975 at 1.2 to 3.9 per cent, which compares with an estimated 3.6 per cent for 1974. Because of its close correlation with GNP, and because of other factors, consumption of rolled steel is expected to be down by as much as 5.1 per cent to 12.4 million tons. However, producer shipments are expected to be up by about 3.2 per cent to replenish depleted stocks at warehouses and steel service centres; to displace non-competitive imports; and to increase exports. Steel production is expected to show a greater increase at 5.9 per cent to allow steelmakers to also replenish their stocks which were severely depleted at year-end.

Steelmaking capacity

Although steelmaking is widespread in Canada, the large plants are concentrated mostly in Ontario. Of the forty-four plants* making steel, five are integrated plants and thirty-nine are electric steel and castings facilities. Of the six pig iron plants in Canada, four — two at Hamilton, Ontario and one each at Sault Ste. Marie, Ontario, and Sydney, Nova Scotia — are part of integrated complexes which have backward linkages into iron ore and coal production and forward linkages into manufacturing and fabrication. The two other pig iron plants — Quebec Iron and Titanium Corporation and the Port Colborne facilities of The Algoma Steel

* Crude steel comprises ingots, semis and steel castings.

* A complete listing of Canadian primary iron and steel plants including steel foundries is in the booklet *Operators List 2, Primary Iron and Steel* (75 cents). More detailed statistics are compiled in MR 133, *Canadian Primary Iron and Steel Statistics to 1971* (75 cents). Both are available from Information Canada.

Corporation, Limited — make iron either for use in foundries or for the production of iron powder. They are, therefore, not considered as integrated steel production facilities since the pig iron is not converted to steel. A fifth, but unconventional type of integrated plant, was added in 1973 with the start up of Sidbec-Dosco Limited's new direct-reduction plant which converts iron ore to reduced iron for use in electric furnaces.

At the start of 1974, total steelmaking capacity stood at 16.1 million tons* (compared with 16.0 million tons predicated by the end of 1973, see Table 3) comprised of 8.2 million tons of BOF capacity, 4.5 million tons of open-hearth capacity, and 3.4 million tons of electric steelmaking capacity. According to company reports, some 2.4 million tons of new capacity were added in 1974 — 1,466,000, 500,000 and 45,000 of BOF capacity by Algoma, Stelco and Dominion

* The net or short ton (2,000 pounds) is used throughout unless otherwise stated.

Table 1. Canada, general statistics of the domestic primary iron and steel industry, 1972-74

		1972	1973	1974p
Production				
Volume indexes				
Total industrial production	1961=100	196.8	214.8	220.2
Iron and steel mills[1]	1961=100	185.4	200.8	209.7
		($ million)	($ million)	($ million)
Value of shipments, iron and steel mills[1]		1,975.6	2,287.4	2,878.8
Value of unfilled orders, year-end, iron and steel mills[1]		306.7	433.2	579.1
Value of inventory owned, year-end, iron and steel mills[1]		433.3	459.1	613.4
Employment, iron and steel mills[1]		(number)	(number)	(number)
Administrative		11,380	..	..
Hourly rated		38,378	..	..
Total		49,758	53,008	..
Employment index, all employees	1961=100	139.0	146.8	
Average hours per week, hourly rated		40.2	40.0	40.0*
		($)	($)	($)
Average earnings per week, hourly rated		182.91	197.39	214.13*
Average salaries and wages per week, all employees		192.28	205.81	220.82*
Expenditures, iron and steel mills[1]		($ million)	($ million)	($ million)
Capital: on construction		36.2	33.2	76.8
on machinery		170.9	182.8	216.0
Total		207.1	216.0	292.8
Repair: on construction		15.7	19.4	22.3
on machinery		200.5	223.2	241.2
Total		216.2	242.6	263.5
Total capital and repair		423.3	458.6	556.3
Trade, primary iron and steel[2]				
Exports		342.1	396.0	650.7
Imports		457.9	579.5	1,172.7

Source: Statistics Canada.
[1] S.I.C. Class 291 — Iron and Steel Mills: covers the production of pig iron, steel ingots, steel castings, and primary rolled products, sheet, strip, plate, etc.
[2] Includes pig iron, steel ingots, steel castings, semis, hot- and cold-rolled products, pipe and wire. Excludes sponge iron, iron castings and cast iron pipe — compilation by Mineral Development Sector.
* 10-month average.
p Preliminary; .. Not available.

Foundries and Steel, Limited, (Dofasco) respectively, and 430,000 tons of electric steelmaking capacity through start up of six new plants or expansions. However, with open-hearth capacity reduced by 360,000 tons to 4.2 millions tons, the net gain was 2.1 million tons, bringing total annual capacity to 18.2 million tons compared with 18.3 million tons predicted by the end of 1974, see Table 3, by the end of the year, for an increase of some 12.9 per cent.

Production and shipments

Both raw steel production at 15.0 million tons and mill shipments of rolled steel products (including steel semis and steel castings) at 11.6 million tons were at record levels in 1974. See Table 3. These represented increases over 1973, when the previous records were established, of 1.8 and 4.6 per cent, respectively. They show a moderation in the growth pattern seen in the last four years. For example, growths of 12.9 and 10.3 per cent were obtained for 1973, and 7.4 and 5.4 per cent for 1972.

Oxygen steel production amounted to 8.1 million tons and comprised 54 per cent of total production compared with only 50 per cent the previous year. Electric steel and steel castings production at 3.1 million tons increased by 16 per cent, well above the 12 per cent average compound growth rate for electric steelmaking between 1960 and 1973. The increase in oxygen and electric steelmaking was at the expense of open-hearth production which declined 18 per cent to

Table 2. Canada, pig iron production, shipments, trade and consumption 1972-74

	1972	1973	1974p
		(net tons)	
Furnace capacity, January 1[1]			
Blast	10,125,000	10,410,000	10,470,000
Electric	782,000	705,000	675,000
Total	10,907,000	11,115,000	11,145,000
Production			
Basic Iron	8,510,470	9,627,429	9,564,449
Foundry iron	853,423	883,565	821,857
Malleable iron	*	*	*
Total	9,363,893	10,510,994	10,386,306
Shipments			
Basic iron	53,042	63,594	123,153
Foundry iron[2]	895,502	952,433	827,963
Total	948,544	1,016,027	951,116
Imports			
Net tons	4,125	2,052	2,472
Value ($'000)	177	183	455
Exports			
Net tons	688,982	641,987	570,381
Value ($'000)	38,316	40,768	61,179
Consumption of pig iron			
Steel furnaces	8,362,780	9,515,584	9,590,811
Iron foundries	293,287	348,907	339,037
Consumption of iron and steel scrap			
Steel furnaces	6.616,320	7,493,341	7,701,647
Iron foundries	1,111,915	1,366,625	1,365,541

Sources: Statistics Canada, *Primary Iron and Steel* (monthly); *Iron and Steel Mills* (annual) and *Iron Castings and Cast Iron Pipes and Fittings* (monthly).
[1] The capacity figures as of January 1 in each year take into account both new capacity and obsolete capacity anticipated for the year.
[2] Includes malleable iron.
* Included under "Foundry iron."
p Preliminary.

3.8 million tons.

Notwithstanding the buoyant domestic demand, the average capacity utilization was only about 82 per cent compared to the year before. This low factor was attributable to some of the new capacity not being available for production because of its coming on stream later in the year; raw material shortages; and a limited availability of hot metal due to heavy blast furnace rebuilding programs.

Although raw steel production increased by 1.8 per cent, pig iron production and consumption, at 10.4 and 9.6 million tons, respectively, increased only marginally over the year before. See Table 2. To provide the extra iron units for steelmaking, scrap consumption increased by 200,000 tons to 7.7 million tons and reduced iron consumption increased by 168,000 tons to 335,000 tons. While the bulk of pig iron in the form of hot metal is utilized by the steel producer to make steel, about 9 per cent is cast and shipped mainly to foundries. Shipments of such pig iron amounted to 951,000 tons of which 570,000 tons were exported.

Producer shipments of rolled steel in 1974 amounted to 11.4 million tons, up 4.6 per cent from 1973. See Tables 4 and 5. This increase was in line with the growth in real GNP, which was about 3.6 per cent for the year. Preliminary figures show that shipments were up for almost all groups, including 40 per cent for track material, 29 per cent for ingots and semis and 7 per cent each for galvanized and wire rods. However, for some of the large-tonnage items such as hot-rolled sheet and strip, hot-rolled bars and structural shapes, growth was only marginal. Lack of supplies rather than demand was at fault. For example, there was a loss in production of hot-rolled sheet and strip while Algoma's hot-strip mill was being relocated late in the year.

Rolled steel shipments to almost all the consuming groups were up from 1973. See Table 5. The situation for the transportation sector was mixed. While shipments to the shipbuilding, and the railroad car and locomotive manufacturing industries were up from the previous year, those to the automotive industry were down by 14 per cent. Notwithstanding an augmentation from the previous year in the production of trucks and trailers, the production of passenger automobiles decreased to the point where some plants were completely shutdown in the last month of the year to bring inventory in line with demand.

Shipments to the construction industry, the largest consumer of steel, were 1.9 million tons, or up 3.3 per cent which lagged considerably behind growth in producer shipments as a whole. Usually, the construction industry does not immediately feel the sudden downturn in the economy because of forward commitments.

The strong sectors of demand included the pipe and tube industry to which shipments were up by 16.6 per cent from 1973, metal stamping and pressing industry (up 13.3 per cent), wire and wire products industry (up 9.11 per cent) and the agricultural implement industry (up 8.0 per cent). The strong growth of shipments to the pipe and tube industry reflected the continuing burgeoning demand for energy in North America.

Trade and consumption

Imports were up by 53 per cent to 3.1 million tons to fill a shortfall in supplies that was caused by an excess of demand over the ability to produce. See Table 6. Apparent consumption of rolled steel increased over 1973 by 12.9 per cent to 13.1 million tons (17.2 million of crude steel, see Table 9) while shipments were up by only 4.6 per cent to 11.4 million tons. See Table 15. Exports at 1.435 million tons gained by only 5.4 per cent from 1973, notwithstanding a world-wide shortage of steel and the possibility of obtaining higher prices for foreign sales. In terms of crude steel equivalents the imbalance in trade favouring imports amounted to 2.16 million tons which represents a 158 per cent increase over 1973. See Table 9. In terms of value, the imbalance represents an exchange loss of $583 million or about $153 million in lost wages to Canadians. See Table 7.

A large increase in the exports of semis was recorded. See Table 6. To provide continuity of supply of flat-rolled products during the relocation of its 106-inch, hot-strip mill, Algoma shipped some 120,000 net tons of slabs for conversion into hot-rolled coils by a steel producer in the United States. Accordingly, this contributed to higher imports of hot-rolled sheet and strip which were returned for further processing and shipment.

The United States was Canada's most important trading partner. See Table 8. In 1974, imports from the United States of finished steel, steel castings, ingots, semis, forgings, pipe and wire amounted to 1.6 million tons, some 47 per cent of total imports. This compares with exports from Canada of 1.5 million tons or 75 per cent of total exports. While Japanese imports amounted to 874,000 tons, or 25 per cent of the total, exports to Japan remained negligible. The ECSC countries and Britain contributed 17 and 5 per cent of total imports, but exports from Canada to these countries were down sharply.

Investment and corporate developments

Capital and repair expenditures in 1974 for iron and steel mills amounted to $556 million compared with $459 million in 1973. See Table 1. Of the total, 53 per cent was spent on new buildings and equipment and the remainder on repairs to structures and machinery. The ratio of repair expenditure per ton of ingot steel produced was $17.54 a ton compared with $14.64 for 1973. With projects either under way or announced, capital expenditures should again increase in 1975.

The Steel Company of Canada, Limited (Stelco), the largest steel company in Canada, increased its expenditures in 1974 by 16 per cent to $135 million. Major facilities completed during the year were two

Table 3. Canada, crude steel production, shipments, trade and consumption, 1972-74

	1972	1973	1974p
		(net tons)	
Furnace capacity January 1[1]			
Steel ingot			
Basic open-hearth	5,380,000	5,830,000	4,125,000
Basic oxygen converter	6,690,000	6,730,000	9,950,000
Electric	2,961,600	2,977,800	3,865,800
Total	15,031,600	15,537,800	17,940,800
Steel castings	429,525	436,525	393,900
Total furnace capacity	15,461,125	15,974,325	18,334,700
Production			
Steel ingot			
Basic open-hearth	5,164,585	4,608,197	3,775,659
Basic oxygen	5,601,287	7,433,896	8,106,525
Electric	2,125,934	2,507,127	2,913,256
Total	12,891,806	14,549,220	14,795,440
Continuously cast in total	1,535,761	1,709,682	2,031,758
Steel castings[2]	181,067	206,159	221,838
Total steel production	13,072,873	14,755,379	15,017,278
Alloy steel in total	1,200,946	1,546,231	1,674,046
Shipments from plants			
Steel castings	174,027	191,617	208,292
Rolled steel products	9,829,866	10,935,708	11,439,226
of which steel ingots are	323,935	388,853	500,995
Total	10,003,893r	11,127,325r	11,647,518
		(000 net tons)	
Exports, equivalent steel ingots	1,824.6r	1,752.2r	1,812.9
Imports, equivalent steel ingots	2,730.5r	2,589.3r	3,974.0
Indicated consumption, equivalent steel ingots	13,978.8r	15,592.5r	17,178.4

Source: Statistics Canada.
[1] The capacity figures as of January 1 in each year take into account both new capacity and obsolete capacity anticipated for the year.
[2] Produced mainly from electric furnaces.
p Preliminary; r Revised.

electric steel plants — one at Edmonton, Alberta, and the other at Contrecoeur, Quebec — and a high-capacity spiral-weld mill at Welland, Ontario. The equipment brought on stream at its main Hilton Works in Hamilton was primarily designed to improve product quality, to increase efficiency and to meet environmental standards. Under construction during the year was a major new integrated steel plant at Nanticoke, Ontario, and reduction facilities at its Griffith iron mine in northwestern Ontario.

The new $26 million Edmonton steel furnace plant, with two furnaces of 75-ton capacity each and a continuous casting machine, is capable of producing 300,000 tons of steel billets a year. However, the net gain in annual capacity will be about 172,000 tons because the old plant which has a 128,000-ton capacity will be shut down. The installation of a $14.5 million, 80-ton electric furnace at Stelco's McMaster Works in Contrecoeur was completed in early 1974. The furnace will feed directly to a new continuous casting operation that can produce 175,000 tons of steel billets a year. Both the Edmonton and Contrecoeur operations will supplement their iron and steel scrap charge with reduced pellets from the new SL/RN reduction plant

Table 4. Producer shipments[1] of rolled steel[2] 1973-74

	(000 net tons)		
	1973	1974	% Growth
Ingots and semis	388.9	501.0	+ 28.8
Rails	302.0	317.0	+ 5.0
Wire rods	801.2	858.1	+ 6.6
Structural shapes	800.6	804.4	+ 0.5
Concrete reinforcing bar	757.4	772.1	+ 1.9
Other HR bars	1,049.0	1,073.1	+ 2.3
Track material	55.7	77.8	+ 39.7
Plate	1,345.7	1,412.7	+ 5.0
Hot rolled sheet & strip	2,469.4	2,504.1	+ 1.4
Cold finished bars	98.4	102.8	+ 4.5
Cold reduced sheet, strip, other, and coated	1,956.9	2,044.3	+ 4.5
Galvanized sheet and strip	910.6	971.8	+ 6.7
	10,935.7	11,439.2	+ 4.6
Alloy steel in total shipments	685.3	738.6	+ 7.8

Source: Statistics Canada, *Primary Iron and Steel* (monthly).

[1] Includes producer exports.

[2] Includes ingots and semis, but not steel castings; comprises both carbon and alloy steels.

being built at the company's Griffith Mine in northwestern Ontario.

In early 1974, Stelco completed the installation of a new $18 million spiralweld tube mill at its Page-Hersey Works near Welland, Ontario. The plant, capable of producing pipe from 30 to 60 inches in diameter, has the capacity to produce 700,000 tons a year of 56-inch pipe. Stelco previously could only make pipe up to 42 inches in diameter and, therefore, the new pipe mill will allow Stelco to compete in the market for large-diameter pipe that is expected to develop within the next few years to bring oil and gas from the Arctic to southern markets in Canada and the U.S.

Stelco continued construction of reduction facilities at its Griffith Mine in northwestern Ontario that was begun in 1973. The SL/RN process, developed by a consortium including Stelco, will convert a portion of the high-quality oxide pellets produced at the mine to a reduced product grading as high as 92 per cent iron. This product will be used as a supplement to the scrap charge in Stelco's new steelmaking plants at Contrecoeur and Edmonton. The plant's rated capacity is 400,000 tons a year and the expected cost is $35 million.

Stelco commenced development of the largest single project ever undertaken by a steel company in Canada. At Nanticoke on Lake Erie, 40 miles southwest of Hamilton, an integrated piant is to be built in several stages that will eventually cost $2 billion and add some 6 million tons of capacity by the late 1980s. The first phase, which will provide Stelco with an additional 1.3 million tons a year of steelmaking capacity by 1978, will cost some $430 million. Facilities scheduled to be constructed during the first phase will include: a blast furnace; a basic oxygen furnace shop; a double-strand continuous casting machine; and an 80-inch continuous hot-strip mill.

The Algoma Steel Corporation, Limited (Algoma) recorded the largest capital investment among steel companies in 1974 with expenditures of $138 million, nearly double that of the previous year. Construction began on a 5,000 ton-a-year blast furnace, which will supply, when completed in 1975, additional hot metal for its new steelmaking facilities installed in 1973. The company's effective steel capacity will then be raised from 2.8 million tons to 3.5 million tons. Construction of a 1,500 ton-a-day coke battery commenced in early 1974 and when also completed in 1975 will provide an adequate supply of coke so that the new blast furnace can then operate at its full rated capacity. With the additional coke supply, hot metal throughput will again increase and steel capacity will be raised further to 4.3 million tons.

Algoma had also under construction a 2-strand continuous slab caster that will provide slabs up to 12 inches thick and from 40 to 85 inches wide. Initial output is expected to be about 750,000 tons per annum. It will be on line with the 166-inch plate mill which can either produce plate or act as the roughing mill for the 106-inch hot-strip mill that was relocated downstream of the plate mill late in 1974. During the year, the wide-flange beam mill facilities were being expanded and modified and when these improvements are completed sometime in 1975, capacity to produce structural shapes will be increased by over 20 per cent.

Canadian Pacific Investments Limited acquired a majority interest in Algoma through the purchase of 2.5 million shares and of the 25 per cent interest held by the Mannesmann A.G. of West Germany.

Dominion Foundries and Steel, Limited (Dofasco) had capital expenditures of $88 million during 1974. It began construction during the year of a 5-strand, 72-inch tandem cold-rolling mill capable of rolling 5,000 feet a minute. It is estimated that the new mill will cost upwards of $50 million and, when completed in 1975, will increase Dofasco's cold-rolling capacity by 60,000 tons a month to a total of 180,000 tons a month. The company's No. 1 blast furnace, which was shut down in 1971, is being rebuilt at an estimated cost of $15 million and when it comes on stream sometime in 1975 it will increase Dofasco's pig-iron capacity by approximately 22 per cent or about 1,700 net tons a day.

Dofasco announced in early 1975 that construction will begin on a new $103 million steelmaking shop in Hamilton. This will be the first phase of the company's plans to double steelmaking and finishing capacity from the three-million-ton level to beyond six million tons a year. The first phase is scheduled for completion in the latter part of 1977 and will be capable of producing 1.25 million tons of crude steel a year.

As part of a $74 million modernization program begun in 1971, the Sydney Steel Corporation (Sysco) completed installation of a continuous slab-caster during the year.

Sidbec-Dosco had a large expansion under way in 1974 as part of its Phase II program which began in 1973. The program calls for the installation of two 150-ton electric furnaces that will raise steelmaking capacity by 700,000 tons a year to 1.58 million tons a year (1.3 million tons at Contrecoeur and 300,000 tons at Montreal); the building of a second reduction plant to increase total reduction capacity by 650,000 tons a year to one million tons a year; and the installation of new rolling mill facilities including a galvanizing line. The program will cost an estimated $185 million and when completed by 1978, Sidbec's raw steelmaking and rolling mill capacities will be in balance.

A major expansion program over the next two years is being planned by Interprovincial Steel and Pipe Corporation Ltd. (Ipsco) that will include the installation of a fifth steelmaking furnace to increase capacity

Table 5. Disposition of rolled steel products[1], 1973-74

	1973	1974	% Growth
		(net tons)	
Wholesalers, warehouses and steel service centres	1,556,067	1,662,246	+ 6.8
Automotive and aircraft	1,683,904	1,448,555	-14.0
Agricultural	211,453	228,378	+ 8.0
Contractors-building	765,609	781,771	+ 2.1
Construction-public and utility	45,743	44,378	- 3.0
Structural steel fabricators	1,027,944	1,073,060	+ 4.4
Containers	590,861	623,835	+ 5.6
Machinery and tools	340,129	363,570	+ 6.9
Wire, wire products and fasteners	795,593	867,717	+ 9.1
Natural resources and extractive industries	238,100	269,747	+13.3
Appliances and utensils	221,565	234,498	+ 5.8
Other metal stamping and pressing	635,459	722,501	+13.7
Railway operating	279,862	289,935	+ 3.6
Railroad cars and locomotives	130,924	173,380	+32.4
Shipbuilding	50,913	62,927	+23.6
Pipes and tubes	1,298,356	1,513,322	+16.6
Miscellaneous	72,797	107,926	+48.2
Total domestic shipments	9,945,279	10,427,746	+ 4.9
Producer exports[2]	990,429	1,011,480	+ 2.1
Total producer shipments	10,935,708	11,439,226	+ 4.6

Source: Statistics Canada, *Primary Iron and Steel* (monthly).
[1] Includes ingots and semis, but excludes steel castings, pipe and wire.
[2] Total rolled steel exports amounted to 1.361 and 1.435 million tons in 1973 and 1974, respectively.

Table 6. Canada, trade in steel by product, 1972-74

	Imports			Exports		
	1972	1973	1974p	1972	1973	1974p
			(000 net tons)			
1. Steel castings (incl. grinding balls)	11.5	19.6	15.8	22.5	25.5	26.8
2. Ingots	50.7	8.5	8.2	79.7	37.7	21.2
3. Semi-finished steel blooms, billets, slabs	217.5	86.8	49.7	49.8	98.7	240.0
4. Total (1+2+3)	279.7	114.9	73.7	152.0	161.9	288.0
5. Finished steel						
A) Hot-rolled						
Rails	8.5	13.6	30.7	72.0	123.2	143.3
Wire Rods	241.5	232.9	326.0	114.0	134.3	140.5
Structurals	322.9	428.5	655.0	168.2	121.8	123.1
Bars	217.1	239.1	492.1	85.8	76.7	73.3
Track Material	1.8	3.4	7.4	8.6	13.7	8.3
Plates	332.7	311.7	600.6	194.2	212.1	192.9
Sheet and Strip	433.4	349.4	496.6	263.2	188.5	155.9
Total hot-rolled	1,557.9	1,578.6	2,608.4	906.0	870.3	837.3
B) Cold-rolled						
Bars	17.4	22.7	35.8	10.6	9.9	17.5
Sheet and strip	160.3	143.6	145.7	119.1	86.7	34.9
Galvanized	51.1	37.4	62.4	105.1	98.3	77.8
Other[1]	100.4	123.0	150.9	147.1	159.3	206.7
Total Cold-rolled	329.2	326.7	394.8	381.9	354.2	336.9
6. Total finished steel (A+B)	1,887.1	1,905.3	3,003.2	1,287.9	1,224.5	1,174.2
7. Total rolled steel (2+3+6)	2,155.3	2,000.6	3,061.1	1,417.4	1,360.9	1,435.4
8. Total steel (4+6)	2,166.8	2,020.2	3,076.9	1,439.9	1,386.4	1,462.2
9. Total steel (raw steel equivalents*)	2,730.5	2,589.3	3,974.0	1,824.6	1,752.2	1,812.9
10. Fabricated steel products						
Steel forgings	13.0	11.2	11.0	19.9	38.7	42.2
Pipe	257.6	270.9	274.7	136.7	216.8	383.9
Wire	86.4	97.4	120.8	39.3	60.0	67.4
11. Total fabricated	357.0	379.5	406.5	195.9	315.5	493.5
12. Total castings, rolled steel and fabricated (8+11)	2,523.7	2,399.7	3,483.4	1,635.7	1,702.0	1,955.7

Source: Statistics Canada, *Exports and Imports by Commodities.*
* Calculation: finished steel (row 6) divided by 0.77 plus steel castings, ingots and semis (row 4).

from 600,000 to one million tons a year. To supply the iron units for this new plant, consideration is being given to participate in the financing of a direct-reduction plant. Also planned is the installation of cold-rolling and galvanizing facilities that were required in the last two years. In 1974, the company purchased the big-inch pipe mill in Calgary from Canadian Phoenix Steel & Pipe Ltd., and exercised its option to purchase a rolling mill which, when installed will convert its existing 4-high mill to a semi-continuous hot strip mill capable of rolling heavier and wider strip.

In April 1974, Ipsco sold treasury shares amounting to 938,400 to the government of Alberta, 135,200 to the government of Saskatchewan and 52,400 to Slater Steel Industries Limited to bring the share ownership of each to 20.1 per cent.

Table 7. Canada, value of trade in steel castings, ingots and rolled products, 1972-74

	Imports			Exports		
	1972	1973	1974p	1972	1973	1974p
	($ 000)					
Steel castings	6,963	16,122	12,778	9,268	10,132	12,792
Steel forgings	13,204	16,496	12,278	11,364	23,248	30,927
Steel ingots	3,991	1,090	3,358	8,306	5,252	3,540
Rolled products						
Hot-rolled	237,182	302,609	758,936	138,293	150,354	235,906
Cold-rolled and other	196,428	243,175	385,380	136,556	166,279	306,403
Total rolled	433,610	545,784	1,144,316	274,849	316,633	542,309
Total steel	457,768	579,492	1,172,730	303,787	355,265	589,568

Source: Statistics Canada, *Trade of Canada.*
Note: The values in this table relate to the tonnages shown in Table 6.
p Preliminary.

Table 8. Canada, trade in steel[1] by country, 1972-74

	Imports			Exports		
	1972	1973	1974p	1972	1973	1974p
	(000 net tons)					
United States	835.7	1,055.9	1,642.9	1,236.0	1,178.6	1,467.3
Britain	175.8	168.7	181.9	63.3	56.3	31.0
ECSC[2] countries	536.2	410.7	585.5	62.9	119.1	87.3
Other European[3]	162.7	141.5	164.9	59.5	39.3	32.3
Africa	6.0	4.6	7.4	3.9	10.7	49.7
Japan	775.1	601.7	873.6	0.2	9.7	0.04
Other Asian	1.6	3.2	15.1	34.2	52.9	37.2
Latin America	3.5	8.2	1.9	142.8	166.7	178.9
Middle East	—	—	—	12.8	57.3	56.0
Oceania	27.1	5.2	10.2	20.1	11.4	16.1
Total	2,523.7	2,399.7	3,483.4	1,635.7	1,702.0	1,955.8

Source: Statistics Canada, *Exports and Imports by Commodities* (monthly).
[1] Comprises steel castings, ingots, semis, finished steel, forgings, pipe and wire.
[2] European Coal and Steel Community (ECSC).
[3] Includes the U.S.S.R. and Satellites.
p Preliminary; — Nil.

The Atlas Steels Division of Rio Algom Mines Limited, Canada's largest producer of stainless and special steels, announced early in 1974 a $20 million program for a new melt shop at its Welland, Ontario, plant. The program, to be completed in late 1976, will replace the six furnaces now in use by two 60-ton and one 25-ton furnaces. A $2.5 million "baghouse" filtering system to clean effluents from the air will also be installed as well as a $1.5 million forging press and a third Sendzimir cold-rolling mill which will increase the cold-rolling capacity by 50 per cent. To improve the quality of the stainless steel produced at its Tracy Quebec plant, a $1.3 million oxygen degassing unit is being installed.

The Burlington Steel Division of Slater Steel Industries Limited had a $2 million furnace-rebuilding

Table 9. Canadian crude steel supply and demand, 1960-74

	Crude Steel Production	Imports[1]		Exports[1]		Indicated Consumption[2]	
		A[3]	B[4]	A[3]	B[4]	A	B
	(000 net tons)						
1960	5,790	1,167	1,353	936	994	6,021	6,149
1961	6,466	999	1,096	803	841	6,662	6,721
1962	7,173	824	1,046	936	990	7,061	7,229
1963	8,190	789	1,295	1,274	1,369	7,705	8,116
1964	9,128	1,621	2,135	1,362	1,485	9,387	9,778
1965	10,068	2,467	2,892	1,091	1,235	11,444	11,725
1966	10,020	1,637	2,096	1,004	1,290	10,653	10,826
1967	9,701	1,523	1,981	1,196	1,368	10,028	10,314
1968	11,198	1,436	1,884	1,605	2,079	11,029	11,003
1969	10,048	2,377	2,935	1,101	1,423	11,324	11,560
1970	12,346	1,680	2,189	1,869	2,299	12,157	12,236
1971	12,170	2,503	3,136	1,789	2,130	12,884	13,176
1972	13,073	2,731	3,355	1,825	2,126	13,979	14,302
1973	14,755	2,589	3,162	1,752	2,203	15,592	15,714
1974p	15,017	3,974	4,715	1,813	2,506	17,178	17,226

Source: Statistics Canada.
[1] From *Trade of Canada,* adjusted to equivalent crude steel by Mineral Development Sector.
[2] Production plus imports, less exports with no account taken for stocks. The two columns of figures depend on the two sets of values for trade.
[3] Calculation: total finished steel (all hot- and cold-rolled steel but excluding wire, steel, pipe and tube) divided by 0.77 plus steel castings, ingots and semis.
[4] Calculation: total, hot- and cold-rolled steel, steel forgings, wire, and steel pipe and tube divided by 0.75 plus steel castings, piston ring castings, ingots, semis, and ingot moulds and stools.
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program under way during the year to increase melting capacity from 254,000 tons a year to 320,000 tons a year. Finishing capacity was expanded in 1974 from 175,000 to 250-275,000 tons a year through modification of its bar mill and other improvements.

The Manitoba Rolling Mills Division of Dominion Bridge Company, Limited (owned 43 1/2 per cent by Algoma) at Selkirk, Manitoba, had under construction in 1974 a new $28.5 million merchant bar-rolling mill. The mill, to be completed at the end of 1975, will replace two obsolete smaller mills.

The Ivaco Rolling Mills Division of Industrial Fasteners Ltd. (Ivaco Industries Limited) at L'Orignal, Ontario, had under construction during the year an electric furnace and continuous casting facilities. When completed in about May 1975, the new installation is expected to provide some 275,000 tons of billets a year when it reaches full capacity. Currently, the company purchases billets to supply its rod mill which has a capacity of 225,000 tons a year. The rods are distributed to the company's other manufacturing operations.

QSP Ltd. had a steel plant under construction during 1974. Original plans called for the construction of a 145,000-ton-a-year steel mill with continuous casting and rolling facilities at a cost of $22.5 million. In mid-1974, the company announced that it will spend an additional $6 million to double the steelmaking capacity to 300,000 tons through the installation of a second electric arc furnace and a continuous casting machine. Although production started in mid-1974, capacity production is not expected until 1975. The company announced in 1974 a $50 million contract to supply semi-finished and finished steel products over a three-year period to Thyssen Steel of Canada Limited.

Lake Ontario Steel Company Limited at Whitby, Ontario, completed in 1974 a $6.5 million program to increase efficiency and raise steelmaking capacity by some 10 per cent to about 350,000 tons a year. The company is considering a $35 million expansion that will double steelmaking and rolling mill facilities, but the implementation of such a plan is dependent, according to the company, on obtaining sufficient iron units, other than scrap, such as reduced pellets.

Western Canada Steel Limited, a wholly-owned subsidiary of Cominco Ltd., had under construction at its Vancouver facilities a $3.5 million furnace program to raise melting capacity from 110,000 to 200,000 tons. More efficient roughing mills, to prepare ingots for

Table 10. Consumption of iron ore[1] by process, 1973-74

	(000 net tons)				
1974	Direct Shipping	Con-centrate	Pellets	Mine Sinter[2]	Total
A. Sinter plant[3]	221	28	156	54	458
B. Direct reduction[4]	100^e	—	318^e	—	418^e
C. Blast furnace	454	—	11,056	2,314	13,824
D. Steelmaking furnace					
Open-hearth	65	—	13	—	78
Oxygen	—	—	53	—	53
Electric	—	—	36	—	36
Grand total	840	28	11,632	2,368	14,868
1973					
A. Sinter plant[3]	331	48	245	54	678
B. Direct reduction[4]	—	—	231	—	231
C. Blast furnace	565	—	11,199	2,212	13,976
D. Steelmaking furnace					
Open-hearth	51	—	86	—	137
Oxygen	—	—	41	—	41
Electric	4	—	5	—	9
Grand total	951	48	11,807	2,266	15,072

[1] Excludes the consumption of 1,949,000 and 1,887,000 tons of ilmenite ore in 1973 and 1974 for the production of pig iron and titania slag at Quebec Iron and Titanium Corporation.
[2] Production from siderite ore at Wawa by The Algoma Steel Corporation, Limited.
[3] Ore that is too fine to be charged directly to blast furnace is screened out and sintered.
[4] Iron ore is reduced at the Sidbec-Dosco Limited reduction plant. Reduced iron ore along with scrap is then charged to the electric furnace for melting and refining.
^{e} Estimated; — Nil.

rolling, will also be installed. Melting capacity at its Calgary, Alberta, plant will also be doubled to 100,000 tons by 1975 when the melting equipment that is being replaced at its Vancouver plant, is installed.

World review 1974

Many countries produced record outputs of steel in 1974 giving a world total of 778 million tons against 764 million tons in 1973. See Table 11. However, the overall increase of 1.6 per cent masked a sharp downturn in world steel markets that began about mid-year. This recessionary period became more pronounced at year's end and by the end of the first quarter in 1975, the situation reached serious proportions. A turn-around in steel markets is not expected before the last quarter of 1975 or possibly 1976.

The U.S.S.R. regained first position as the world's largest steelmaker in 1974 when production increased by 3.3 per cent to 149 million tons. While the United States fell to second position when output decreased by 3.6 per cent to 145 million tons, Japan maintained its strong third position with 129 million tons, an increase of 5.8 per cent. All members of the EEC except Britain recorded gains in production and total output was up 3.8 per cent to 172 million. West Germany with production of 59 million tons had the largest gain while British production fell 13.7 per cent to 24.8 million tons.

Steel prices

Under the pressure of an expanding demand, and because of a steep rise in production costs, mainly for raw materials, see Table 12, and wages, steel prices in Canada rose much more sharply in 1974 than in the previous year. There were two major general price increases during the year — one in January and the other on May 15 — as well as three other price increases which were applicable for only certain products.

With a general increase in January 1974, prices rose by as much as 10 per cent over the full range of products in less than a year. Steel prices fob plant for the first quarter of 1974 stood at $181 a ton for galvanized; $176 a ton for cold rolled; $164 a ton for structurals (Algoma price); $157 a ton for plate; $169 a ton for merchant bars, and $141 a ton for hot-rolled sheet and coil.

New price increases followed quickly after those of

Table 11. World production of crude steel, 1973-74

	1973	1974p
	(000 net tons)	
North America, total	170,745	166,168
Canada	14,755	15,017
Mexico	5,191	5,657
United States	150,799	145,494
South America, total	12,839	13,609
Western Europe, total	194,240	202,461
Belgium and Luxembourg	23,640	24,990
France	27,849	29,774
West Germany	54,587	58,679
Italy	23,143	26,303
Netherlands	6,199	6,430
Denmark	495	590
Britain	29,375	24,806
Irish Republic	128	123
Total EEC	165,416	171,695
Other Western Europe	28,824	30,766
Eastern Europe, total	198,989	205,773
Czechoslovakia	14,504	15,069
Poland	15,495	15,862
U.S.S.R.	144,403	149,142
Other	24,587	25,700
Africa and Middle East, total	7,319	7,502
Far East, total	171,122	171,860
China	26,455	28,660
India	7,613	7,679
Japan	131,530	129,128
Other	5,524	6,393
Australia and other Oceania	8,487	8,612
World, total	763,741	775,985

Sources: Statistics Canada, Statistisches Bundesamt, and others.
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January. Prices for hot- and cold-rolled steel sheet and strip increased by an average of 7.8 per cent in March and steel reinforcing bars by about 7 per cent in April. Further price increases amounting to about 12 per cent by the major steel companies in May finally prompted the formation of a royal commission* to determine if the price increases would result in excessive profit margins. The companies then maintained that not only were the price increases justified but that further increases could be expected during the remainder of the year to offset increased costs. Accordingly, the price for certain products rose again in June and September and, as discussed below, towards the end of the year in December.

Of tremendous importance to the steel industry was the timely release in October 1974 of the Steel Profits Enquiry Report which "cleared" the steel industry of all inferences of profiteering either through price increases or the withholding of steel inventories. Furthermore, the report showed that the price increases, from 1973 to 1974, were justified in that they were related to increases in the cost of raw materials and labour. From 1973 to 1974, the three major steel producers experienced cost increases for raw materials ranging from 58 to 74 per cent. Typical prices as they stood in October 1974 were $201 a ton for plate, $176 a ton for hot-rolled sheet, $200 a ton for cold-rolled sheet, and $281 a ton for galvanized. As Table 13 indicates, fob prices producing mill were considerably lower than either U.S. or West German prices.

To cover increased costs for coal following a major wage settlement in the U.S. coal industry in October, Stelco announced price increases for some one third of its products. They amounted to $24.60 a ton or 12.3 per cent on cold-rolled sheet and strip; $21.80 a ton or 12.2 per cent on hot-rolled sheet and strip; and $29.80 a ton, or 11.1 per cent on galvanized sheet.

A decrease in scrap prices in the last quarter of 1974 would have probably lead to a moderation in the price of steel in 1975. However, with a large wage settlement expected by the steel industry in August, an increase in the price of iron ore, and further increases in the cost of energy, steel prices should rise again in 1975, but at a reduced rate.

In the United States, some marginal price increases were obtained for certain steel products, but with the removal of all price controls in April, prices began to rise sharply and by October they had increased by as much as 43 per cent. As expected, with increase in coal prices to reflect a huge wage settlement in the U.S. coal industry, steel prices again rose in December for some products. At year-end, U.S. prices in terms of Canadian dollars averaged about 20 per cent higher than Canadian prices for similar products. See Table 13.

In the EEC, the average basic list prices for the main rolled products increased in the period from January 1974 to March 1974 by about 20 per cent in Germany; 33 per cent in France; 36 per cent in the Netherlands; 40 per cent in Luxembourg; 50 per cent in Italy and 66 per cent in Belgium. Further price increases were recorded after March 1974 and prices in Canadian dollars per net ton ranged from $221 for hot-rolled bars to $239 for plate and $283 for galvanized. See Table 13. These prices were generally higher than U.S. prices and on average were about 25 per cent higher than Canadian prices.

Japan's export prices were somewhat higher than the base prices of the EEC during 1973 and the early

* The commission, headed by Justice W.Z. Estey, published its report, *Steel Profits Enquiry*, in October, 1974.

Table 12. The Canadian steel industry, increased costs for raw materials, 1974/1973

	Dofasco	Stelco	Algoma
	% Sept. 1974/1973 Ave.	% Aug.1974/1973 Ave.	% Oct.1974/1973 Ave.
Iron ore and pellets	36	33	30
Coal[1]	92	122	108
Scrap[2]	112	105	Does not purchase scrap
Zinc	71	62	Does not make galvanized
Ingot moulds	40	62	Does not make galvanized
Alloy additions	40	62	37
Tin	98	75	Does not make tinned sheet
Fuel oil	125	72	101
Natural gas	125	67	78
Reagents	125	70	78
All raw materials and fuels	58	74	59

Source: Royal Commission Report, Steel Profits Enquiry, October 1974.
[1] Percentage increases do not take into consideration increased coal costs in December 1974 that resulted from a 40 per cent wage settlement in the U.S. coal industry.
[2] Percentage increases would be reduced at year-end 1974 because of a reduction in prices.

Table 13. Comparison of Canadian, U.S. and West German prices[1]

Product	Stelco, Hamilton, Ont.	Pittsburgh	Inland Steel, Chicago	ATH, Duisburg–Hamborn
	(Dec. increases in brackets)	($/net ton)		
Plate	201	227	227	239
Structural steel	199	216	..	223
Bars, hot-rolled	299	232	240	221
Bars, reinforcing	203	215	..	257
Sheets, hot-rolled	176 (21.80)	220	220	245
Sheets, cold-rolled	200 (24.60)	260	260	269
Sheets, galvanized	281 (29.80)	281	367	283
Strip, cold-rolled	240	323	..	..
Pipe, standard	595	753	..	..

Sources: Steel Profits Enquiry report, October 1974, page 38, and Skillings' *Mining Review*, December 14, 1974.
[1] fob producing mill for selected steel products, October 1974.
[2] Algoma quotation fob Sault Ste. Marie.
.. Not available or not applicable.

part of 1974. However, its domestic prices were anywhere from $67 to $100 less than those for its exports.* The ability of Japan to increase its exports is evidence of Japan's outstanding cost competitiveness.

*Source: Nomura Weekly Economic and Financial Report (No. 1420, May 13, 1974).

Since the advent of the natural resources crisis in 1973, it has been generally conceded that Japan's advantages in the procurement of raw materials have been largely negated. However, the large disparity between Japan and its competitors, in terms of labour costs per unit of output, has remained relatively unchanged because of further enlargement in the scale of operations and rationalization of existing facilities.

Table 14. Capital expenditures of selected large Canadian companies in 1974 and plans for 1975

	Actual for 1973	Estimated for 1974	Planned for 1975	% Change current $	1975/1974 1973 $
			(Millions of Dollars)		
Manufacturing companies	1,626.2	2,502.3	3,468.5	38.6	26.7
Mining companies	578.0	452.1	528.8	17.0	12.4
Oil and gas companies	955.9	1,460.4	2,086.9	42.9	30.7
Electric utilities	2,402.2	22,612.5	3,502.6	34.1	11.0
Transportation and communication cos.[1]	2,163.3	2,612.7	3,057.3	17.0	8.5
Other companies[2]	575.7	628.5	714.4	13.7	7.5
Total	8,301.3	10,268.5	13,358.5	30.1	16.6

[1] Includes oil and gas pipelines and storage.
[2] Includes financial institutions, retailers, real estate developers.

Outlook and forecast

The demand picture for steel in 1975 appears clouded. Government and private sector economic forecasts puts the growth of real Gross National Product at anywhere from 1.2 to 3.9 per cent. This low growth rate predicted is justifiable in view of the below-average performance of the economy in 1974, the downturn in some key economic sectors towards the end of the year and the poor outlook for the world economy that could have a negative effect on Canadian exports. Growth in the fourth quarter was only about 0.5 per cent, bringing the average economic growth for the year to 3.6 per cent, which compares with 6.8 per cent the year previous. Particular areas of concern for 1975 include housing, exports and consumer spending on durable goods.

The prime weaknesses in the economy are expected to be related to consumer spending on durable goods such as automobiles. In the United States, the automotive industry curtailed production in the last quarter of 1974 to bring supplies in line with demand because of reduced sales. Canadian sales also slumped, and this slowdown is expected to continue well into 1975 because of the U.S. situation and because consumer debt is currently at high levels which may deter spending on anything but essentials.

Consumer spending for appliances is also expected to be reduced because of a reduction in house completions. Starts on new residential construction were at an annual rate of 204,000 in the third quarter, but fell to an average of only 170,000 in October and November. Measures to stimulate housing may not have much immediate effect and therefore no turn-around situation in housing construction is expected until the latter half of 1975.

Following a year of exceptional strength, a buoyant outlook for capital investment plans for 1975 was reported by some 220 large corporate enterprises surveyed by the Department of Industry, Trade and Commerce in October. See Table 14. Capital expenditures planned for 1975 amounts to $13.4 billion which represents a rise over 1974 of 30.1 per cent in current dollars or 16.6 per cent in constant 1973 dollars. Although these figures are based on a sample of only large corporations they do reflect the overall trend in the disposition of capital dollars. This particular trend reflects increases in expenditures for non-residential construction and for machinery and equipment.

Steel demand is also expected to be particularly strong for the manufacture of such transportation equipment as rail cars, ships, trucks and trailers. Major orders placed for railway rolling stock in 1973–74 will extend through 1975. Public works projects will continue to demand large tonnages of steel and the manufacture of farm equipment will remain strong.

In the trade sector, exports are not expected to be affected by a downturn in the U.S. economy since the low level of exports in 1974 of about 1.4 million tons had already discounted this factor. Imports, on the other hand, are expected to decline in 1975 because the Canadian steel industry will be able to supply steel at lower prices. This downward trend may not be so pronounced as expected, however, if some foreign producers faced with low demand in its own markets, cut prices to capture certain markets, such as Canada, where demand is still comparatively higher.

Taking into account all the factors in the foregoing, consumption of finished steel is expected to be down by 5.1 per cent to 12.4 million tons in 1975 as real GNP decreases from 1974 by about 2 percentage points to about 2.6 per cent. See Table 15. However, producer shipments will probably be up by 3.2 per cent to replenish depleted stocks at warehouses and steel service centres; to displace some imports which will become non-competitive because of their higher price; and to supply a slight increase in exports. Although

Table 15. Rolled steel supply and demand, 1972-74, forecast to 1975

	Producer or Mill Shipments[1]	Exports[2]	Imports[3]	Apparent Rolled Steel Consumption[4]	Raw Steel Production[5]
			(million net tons)		
1972	9.830	1.417	2.155	10.568	13.073
1973	10.936	1.361	2.001	11.576	14.755
1974	11.439	1.435	3.061	13.065	15.017
Increase 1974/1973	+4.6%	+5.4%	+53.0%	+12.9%	+ 1.8%
			Forecast		
1975	11.8	1.6	2.2	12.4	15.9
Increase 1975/1974	+3.2%	+11.5%	–28.1%	–5.1%	+5.9%

Source: 1972-74 statistics from *Canada Primary Iron and Steel* (monthly) and *Trade of Canada*.

[1] Comprises domestic shipments + producer exports. A portion of domestic shipments to warehouses and steel service centres is also exported. Excludes steel castings amounting to 174,000 tons in 1972, 192,000 tons in 1973 and 208,000 tons in 1974.

[2] Total exports includes producer exports plus exports from warehouses and steel service centres. Excludes exports of pipe, wire, forgings and castings.

[3] Excludes imports of pipe, wire, forgings, and castings.

[4] Excludes apparent consumption of steel castings amounting to 164,000 tons in 1972, 188,000 tons in 1973 and 197,000 tons in 1974.

[5] Includes production of steel castings amounting to 181,067 tons in 1972, 206,159 tons in 1973 and 221,838 tons in 1974.

raw steel production will not nearly attain maximum capacity because of restrictive factors relating principally to hot metal supply, the steel industry is expected to produce as much as 15.9 million tons of raw steel, up 5.9 per cent from 1974. An increase over and above that for producer shipments is predicated upon a considerable build up in stocks by the steel companies, a normal practice in any downturn in the economy. Any new production record will depend, among other factors, on the successful negotiations of a steel industry-wide labour contract in mid-year.

For 1980, 1985 and 2000, crude steel consumption is forecast to 20.8, 25.6 and 35.5 million tons, while production is expected to reach 19.1, 23.2 and 33.0 million tons. See Table 16. These forecasts are based on forces already at work and assume that no fundamental changes in the approach by industry or government will occur.

The compound growth rates for rolled steel production and consumption to 1985 are calculated to be 4.2 and 4.7 per cent, respectively. See Table 16. The predicted growth rate for production, below the growth rate for consumption, anticipates a growth rate of 9.3 per cent for imports compared with a rate of 9.0 for exports.

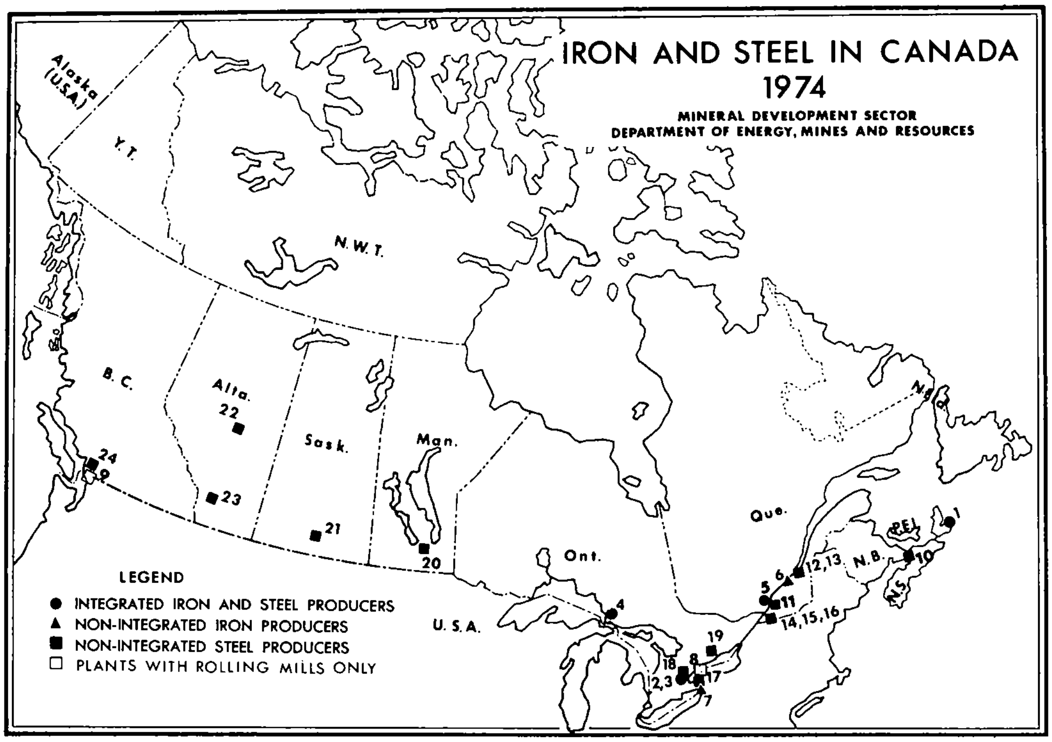
The analysis shows that, while both exports and imports of rolled steel are expected to increase over time, the trade imbalance will reflect higher imports with the difference amounting to 0.8, 1.4, 1.9 million tons in 1975, 1980 and 1985, respectively. It seems certain that Canadian exports will be constrained by political decisions in importing countries (mainly U.S.A.) and while it is expected that producer shipments will remain as forecast, this will mean there must be a transfer of potential exports to domestic shipments thereby reducing import requirements. Until the numerous factors of supply and demand and other considerations can be identified, the foregoing figures are accepted as indicated.

Table 16. Forecast of rolled steel and steel castings supply and demand

	1975[1]	1980	1985	2000 High	2000 Low
	(000 net tons)				
A. Rolled steel and semis and ingots					
Domestic shipments	10,084	12,395	14,844	23,047	22,400
Plus producer exports	1,629	2,237	2,940	5,624	2,900
Total producer shipments	11,713	14,632	17,784	28,671	25,300
Imports	2,445	3,539	4,834	9,921	4,800
Apparent consumption	12,534	15,934	19,678	32,968	27,200
B. Raw steel equivalents[2]					
Domestic shipments	13,012	16,007	19,188	29,841	29,001
Plus producer exports	2,070	2,860	3,773	7,259	3,721
Total producer shipments	15,082	18,867	22,961	37,100	32,722
Imports	3,115	4,536	6,218	12,824	6,174
Apparent consumption	16,127	20,543	25,406	42,665	35,175
C. Steel castings					
Domestic shipments	178	201	225	295	295
Plus producer exports	27	27	27	27	27
Total producer shipments	205	228	252	322	322
Imports	15	15	15	15	15
Apparent consumption	193	216	240	310	310
D. Total raw steel (B + C)					
Domestic shipments	13,190	16,208	19,413	30,136	29,296
Plus producer exports	2,097	2,887	3,800	7,286	3,748
Total producer shipments	15,287	19,095	23,213	37,422	33,044
Imports	3,130	4,551	6,233	12,839	6,189
Apparent consumption	16,320	20,759	25,646	42,975	35,485

[1] Trend values may differ somewhat from those values predicted for 1975 in the text because the former does not take into account the cyclical nature of supply and demand.

[2] Derived by adding forecast tonnages of ingots and semis to tonnages of rolled steel adjusted to raw steel equivalents by dividing by a factor of 0.77 (i.e., one ton of raw steel is equivalent to 0.77 ton of rolled steel).



Integrated iron and steel producers
(numbers refer to numbers on map)

1. Sydney Steel Corporation (Sydney)
2. Dominion Foundries and Steel, Limited (Hamilton)
3. The Steel Company of Canada, Limited (Hamilton)
4. The Algoma Steel Corporation, Limited (Sault Ste. Marie)
5. Sidbec-Dosco Limited (Contrecoeur)*

Nonintegrated iron producers

6. Quebec Iron and Titanium Corporation (Sorel)
7. Canadian Furnace Division of Algoma (Port Colborne)

Principal nonintegrated steel producers

8. The Steel Company of Canada, Limited (Contrecoeur)
9. QSP Ltd. (Montreal) – to start in 1975
10. Ivaco Industries Limited** (L'Orignal, Ontario)
11. Enheat Ltd. (Amherst)
12. Atlas Steels Division of Rio Algom Mines Limited (Tracy)
13. Colt Industries (Canada) Ltd. (Sorel)
14. Canadian Steel Foundries Division of Hawker Siddeley Canada Ltd. (Montreal)
15. Canadian Steel Wheel Limited (Montreal)
16. Sidbec-Dosco Limited (Montreal)
17. Atlas Steels (Welland)
18. Burlington Steel Division of Slater Steel Industries Limited (Hamilton)
19. Lake Ontario Steel Company Limited (Whitby)
20. Manitoba Rolling Mills Division of Dominion Bridge Company, Limited (Selkirk)
21. Interprovincial Steel and Pipe Corporation Ltd. (Regina)
22. Premier Works of Stelco (Edmonton)
23. Western Canada Steel Limited (Calgary)
24. Western Canada Steel Limited (Vancouver)

* Iron ore reduction facilities installed in 1973.
** Rolling facilities only. Electric furnace plant to be installed in 1975.

Lead

G.R. PEELING

In 1974, Canada's production of lead, based on lead recovered from domestic ores and concentrates exported was estimated at 335,985 short tons*, a decrease of 10.9 per cent from 1973. Although production decreased in 1974, higher metal prices raised the value of Canadian lead production by $17.4 million to $139.1 million, 14.3 per cent above that of 1973. The decrease in production resulted mainly from labour strikes and lockouts which resulted in substantially lower output in British Columbia, Yukon Territory and the Northwest Territories. The total mine output of lead, expressed as the lead content of domestic ores and concentrates produced was estimated at 346,253 tons compared with 427,441 tons in 1973. One new mine commenced production and one mine reopened in 1974. Sturgeon Lake Mines Limited, in northern Ontario, officially began operations in late October 1974. It is an open-pit operation with a milling rate of 1,200 tons a day (tpd). Nigadoo River Mines Limited dewatered its mine in New Brunswick in 1973 and recommenced production in February 1974.

Primary refined lead output totalled 139,398 tons compared with 206,012 tons in 1973. The large decrease in refined lead output was principally a result of a four-month labour strike at Cominco Ltd.'s Trail, British Columbia smelter. About 65,000 tons of refined lead production was lost at the Cominco plant which has a capacity of 210,000 tons annually. The only other producer of refined lead in Canada is the Brunswick Mining and Smelting Corporation Limited which has a refinery of 70,000 tons annual capacity at Belledune, New Brunswick. The Belledune plant operated normally throughout the year except for a maintenance shutdown in October when the $588,000 second-stage conversion to a lead smelter was completed. Smelter production was unaffected by 15 days of rotating walk-outs and a two-month lockout of employees at the mine operations of the company as 28,000 tons of stockpile lead concentrates were processed by the refinery.

About 28 per cent of the lead ores and concentrates produced in western and northern Canada were treated by Cominco Ltd., at Trail, British Columbia; about 70 per cent were treated in Japan and the remainder in the United States. About 20 per cent of the lead concentrates produced in eastern Canada, excluding those of Brunswick Mining and Smelting Corporation smelted at Belledune, were treated at Trail, with 30 per cent going to the United States and the remainder being shipped to West Germany, United Kingdom and Italy.

Exports of lead contained in ores and concentrates decreased to 213,946 tons in 1974 from 222,407 tons in 1973. The major portion of these exports, 124,376 tons or 58.1 per cent, was shipped to Japan. Most of the remainder was shipped to smelters in the United States, West Germany, Brazil and Britain. Metal exports in 1974 were 79,050 tons, a substantial decrease from the 125,281 tons exported in 1973. The decrease in exports of refined metal mainly reflected the loss in production of Cominco Ltd. at Trail because of the four-month strike. Britain and the United States, combined, continued to be the major customers, accounting for 78 per cent of the total. Imports of refined metal were 19,149 tons in 1974 compared to 7,253 in 1973.

Canadian consumption of primary and secondary lead metal in 1974 was 78,375 tons and 37,695 tons respectively, compared with 76,130 tons and 42,952 tons respectively in 1973.

The federal government introduced standards to control the amount of lead that can be introduced into the air by secondary lead smelters and lead-smelting operations. The new standards will take effect October 1, 1975. The standards will limit to 0.046 gram a cubic metre the quantity of the lead-bearing matter emitted by blast furnaces, cupolas or reverberatory furnaces. Penalties up to $200,000 can be incurred for each violation of the act. Following the initial tests, further tests will take place at least once a year. The Department of the Environment reported that there will be little additional expenditure required by industry to meet the standards. There will be 30 control officers to monitor emissions, and all plants that are affected by the standards will be tested within two months after the standards take effect. New operations will be tested within 90 days of commencing operations.

Canadian developments

Newfoundland. American Smelting and Refining Company, Buchans Unit, remained the only lead producer in Newfoundland. The company operates a 1,250-ton-a-day concentrator at Buchans in the central part of the province and produces lead, zinc and copper concentrates. Production in 1974 was substantially higher than in 1973 (a six-month strike severely curtailed produc-

* The short ton (2,000 pounds) is used throughout unless otherwise stated.

Table 1. Canada, lead production trade and consumption, 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Production				
All forms[1]				
Yukon Territory	117,761	38,013,324	106,305	44,010,000
Northwest Territories	99,943	32,261,787	91,732	37,977,000
British Columbia	93,577	30,206,564	61,714	25,550,000
New Brunswick	44,011	14,206,916	50,290	20,825,000
Newfoundland	8,444	2,725,614	13,715	5,679,000
Ontario	11,496	3,710,910	10,898	4,513,000
Quebec	1,351	436,268	1,069	443,000
Nova Scotia	292	94,122	217	90,000
Manitoba	64	20,561	45	18,000
Total	376,939	121,676,066	335,985	139,105,000
Mine output[2]	427,441		346,253	
Refined production[3]	206,012		139,398	
Exports				
Lead contained in ores				
Concentrates				
Japan	143,670	32,548,000	124,376	39,805,000
United States	23,078	3,529,000	27,367	5,694,000
West Germany	25,699	4,357,000	20,534	4,244,000
Brazil	7,820	1,326,000	11,890	3,552,000
Britain	—	—	10,640	2,751,000
Belgium and Luxembourg	14,515	3,286,000	5,156	1,787,000
France	—	—	5,569	1,469,000
Spain	—	—	3,947	1,162,000
Italy	6,839	668,000	4,467	924,000
Other countries	786	286,000	—	—
Total	222,407	46,000,000	213,946	61,388,000
Lead, pigs, blocks and shot				
Britain	54,708	18,702,000	30,908	14,719,000
United States	52,898	15,022,000	30,803	11,928,000
India	5,051	1,436,000	3,779	1,692,000
Italy	1,824	520,000	4,062	1,141,000
Netherlands	3,460	1,210,000	2,131	1,077,000
Pakistan	1,300	362,000	2,856	939,000
Argentina	—	—	1,429	400,000
West Germany	2,041	783,000	552	254,000
Japan	827	298,000	600	246,000
Brazil	220	88,000	385	142,000
Norway	220	64,000	220	104,000
Denmark	471	139,000	373	104,000
Other countries	2,261	664,000	952	308,000
Total	125,281	39,288,000	79,050	33,054,000
Lead and alloy scrap (gross weight)				
Netherlands	13,786	3,687,000	3,208	1,335,000
Italy	123	40,000	1,678	512,000
United States	387	100,000	933	274,000
South Korea	3,368	609,000	1,468	212,000
West Germany	738	171,000	648	193,000
Denmark	870	324,000	278	159,000
Brazil	534	167,000	697	125,000

Table 1 (concl'd)

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Exports (cont'd)				
South Africa	—	—	337	108,000
Other countries	4,128	1,099,000	1,013	219,000
Total	23,934	6,197,000	10,260	3,137,000
Lead fabricated materials not elsewhere specified				
United States	9,592	3,683,000	8,947	5,215,000
Turkey	—	—	878	1,156,000
Italy	—	—	165	46,000
Britain	161	134,000	60	20,000
Other countries	242	86,000	34	26,000
Total	9,995	3,903,000	10,084	6,463,000
Imports				
Lead pigs blocks and shot	4,011	1,288,000	12,519	6,169,000
Lead oxide; litharge red lead mineral orange	1,995	751,000	5,856	3,297,000
Lead fabricated materials not elsewhere specified	1,247	599,000	774	647,000
Total	7,253	2,638,000	19,149	10,113,000

	1973			1974p		
	Primary	Secondary[4]	Total	Primary	Secondary[4]	Total
	(short tons)					
Consumption						
Lead used for, or in the production of						
antimonial lead	1,457	27,129	28,586	1,295	21,366	22,661
battery and battery oxides	31,371	3,011	34,382	35,388	5,417	40,805
cable covering	2,903	—	2,903	3,126	—	3,126
chemical uses: white lead, red lead, litharge, tetraethyl lead, etc.	26,708	3,891	31,122	23,022	4,700	28,230
copper alloys; brass, bronze, etc.	427	96		418	90	
lead alloys						
solders	5,028	1,263	6,291	4,755	1,701	6,456
others (including babbitt, type metals etc.)	524	..	524	1,564	..	1,564
semifinished products: pipe, sheet, traps, bends, blocks for caulking, ammunition, foil, collapsible tubes, etc.	4,556	371	4,927	5,383	362	5,745
Other	3,156	7,191	10,347	3,424	4,059	7,483
Total, all categories	76,130	42,952	119,082	78,375	37,695	116,070

Source: Statistics Canada.
[1] Lead content of base bullion produced from domestic primary materials (concentrates, slags, residues, etc.) plus estimated recoverable lead in domestic ores and concentrates exported,
[2] Lead content of domestic ores and concentrates produced.
[3] Primary refined lead from all sources.
[4] Includes all remelt scrap lead and scrap lead used to make antimonial lead.
p Preliminary; — Nil; .. Not available.

tion in 1973). Ore reserves are adequate to support production for about another six years and, in addition, large tonnages in low-grade disseminated zones are being evaluated for possible future production.

Nova Scotia. Dresser Minerals Division of Dresser Industries, Inc. at Walton, Nova Scotia shipped a small amount of concentrates accumulated from previous operations. The mine continues to operate as a barite producer. Imperial Oil Limited continued diamond drilling on the Gays River lead-zinc property of Cuvier Mines Ltd. The property is about 35 miles northeast of Halifax. The mineralization occurs in a dolomitic reef complex and the mineralized zones vary in thickness from 1 to 100 feet with the average thickness of ore-grade material about 21 feet. Early in 1975, Imperial Oil decided to drive a decline to the ore zone.

New Brunswick. Total mine output of lead increased in the province in 1974. Nigadoo River Mines Limited, closed since January 1972, recommenced production early in 1974 and plans are underway to expand the mill rate capacity from 1,000 to 1,200 tons a day. The Anthonian zone, with a minimum 500,000 tons of ore grading slightly higher than mine average, is currently being developed for production. Heath Steele Mines Limited is increasing its milling capacity from 3,100 to 4,000 tons a day by late 1975 and is also sinking a new production shaft (No. 5) which will extend to a depth of 3,000 feet and incorporate a new underground crusher station. The expansion program will cost about $11 million. The Brunswick Mining and Smelting Corporation showed increased production at its No. 6 and No. 12 mines in 1974 even though the company experienced over two months of lost production because of a labour dispute which ended with the signing of a new contract on June 25. The $48 million expansion program at the company's No. 12 mine, which will raise capacity at the mine from an initial 6,350 to 11,000 tons a day by 1979, was well underway with $10 million having been spent or committed by year-end. The capacity of the No. 12 mill was increased to 10,000 tons a day in 1974. At year-end, lead-zinc reserves (combined No. 6 and No. 12) are estimated at 92.5 million tons grading 13 per cent combined lead and zinc; in addition, copper reserves in a separate orebody are estimated at 14.1 million tons grading 1.11 per cent copper.

Exploration activity was high in the province in 1974, centring on the Bathurst region Canex Placer Limited investigated the long-dormant Restigouche property (3.3 million tons of 10.5 per cent lead-zinc, 2.5 ozs. silver a ton), and the Kennco-Murray property (23.6 million tons of 0.4 per cent copper, 3 per cent lead-zinc). Anaconda Canada Limited continued exploration and development work on its 50 million ton lead-zinc orebody at the site where the company mined a small copper orebody during 1973 and part of 1974. It grades about 4 per cent zinc, 2 per cent lead, 0.5 per cent copper and 1 oz. silver a ton. Texasgulf Inc., owner of the Half-Mile Lake property, purchased the adjoining Bay Copper Mines Limited property. The common boundary deposit contains an estimated 6.8 million tons grading 6.5 per cent zinc and 2.5 per cent lead. Texasgulf will spend a minimum of $100,000 a year for the next five years to explore the property and Bay Copper will retain a 10 per cent carried interest in the combined properties. Chester Mines Limited, Key Anacon Mines Limited, Teck Corporation Limited and others are continuing exploration work in the province. The major barrier to production is the problem of beneficiating the fine-grained ore. If concentrating problems are overcome, the Bathurst region could become one of the largest producing base metal camps in Canada.

Quebec. There was only a small amount of lead produced in Quebec in 1974, mostly as a byproduct from copper-zinc and zinc producers. Noranda Mines Limited is studying the feasibility of reopening in 1975 the former zinc-lead-silver producer of Manitou-Barvue Mines Limited, located in Barraute Township. Reserves, at the time of closure, at the 600-foot level are given as 4 million tons, grading 3.5 per cent zinc and 1.2 ozs. a ton silver.

Ontario. Mine production of lead decreased slightly in 1974 from the 1973 level (10,899 tons, down from 11,496 tons). Ecstall Mining Limited produced less lead in 1974 as a result of mining lower grade ore. The company embarked on a $95 million expansion program which will increase mining from 3.6 to 5.0 million tons a year. Consequently, lead output should marginally increase in the next few years. In October, Sturgeon Lake Mines Limited began operations. It is an open-pit operation with an initial milling rate of 800 tons a day which will be increased to 1,200 tons a day early in 1975. Ore reserves are 2,110,600 tons grading 2.98 per cent copper, 10.64 per cent zinc, 1.47 per cent lead, 6.14 ozs. a ton silver and 0.02 oz. a ton gold. The mine is owned 67 per cent by Falconbridge Copper Limited and 33 per cent by NBU Mines Limited.

British Columbia. There was a significant decrease in mine output of lead in 1974 in British Columbia. Output decreased by about 30 per cent as a result of the four-month strike at Cominco's mines, manpower shortages and the mining of lower grade ore. Cominco's Sullivan Mine at Kimberley and the H.B. mine at Salmo were shut down by the strike from July 1 to November 1, 1974. The new labour agreements will expire on April 30, 1977. As a result of the lengthy closure, full mine production was not restored until the end of the year.

Consolidated Columbia River Mines Ltd. stated that it will attempt to arrange financing to reopen its 55 per cent held Ruth-Vermont Mine near Golden. Production at this mine resumed in September 1973 but the mine was shut down at the end of December 1973. Reserves are estimated at 291,384 tons grading 5.65 per cent zinc, 4.78 per cent lead and 6.62 ozs. of silver a ton.

Northair Mines Ltd. plans to put into production by

Table 2. Canada, lead, production, trade and consumption, 1964-74

	Production		Exports				
	All Forms[1]	Refined[2]	In Ores and Concentrates	Refined	Total	Imports Refined[3]	Consumption[4]
				(tons)			
1964	203,717	151,372	80,357	95,867	176,224	73	82,736
1965	291,807	186,484	106,964	129,065	236,029	71	90,168
1966	300,622	184,871	112,934	106,468	219,402	626	96,683
1967	317,963	193,235	126,194	132,320	258,514	438	93,953
1968	340,176	202,100	143,853	138,781	282,634	152	94,660
1969	318,632	187,143	140,175	107,090	247,265	131	105,915
1970	389,185	204,630	165,912	152,821	318,733	2,199	93,437
1971	405,510	185,554	214,354	136,884	351,238	4,632	92,961
1972	369,425	205,978	178,576	140,841	319,417	11,520	116,234
1973	376,939	206,012	222,407	125,281	347,688	4,011	119,082
1974ᵖ	335,985	139,398	213,946	79,050	292,996	12,519	116,070

Source: Statistics Canada.
[1] Lead content of base bullion produced from domestic primary materials (concentrates, slags, residues, etc.) plus the estimated recoverable lead in domestic ores and concentrates exported. [2] Primary refined lead from all sources. [3] Lead in pigs and blocks. [4] Consumption of lead, primary and secondary in origin.
ᵖ Preliminary.

late 1975 its property in the Brandywine area, 70 miles north of Vancouver. The milling rate will be 300 tons a day. The ore veins grade between 2.4 per cent and 6.6 per cent zinc, and 1.4 per cent and 5.4 per cent lead, with substantial values in gold and silver. In the same area of British Columbia, Van Silver Explorations Ltd. plans to commence production at 200 tons a day by September 1975 at its gold-silver-lead-zinc property.

Exploration activity in British Columbia decreased significantly from levels of previous years. All indications point to a continuing low level of activity in 1975.

Yukon Territory. There were two producers of lead in the Yukon in 1974 and both showed production decreases. Cyprus Anvil Mining Corporation, which operates the Faro #1 mine, mined a lower grade of ore in 1974 and also lost production as a result of a 33-day work stoppage during May and June. The merger between Dynasty Explorations Limited and Anvil Mining Corporation Limited, agreed upon in March 1974, is being delayed by a United States' Internal Revenue Service ruling. The company is currently operating under the name of Cyprus Anvil Mining Corporation on an interim basis. Output at United Keno Hill Mines Limited was down in 1974 because of a shortage of skilled labour.

Exploration activity remained high in 1974, with exploration expenditures estimated at $11 million. The most important discovery made was the lead-zinc-silver discovery of Kerr Addison Mines Limited (60 per cent) and Aex Minerals Corporation (40 per cent) in the Vangorda Creek area. The mineralized zone is reported to have a length of about 8,000 feet and a width between 1,000 feet and 1,400 feet with the zone still open down dip. The thickness of the ore varies from a few feet to 205 feet. Grades of significant intersections range from 5 to 10 per cent zinc, 3 to 6 per cent lead, and 1.0 to 2.5 ozs. of silver a ton. Hudson Bay Mining and Smelting Co., Limited holds the Tom deposit at McMillan Pass. Reserves are estimated as 8.6 million tons grading 8.4 per cent zinc, 8.1 per cent lead and 2.75 oz. of silver a ton. Work is continuing as the deposit has not been fully outlined and the potential for more ore is excellent. Exploration interest remained high in the Bonnet Plume-Goz Creek area during 1974 and exploration of the lead-zinc deposits in this area will continue in 1975. Other exploration camps in the Mackenzie Fold Belt are at Arctic Red River, Godlin Lake and Summit Lake. The numerous discoveries of lead-zinc deposits in the Selwyn, Anvil and Mackenzie areas bodes well for making the feasibility of a lead and/or zinc smelter in the Yukon Territory a more reasonable consideration in the future.

Northwest Territories. Pine Point Mines Limited continued to be the only lead producer in the Territories in 1974. Production levels were only slightly lower than those of 1973 even though there was a four-month strike at Cominco's Trail, B.C. smelter where about 70 per cent of Pine Points' concentrates are treated. Pine Point Mines purchased the Conwest Exploration Company Limited "408 orebody", located four miles west of the Pine Point concentrator for $3.5 million. The indicated reserves are 1.4 million tons, grading 3.4 per cent lead and 9.6 per cent zinc. The

Table 3. Location of new or expanded smelter capacity

Expected start-up year		Increase in capacity
		(metric tons a year)
1975	India, Tundoo, expansion of a pyrometallurgical plant with capacity of 2,000	4,000
	Japan, Kosaka, new smelter and electrolytic refinery	30,000
	Mexico, Monterrey, expansion of existing plant with capacity of 120,000	60,000
	Morocco, Oued-el-Heimer, new smelter and refinery	35,000
1976	India, Vizag (Andhra Pradesh), new pyrometallurgical plant	10,000
	Spain, Linares, new plant replaces old plant with a capacity of 18,000	40,000
1977	Morocco, Fonderie Centrale, a new plant	40,000
	Spain, Huclua, new plant	20,000
1978	Peru, new plant	100,000

Source: International Lead and Zinc Study Group Monthly Bulletin, various publications.

orebody is being worked into Pine Point's mining program and will be opened up as an open-pit operation sometime in the next three years.

On June 18, 1974, the Honourable Jean Chrétien, the Minister of Indian Affairs and Northern Development, announced that the federal government would invest $16.7 million towards the opening of the lead-zinc mine of Mineral Resources International Limited (MRI) on Baffin Island. The property, in which Ecstall Mining Limited has a 35 per cent carried interest, will be operated by a new company to be named Nanisivik Mines Ltd. Nanisivik will be owned 59.5 per cent by MRI, 18 per cent by the federal government and 11.25 per cent each by Metallgesellschaft AG of Germany and Billiton N.V. of Holland. The orebody is estimated to contain 6.9 million tons grading 14.1 per cent zinc, 1.4 per cent lead and 1.77 ozs. of silver a ton. Start up is expected by late 1976 or early 1977 at an initial milling rate of 1,500 tons a day. Construction of surface facilities and underground development is continuing on schedule.

Arvik Mines Ltd., owned by Cominco 75 per cent and Bankeno Mines Limited 25 per cent, has a 25-million-ton orebody grading 18.4 per cent combined lead-zinc (about a 1 to 4 ratio), on Little Cornwallis Island northwest of Resolute. A decision to bring the property into production may be made in 1975.

In the Hackett River area, Cominco Ltd. continued its diamond drilling program on the high-grade lead-zinc-silver property of Bathurst Norsemines Ltd. Drill-indicated reserves are in the order of 20 million tons in three zones, the Main A, East Cleaver Lake and Boot Lake zones.

Encouraging results were achieved in the exploration program of the lead-zinc deposit at H Lake (a joint venture of Conwest Exploration Company Limited, Brascan Resources Limited and Yava Mines Limited). Further work is planned for 1975.

Table 4. Noncommunist world mine production of lead, 1973-74

	1973	1974p
	(tons)	
United States	628,090	696,760
Australia	435,410	396,170
Canada	427,470	331,240
Peru	219,360	212,740
Mexico	185,190	189,600
Yugoslavia	116,290	124,120
Sweden	81,680	80,140
Morocco	99,210	78,260
Spain	70,440	68,450
Republic of South Africa	69,780	59,970
Ireland	63,930	55,120
Japan	58,310	48,720
Argentina	38,580	40,790
West Germany	44,090	40,010
Tunisia	36,710	37,480
Zambia	27,890	26,460
Brazil	26,460	26,460
Other countries	239,110	269,510
Total	2,868,000	2,782,000[1]

Source: International Lead and Zinc Study Group, Monthly Bulletin, May 1975.
[1] Total includes estimates for those countries for which figures are not available.
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United States imports and stockpiles

The United States government stockpile at the beginning of 1974 had a lead inventory of 829,053 tons of which 763,953 tons was excess to stockpile requirements. In April 1973 the stockpile objective for lead was reduced from 530,000 tons to 65,100 tons. Because of commitments of 226,004 tons in 1974 by the General Services Administration (GSA), the lead inventory

Table 5. Noncommunist world production[1] of refined lead, 1973-74

	1973	1974p
	(tons)	
United States	1,212,750	1,185,080
West Germany	330,690	351,960
United Kingdom	292,220	294,200
Japan	251,320	248,020
Australia	243,500	246,700
Mexico	195,110	225,970
France	205,470	197,860
Canada	206,020	141,430
Belgium	107,700	104,390
Yugoslavia	107,360	102,510
Spain	132,170	101,190
Peru	91,820	93,030
Republic of South Africa	70,110	70,880
Brazil	65,040	69,450
Italy	51,480	61,840
Argentina	52,910	60,190
Sweden	46,740	45,080
Other countries	192,660	182,210
Total	3,855,070	3,781,990

Source: International Lead and Zinc Study Group, Monthly Bulletin, May 1974.

[1] Total production by smelters or refineries, of refined pig lead, plus the lead content of antimonial lead — including production on toll in the reporting country — regardless of the type of source material, i.e., whether ores, concentrates, lead bullion, lead alloys, mattes, residues, slags or scrap. Remelted pig lead and remelted antimonial lead are excluded.

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was reduced to 603,049 tons by the end of 1974, thus leaving 537,959 tons of lead as excess to requirements. Of this excess, 73,000 tons is authorized for sale.

United States imports of lead metal and lead in ores and concentrates totalled 214,596 tons in 1974, a sharp decrease from the 280,583 tons in 1973. The bulk of the decrease was accounted for by lower shipments from Canada. The United States also exported 61,983 tons of lead materials, excluding scrap, in 1974, compared with 66,576 tons in 1973. As a result of the finding by the United States Tariff Commission on January 10, 1974, that imports of lead from Australia and Canada were likely to injure the domestic lead industry, Australian producers stopped shipping lead to the United States and imports from Canada were sharply reduced and dumping duties were avoided by pricing Canadian lead in the United States at 3 cents a pound above the Canadian level. A group of major United States' consumers, concerned about future supplies, requested revocation of the ruling but the Commission refused to reverse its findings. Although imports were lower in 1974, the continued high level of domestic consumption (about 1.53 million tons in 1974 compared to the record high of 1.54 million tons in 1973), was satisfied by an 11 per cent increase in mine output and increased sales from the GSA stockpile.

In March 1973, a lead-zinc flexible tariff bill (HR 6437) was introduced in the United States Congress. The bill would allow quantities of lead ores and concentrates and lead and zinc metals to enter the United States at the present low-duty rates. Excessive imports would be subject to higher duties. The quantities of lead and zinc metals allowed at low rates would be increased as consumption of lead and zinc metals increased in the U.S. The bill died in Congress at the end of 1974 as no action had been taken on it.

The Environment Protection Agency (EPA) in the United States has proposed new standards of performance for primary lead smelters. The particulate standard is: no gases shall be discharged which contain particulate matter in excess of 50 milligrams a cubic meter at standard conditions. The sulphur dioxide standard is: no gases shall be discharged which contain sulphur dioxide in excess of 0.65 per cent by volume. The standard for visible emission is: no visible emissions shall be discharged which exhibit 20 per cent or greater opacity, except for two minutes in any one hour. The EPA figures show that the cost for control measures designed to meet the standards are expected to add between 0.7 and 0.8 of a cent (United States) a pound of lead produced.

World production and consumption

Noncommunist world mine production of lead, according to statistics published by the International Lead and Zinc Study Group, was 2.82 million tons in 1974, a small decrease from the 2.86 million tons in 1973. Canada showed the largest decrease in mine output, mainly a result of labour difficulties. The United States retained its position as the world's leading producer followed by Australia and Canada. Noncommunist world production of primary and secondary refined lead totalled an estimated 3.95 million tons, a decrease of 46,000 tons from 1973.

Mine production of lead in the United States increased 11 per cent over the 1973 level and was the highest level since 1926. Production in the State of Missouri increased and accounted for 85 per cent of United States mine production of lead. Refined lead produced at primary refineries in the United States totalled 669,204 tons in 1974, compared to 674,516 tons in 1973.

Consumption of lead in the noncommunist world in 1974 increased slightly to 4.08 million tons from 3.91 million tons in 1973. The United States remained the largest consumer, using 1.53 million tons (39 per cent of total world consumption), some 8,000 tons less than in 1973. Net exports to socialist countries was 74,000 metric tons compared with 35,000 metric tons in 1973.

As the world economy slowed down in the second

Table 6. Principal lead (mine) producers in Canada, 1974 and (1973)

Company and Location	Mill Capacity	Grade of Ore Milled (principal metals) Lead	Zinc	Copper	Silver	Ore Milled	Lead in Concentrates and Direct Shipping Ores	Remarks
	(tons ore/day)	(%)	(%)	(%)	(troy oz/ton)	(tons)	(tons)	
Newfoundland								
American Smelting and Refining Company (Buchans Unit), Buchans	1,250 (1,250)	6.28 (6.48)	11.24 (11.51)	1.01 (1.00)	3.25 (3.45)	264,000 (124,000)	15,459 (7,633)	Reserves sufficient to operate at current level of production for about six years.
Nova Scotia								
Dresser Minerals Division of Dresser Industries, Inc., Walton	— (140)	— (6.68)	— (1.00)	— (0.27)	— (5.43)	— (8,178)	217 (547)	Mill closed in 1973, final shipment of concentrate in June 1974.
New Brunswick								
Brunswick Mining and Smelting Corporation Limited, Bathurst	10,000 (9,850)	2.96 (2.81)	6.70 (7.00)	0.38 (0.34)	2.32 (2.53)	2,607,965 (3,288,081)	49,395 (66,415)	Production lost due to 15 days of rotating walkouts and a 2-month lockout. $48 million expansion program well underway.
Heath Steele Mines, Limited, Newcastle	3,100 (3,100)	1.72 (1.64)	4.39 (4.90)	1.04 (0.86)	1.98 (1.83)	1,085,495 (1,077,816)	12,016 (11,026)	Sinking new shaft and expanding mill capacity to 4,000 tpd by end of 1975.
Nigadoo River Mines Limited, Bathurst	1,000 (—)	2.53 (—)	2.74 (—)	0.33 (—)	3.79 (—)	205,691 (—)	4,406 (—)	Reopened early 1974. Expanding mill capacity to 1,200 tons a day.
Quebec								
Manitou-Barvue Mines Limited Golden Manitou Mine, Val d'Or	1,600 (1,500)	0.35 (0.30)	2.20 (2.07)	 (. .)	2.58 (. .)	225,303 (197,312)	521 (400)	Mine exploration continuing.
Sullivan Mining Group Ltd., Clinton Mine, Stratford Centre	Custom treated	0.48 —	2.50 —	2.64 —	0.95 —	52,656 —	92.5 —	Started production from "O zone" early in 1974. Ore shipped to central concentrator.

Table 6 (cont'd)

Company and Location	Mill Capacity	Grade of Ore Milled (principal metals) Lead	Zinc	Copper	Silver	Ore Milled	Lead in Concentrates and Direct Shipping Ores	Remarks
	(tons ore/day)	(%)	(%)	(%)	(troy oz/ton)	(tons)	(tons)	
Cupra Division, Stratford Centre	1,500 (1,500)	0.59 (0.66)	4.78 (4.88)	2.49 (2.41)	1.11 (1.09)	87,474 (89,814)	320 (327)	Operates central concentrator for all three mines.
D'Estrie Mining Company Ltd., Stratford Centre	Custom treated	0.61 (0.74)	2.72 (3.16)	2.56 (2.74)	1.16 (1.23)	162,081 (130,265)	611 (541)	
Ontario								
Ecstall Mining Limited, Kidd Creek mine, Timmins	10,000 (10,000)	0.30 (0.33)	9.20 (9.78)	1.75 (1.61)	3.17 (3.72)	3,723,865 (3,609,657)	4,198 (8,080)	Expanding underground mine and mill capacity.
Mattabi Mines Limited, Sturgeon Lake	3,000 (3,000)	0.91 (1.06)	8.81 (11.37)	0.91 (1.10)	4.31 (5.31)	1,138,965 (1,111,765)	4,355 (4,757)	Preparations to mine the underground part of the orebody are continuing.
Noranda Mines Limited, Geco Division, Manitouwadge	5,000 (5,000)	0.20 (0.20)	4.72 (4.53)	1.72 (1.70)	1.56 (1.63)	1,826,704 (1,463,585)	1,731 (1,664)	Continuing exploration of main orebody. Started construction of waste water treatment plant.
Sturgeon Lake Mines Limited, Sturgeon Lake	1,200 (—)	1.09 (—)	7.59 (—)	2.05 (—)	.. (—)	82,592 (—)	71 (—)	Production commenced September 1974.
Willroy Mines Limited Manitouwadge	1,700 (1,700)	0.23 (0.17)	3.06 (2.74)	0.42 (0.98)	1.37 (1.42)	394,154 (430,486)	165 (386)	Reserves sufficient for 2 more years of operation at current level.
Manitoba-Saskatchewan								
Hudson Bay Mining and Smelting Co., Limited, Flin Flon	8,500 (8,500)	Central mill at Flin Flon treats the ore from all the company's mines					47.5* (163)	Only Chisel Lake and Ghost Lake mines have appreciable lead content.
Chisel Lake Mine, Snow Lake, Manitoba		0.51 (0.39)	10.06 (9.40)	0.96 (0.60)	0.99 (0.95)	169,789 (182,447)		

Table 6 (cont'd)

Company and Location	Mill Capacity	Grade of Ore Milled (principal metals): Lead	Zinc	Copper	Silver	Ore Milled	Lead in Concentrates and Direct Shipping Ores	Remarks
	(tons ore/day)	(%)	(%)	(%)	(troy oz/ton)	(tons)	(tons)	
Ghost Lake Mine, Snow Lake, Manitoba		0.45 (0.31)	11.49 (11.71)	2.03 (1.90)	1.72 (1.20)	68,662 (99,719)		
British Columbia								
Cominco Ltd., Sullivan Mine, Kimberley	10,000 (10,000)	4.11 (4.97)	4.49 (4.99)	. . (. .)	1.41 (1.76)	1,416,489 (2,214,415)	51,837 (99,235)	A four-month strike drastically reduced production. Studying conversion from tracked to trackless mining.
H.B. Mine, Salmo	1,200 (1,250)	1.1 (1.6)	3.7 (4.2)	— (—)	. . (. .)	256,121 (351,682)	2,235 (2,838)	A four-month strike reduced production.
Kam-Kotia-Burkam Joint Venture Silmonac Mine, Sandon	140 (150)	. . (5.36)	. . (5.41)	. .	. . (14.45)	. . (13,949)	397 (717)	Underground exploration continuing.
Reeves MacDonald Mines Limited, Annex Mine, Remac	1,000 (1,000)	1.18 (1.67)	3.84 (4.49)	— (—)	0.64 (1.06)	195,565 (191,438)	1,681 (2,822)	Mine will close on May 1, 1975.
Teck Corporation Limited, Beaverdell Mine, Beaverdell	110 (115)	0.41 (0.62)	0.52 (0.61)	0.003 (0.003)	9.06 (12.36)	37,184 (37,202)	154** (229)	Approximately two years. of reserves left.
Western Mines Limited, Buttle Lake, Vancouver Is.	1,100 (1,000)	1.48 (1.28)	8.05 (8.29)	1.28 (1.39)	4.52 (4.60)	297,290 (354,420)	4,060 (4,270)	Shortage of skilled labour hampered production in 1974.
Yukon Territory								
Cyprus Anvil Mining Corporation Faro #1, Faro	10,000 (8,000)	4.51 (4.88)	5.60 (6.37)	— (—)	. . (. .)	2,925,000 (2,899,145)	103,135 (119,306)	A 33-day work stoppage resulted in decreased production.

Table 6 (concl'd)

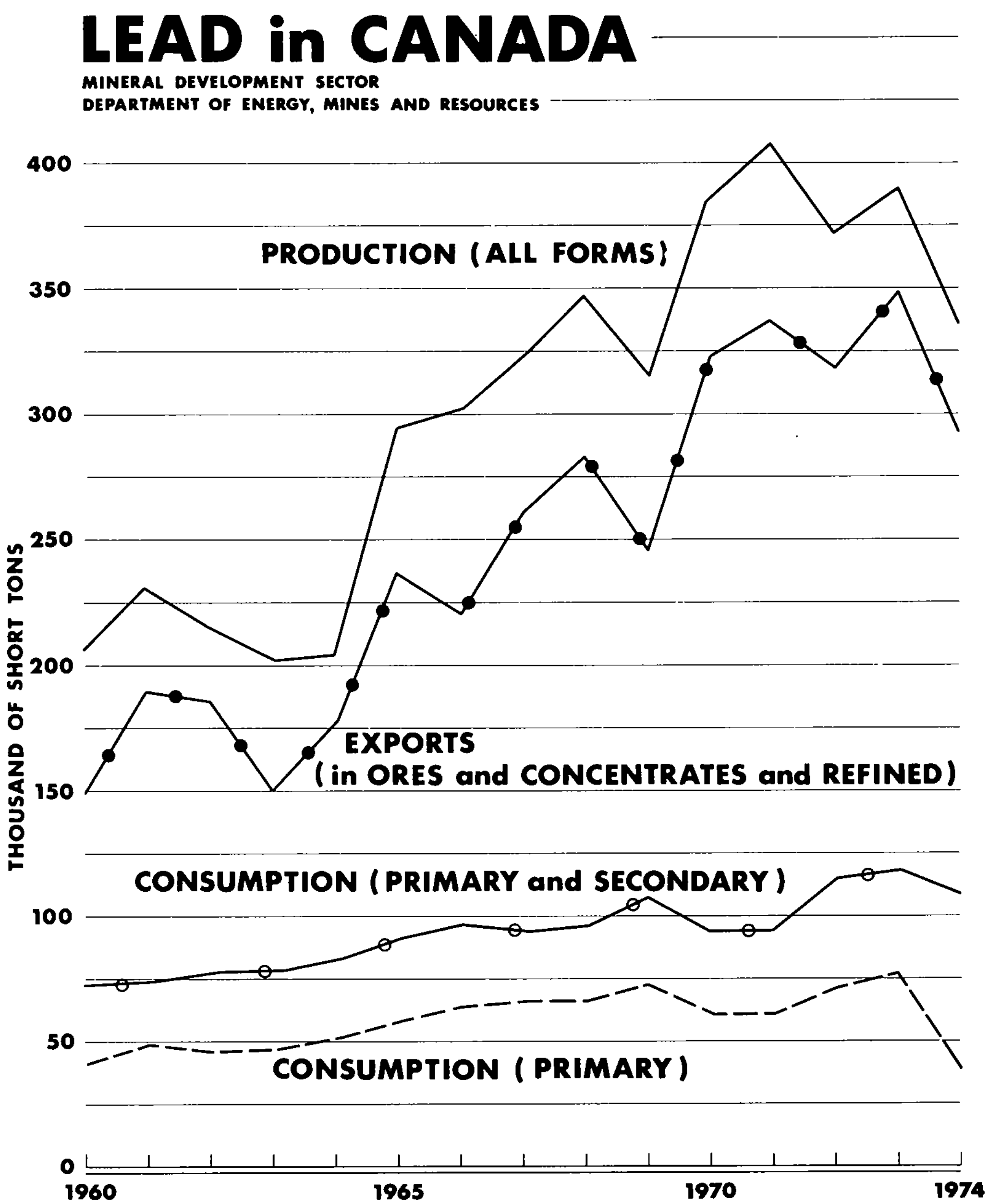
Company and Location	Mill Capacity	Grade of Ore Milled (principal metals) Lead	Zinc	Copper	Silver	Ore Milled	Lead in Concentrates and Direct Shipping Ores	Remarks
	(tons ore/day)	(%)	(%)	(%)	(troy oz/ton)	(tons)	(tons)	
United Keno Hill Mines Limited, Elsa, Husky, No Cash, Townsite Mines, Mayo District	255 (550)	4.22 (4.00)	1.15 (1.00)	— (—)	37.73 (34.62)	93,232 (94,819)	3,368 (3,631)	Resumed production at the Keno mine and are developing the Shamrock mine.
Northwest Territories								
Pine Point Mines Limited, Pine Point	11,000 (11,000)	2.58 (2.9)	5.28 (6.01)	— (—)	.. (..)	4,135,380 (3,896,357)	100,883 (105,706)	Purchased Conwest "408" orebody.

* Lead content of lead concentrates only.
** Lead content of lead concentrates and jig.
.. Not available.
— Nil.
( ) 1973 data.

half of 1974, producers' stocks of lead increased rapidly, particularly in the last quarter.

No new primary smelters began production in 1974. New smelters or expansions that are planned to commence operations in the period from 1975 to 1978 are listed in Table 3.

In 1974, five new mines started production; one in each of Canada, India, Japan, Morocco and Yugoslavia. These new mines will add a total of 80,000 tons of lead annually to world producing capacity.



Outlook

Canada's mine production of lead in 1975 is forecast to be about 360,000 tons, an increase of 14,000 tons from the 1974 level, but still 67,000 tons less than the amount produced in 1973. During the next upturn in the economy, particularly in the automotive and construction sectors, Canada's mine output could rise to or surpass the 1973 level of 427,441 tons. Canada's refined production of lead metal is expected to rise from the abnormally low strike-induced level of 1974 by 21,000 tons to 160,000 tons in 1975. This is still 46,000 tons below the 1973 output of 206,012 tons.

For 1975, the International Lead and Zinc Study Group (ILZSG) forecast lead mine production to rise by about 220,000 tons to 3,045,000 tons and lead metal production to rise by 200,000 tons to 4,125,000 tons. Lead metal consumption is forecast by the ILZSG to rise by only 26,000 tons to 3,993,000 tons. If net exports to socialist countries remain at about 40,000 tons in 1975, supplies would exceed demand by about 95,000 tons according to the ILZSG figures. These figures were released by the ILZSG late in 1974 and since that time the world economy has slumped dramatically, with little prospect of recovery before late 1975 or early 1976. Consequently, a more restrained view of world production and consumption must be taken. It is likely that decreases will occur in 1975. World mine production of lead is expected to decrease by 200,000 tons to 2,625,000 tons; metal production to decrease by about 400,000 tons to 3,525,000 tons in 1975; and consumption to decline by 500,000 tons to 3,467,000 tons. Even with the above decreases in production and consumption, an oversupply of 40,000 to 80,000 tons is likely, depending on exports to socialist countries and releases from the United States government stockpile by the GSA.

The major uses of lead are in the manufacture of batteries and in the form of lead additives to gasoline. In 1974, over 1.2 million tons of lead were used in the manufacture of batteries throughout the noncommunist world. While battery life has increased (from an average of 3 years in the 1960s to 4 years currently), and the weight of lead per battery has decreased, the consumption of lead for batteries is growing faster than total lead consumption. If the present trend continues, batteries could account for over 50 per cent of the total refined lead consumed by 1980. The future for the metal still appears to be its use in lead-acid batteries, not only for original installation and replacement batteries in the growing output of gasoline-powered vehicles but also as the power source in the accelerated development of battery-powered vehicles. When battery manufacturers are able to meet the challenges of making major improvements in the power-to-weight ratios in batteries and efficient fast recharging an unprecedented growth in the consumption of battery lead for passenger vehicles can be expected.

According to a study conducted by the Lead Industries Association, 70 per cent of the 23.5 million internal combustion engine vehicles in service in the United States are in a category which would allow replacement by battery-powered vehicles. The use of battery-powered vehicles has the greatest potential for increasing lead usage in the next 10 years, but it is believed that most of this increase will occur in the 1980s. Antiknock additives have grown strongly in recent years but, in 1974, consumption declined to 8 per cent of world consumption of lead and 16 per cent of consumption of lead in the United States (down from 12 per cent and 20 per cent respectively in 1973). This application of lead appears to have reached its peak and is expected to decline from its current consumption level.

Lead in gasoline

In 1973, the United States' Environmental Protection Agency (EPA) announced regulations for the phasedown of lead in gasoline. The regulations starting from a level of 1.7 grams of lead per U.S. gallon in 1975, would limit the content to 0.5 gram by 1979. The phasedown regulations were based on alleged endangerment of public health. Ethyl Corporation, joined by other manufacturers of tetraethyl (TEL) and tetramethyl (TML) lead, filed suite against the EPA. In December, the Washington, D.C. Federal Court of Appeals ruled in favour of the companies and in the written decision which was made public in January 1975 stated "that evidence did not support the (EPA) Administrator's findings that auto emissions contributed significantly to blood lead levels in adults and children and that the issuance of regulations was arbitrary and capricious". The EPA appealed the decision and in March 1975 the court granted a rehearing of the case and vacated the earlier decision. The rehearing is set for May 30, 1975, but whichever way the court decides it will likely take a Supreme Court ruling to resolve the issue. If the final decision is in favour of the EPA regulations the use of lead in gasoline could decrease by 70 per cent by 1980 (about 250,000 tons of lead were used in gasoline as antiknock additives in 1974 in the United States).

Also, on the environmental front, the Clean Air Act of 1970 originally required that by 1975, automotive emissions of hydrocarbons and carbon monoxide be reduced to about 10 per cent of their 1971 level and that by 1976, the oxides of nitrogen be reduced to about 10 per cent of their 1971 level. These regulations, after a series of appeals by automobile manufacturers, have been delayed until 1977, and the EPA has proposed freezing auto emission standards until 1981. The fate of the platinum catalytic converter, the principal means of achieving the emission standards, hangs in the balance. Recent tests by the EPA show that sulphate emissions from the catalytic converters may be more harmful than the emissions that the converter was designed to reduce. Most 1975 automobiles are equipped with catalytic converters which must use only no-lead gasoline to be effective. The EPA promulgated regulations in 1973 requiring the availability of at least one grade of no-lead gasoline by July 1, 1974 at each gasoline station that pumps 200,000 gallons or more a month. At year-end, no-lead gasoline was commanding only 3 to 4 per cent of the United States' market. This whole emission and catalytic converter problem is further compounded by the fact that to produce the equivalent power from no-lead gasoline up to 7 per cent more petroleum is used in the manufacturing process. With the present emphasis on husbanding resources, Russell Train, the EPA administrator, has recommended that a five-year moratorium on emission standards would be in the public interest because of energy and other requirements. This recommendation was prompted, in part, by President Ford's request that there be a 40 per cent fuel improvement by 1980 and automakers have insisted that this would be impossible without a freeze on safety and emission standards.

Uses

Lead has many useful chemical properties and, because of this versatility, it has a variety of industrial applications. It is soft, ductile, alloys readily with other materials, has good corrosion resistance, a high boiling point, a low melting point and a high specific gravity. Lead is one of the oldest metals known to man and since medieval times has been used in piping, building materials, solders, paint, type metal, ammunition and castings.

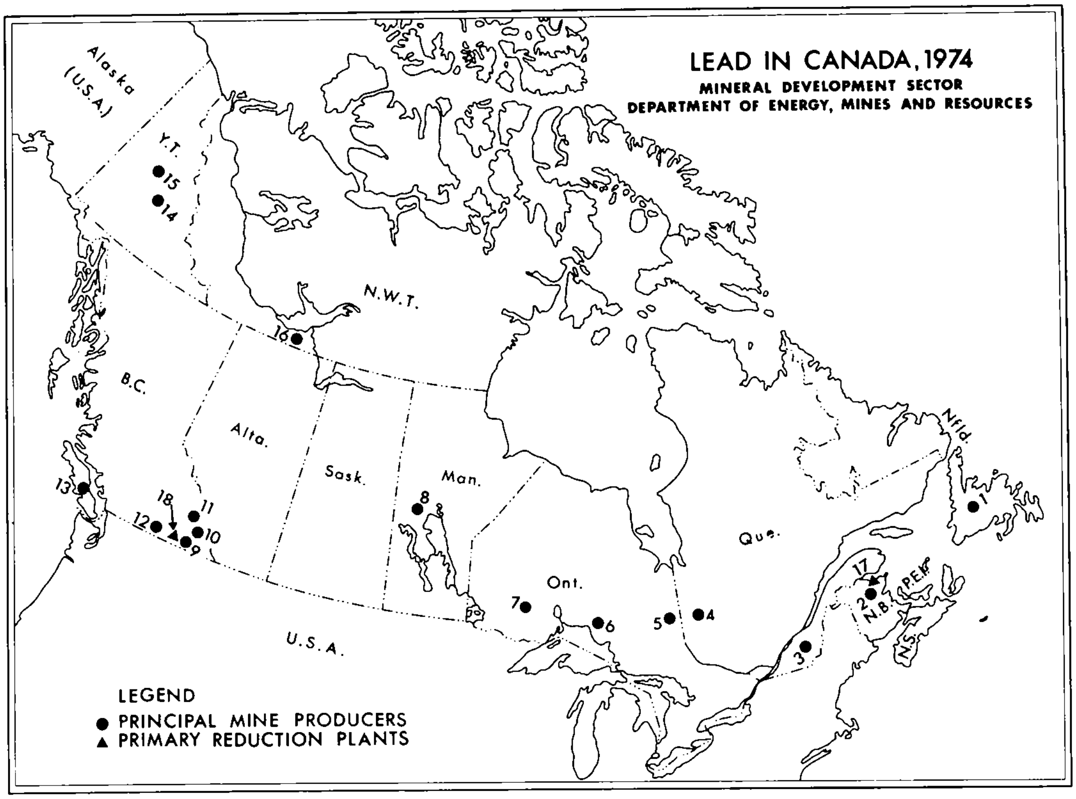
Lead is used mainly in lead-acid storage batteries, the bulk of which are used for starting, lighting and ignition (SLI) in automobiles and trucks. Recent improvements in battery manufacture have significantly reduced the weight of lead in a battery unit and increased the average battery life and performance. However, lead usage in SLI batteries is expected to continue to grow. This growth will be added to by the rapid expansion in the use of electric-powered industrial trucks. Major battery manufacturers have been developing attractive battery-powered cars, buses and utility trucks and have been test driving them in normal driving cycles for the past three years in the United States. The United States Postal Service has ordered 350 electric-powered delivery vehicles and it is estimated that each vehicle will use about 700 pounds of lead for its batteries. The Postal Service plans to expand this fleet to over 6,000 vehicles in 1977 and, if the test program continues to be successful, the Service projects an annual demand of 5,000 vehicles. Japan has a five-year, government-funded program for developing commercially competitive electric-powered vehicles, and several Japanese cities have electric buses in service which use lead-acid batteries. The use of electric-powered road vehicles is spreading throughout Europe. In Great Britain over 30,000 electrics are in operation and it is claimed that these vehicles are cost effective. Recreational and household uses have also helped increase the demand for lead-acid storage batteries. Maintenance-free, sealed lead-acid batteries are now making an impact on the SLI market and are standard equipment on some new automobiles today. They have the advantage of being able to be used in almost any position and can be removed from the normal under-the-hood location to make room for antipollution devices.

The next most important use of lead is as an antiknock additive in gasoline. Lead consumed for batteries and gasoline additives in 1974 accounted for over 64 per cent of the total lead consumption in the United States. The metal is also used extensively for cable sheathing, collapsible tubes, caulking materials, corrosive-liquid containers, galvanizing spelter and lead-base babbitts.

The commercial and residential construction industry is a growing market for lead in the form of sound-proofing, flashing and construction panels. Because of its unique sound control characteristics there is an expanding use for lead in sound attenuation both as sheets and lead-composition panelling. Composite thermal-acoustical panels are now being used to contain the noise from industrial plants. The International Lead Zinc Research Organization, Inc. (ILZRO) has designed and constructed an all-metal house requiring a minimum of maintenance and containing approximately 1.5 tons of lead and zinc. Lead-coated steel sheeting (terne steel) that combines lead's corrosion resistance and sound-barrier properties with the strength of steel is now available for many building applications. In 1974, in the United States 997,759 tons of terne steel were shipped. Terne steel is sheet steel coated with an alloy containing 85 per cent lead. In the allied field of vibration isolation, lead-asbestos antivibration pads are now being widely used in foundations for office buildings, hotels and apartments exposed to severe vibration from nearby heavy traffic. Because of its sound-control qualities lead is also used in the mounting of various types of equipment including air-conditioning systems, heavy industrial equipment and commercial laundry machines.

The use of chrome yellow (lead chromate) paints on highways for pavement marking is growing because it is the most versatile low-cost pigment available for traffic control paints.

Miscellaneous uses include automotive wheel weights, ship ballast, and various alloys; and as lead-ferrite for permanent magnets in small electric motors. Relatively new uses are for leaded-porcelain enamel in coating aluminum and for radiation shielding against gamma rays in nuclear-powered reactors, nuclear-powered ships and submarines and shipping casks for transporting radioactive materials. Continuing research has developed new and promising markets for



Principal mine producers

(numbers refer to numbers on map)

1. American Smelting and Refining Company (Buchans Unit)
2. Brunswick Mining and Smelting Corporation Limited (Nos. 12 and 6 mines)
   Heath Steele Mines Limited
   Nigadoo River Mines Limited
3. Sullivan Mining Group Ltd. Cupra Division D'Estrie Mining Company Ltd.
4. Manitou-Barvue Mines Limited
5. Ecstall Mining Limited
6. Noranda Mines Limited, Geco Division
   Willroy Mines Limited
7. Mattabi Mines Limited
   Sturgeon Lake Mines Limited
8. Hudson Bay Mining and Smelting Co., Limited (Chisel Lake, Ghost Lake mines)
9. Reeves MacDonald Mines Limited (Annex mine)
10. Cominco Ltd. (Sullivan and H.B. mines)
11. Kam-Kotia Mines Limited (Silmonac mine)
12. Teck Corporation Limited (Beaverdell mine)
13. Western Mines Limited
14. Cyprus Anvil Mining Corporation
15. United Keno Hill Mines Limited
16. Pine Point Mines Limited

Primary reduction plants

17. Brunswick Mining and Smelting Corporation Limited, Smelting Division
18. Cominco Ltd.

organometallic lead compounds in such applications as antifouling paints, wood and cotton preservatives, lubricant-oil additives, polymethane foam catalysts, molluscicides, antibacterial agents and rodent repellents.

Refined lead is marketed in several grades that vary mainly according to the content of impurities, including silver, copper, arsenic, antimony, tin, zinc, iron and bismuth. The three principal grades are corroding, chemical, and common desilverized lead. The corroding grade has the highest purity and is used chiefly in the manufacture of pigments, battery oxides and tetraethyl lead. Common lead is used mostly in industrial and home construction, while chemical lead possesses superior creep and corrosion resistance and is ideally suited for cable sheathing.

Table 7. United States consumption of lead by end-use, 1973-74

	1973	1974p
	(short tons)	
Storage batteries	769,447	737,460
Gasoline antiknock additives	274,410	250,502
Solder, type metal, terne metal and bearing metals	112,007	86,039
Ammunition and collapsible tubes	84,339	89,424
Pigments	108,766	105,901
Cable sheathing	43,005	38,411
Sheet and pipe	44,685	31,405
Caulking	20,057	15,440
Miscellaneous	84,493	58,553
Total reported[1]	1,541,209	1,413,135
Estimated undistributed consumption	—	120,000
Grand Total	1,541,209	1,533,135

Sources: United States Department of the Interior; Bureau of Mines Mineral Industry Surveys; Lead Industry in December 1974.
[1] Includes lead content of scrap used directly in fabricated products.
p Preliminary; — Nil.

Prices

The Canadian producers' domestic price of lead fob Toronto and Montreal opened the year at 17.5 cents a pound. On January 4, the price was increased to 19.0 cents a pound. This price held until April 8 when it was raised to 21.5 cents a pound by Cominco Ltd. Subsequently, Noranda Mines Limited increased its quoted price to the 21.5-cents-a-pound level which held during the remainder of the year. In the United States, the quoted price fob New York was 17.5 cents a pound at the start of the year, and was increased to 19.0 cents a pound on January 4. On March 25, a split price of 19.0 – 21.5 cents a pound was instituted and it held until April 8 when the quoted price was 21.5 cents a pound United States. On June 21, the price was increased to 24.5 cents a pound United States and remained in effect for the rest of the year. The price of Canadian lead sold in the United States was 1.5 cents a pound higher than the quoted price in Canada at the start of the year because of antidumping charges which had been filed in the United States against Australian and Canadian producers. On January 10, when the United States Tariff Commission ruled that dumping had taken place, the price differential was increased to 2.5 cents and when the United States domestic price of lead was increased later in the year to 24.5 cents a pound, the price of Canadian lead sold in the United States was also raised to 24.5 cents a pound U.S.

On the London Metal Exchange (LME), the producers' price of lead exhibited some strength during the first half of the year. The LME price at the beginning of January was £254.5 a metric ton (26.22 cents a pound Can.). The price then rose erratically and reached an all-time high of £324 (32.83 cents a pound Can.) on February 27. The previous high was £295 (31.2 cents a pound Can.) quoted in December of 1973. In June the price began to weaken and prices quoted ranged from £239 to £254 a metric ton. On July 9, the price hit £217 a metric ton (22.89 cents a pound Can.) and this price was the low for 1974. From August through to year-end the price was quite stable, being quoted in a narrow range of £227 to £240 a metric ton as primary lead producers mustered their resources to support the price. The LME price at year-end was £227 a metric ton (23.97 cents a pound Can.).

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
32900-1	Ores of metals, not otherwise provided for	free	free	free
33700-1	Lead, old, scrap, pig and block, per lb.	free	free	1¢
33800-1	Lead, in bars and in sheets	5%	5%	25%

United States

Item No.	Effective December 20, 1971	Noncommunist Countries	Designated Communist Countries
		(¢ per lb)	(¢ per lb)
602.10	All lead-bearing ore, on lead content	0.75	1.5
624.02	Unwrought lead Lead bullion, on 99.6% of lead content	1.0625	2.125
624.03	Other, on lead content	1.0625	2.125
624.04	Lead waste and scrap, on 99.6% of lead content	1.0625	2.125

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Lime

D. H. STONEHOUSE

Carbonate rocks, commonly known as limestones, can be classified according to their content of the minerals calcite ($CaCO_3$) and dolomite ($CaCO_3 \cdot MgCO_3$). They range from calcium limestone containing less than 10 per cent magnesium carbonate to magnesian limestone containing between 10 and 40 per cent magnesium carbonate and to dolomite containing between 40 and 45.65 per cent magnesium carbonate. High-calcium limestones are those with less than 3 per cent total impurities. Limestones vary in colour, texture and hardness as well as in chemical composition, giving rise to a wide range of applications. Quicklime (CaO or $CaO \cdot MgO$) is formed by the process of calcination, in which limestones are heated to the dissociation temperature of the carbonates (as low as 402°C for $MgCO_3$ and as high as 898°C for $CaCO_3$) and held at that temperature over sufficient time to release carbon dioxide. Although the word "lime" is used generally, and wrongly, to refer to pulverized limestone as well as to forms of burned lime, it should refer only to calcined limestone (quicklime) and its secondary products, slaked lime and hydrated lime. The former is the product of mixing quicklime and water, the latter of slaked lime dried and, possibly, reground.

Calcining is done in kilns of various types but, essentially, those of vertical or rotary design are used, having incorporated many adaptations to the standard designs over the years. Of comparatively recent design are the rotary hearth, travelling grate, fluo-solid and inclined vibratory types. The high cost of energy has made it imperative to include preheating facilities in any new plant design just as environmental regulations have necessitated the incorporation of dust collection equipment.

Canadian industry and developments

Lime plants have been established near urban and industrial centres in Canada where there are large reserves of suitable limestone and where most of the major consumers of lime are situated. Lime is a high-bulk, low-cost commodity and it is uncommon to ship it long distances when the raw material for its manufacture is available in so many localities. The more heavily populated and industrialized provinces of Ontario and Quebec together produced about 85 per cent of Canada's total lime output in 1974, with Ontario contributing two thirds of Canada's total. More limited markets in the other provinces resulted in much lower production in those areas. Commercial lime (lime that is normally produced for shipment and use off the plant site) was not produced in 1974 in Nova Scotia, Prince Edward Island, Newfoundland or Saskatchewan; the needs in each of these provinces being supplied from plants in neighbouring provinces or states.

During 1974, 18 companies operated a total of 24 lime plants in Canada: one in New Brunswick, four in Quebec, ten in Ontario, three in Manitoba, four in Alberta and two in British Columbia. A total of 85 kilns was available – 27 rotary, 54 vertical, one vibratory grate and three rotary grate. Preliminary returns indicate that lime production in 1974 was 2,088,000 tons, excluding some captive production such as that from pulp and paper plants that burn sludge to recover lime for reuse in the causticization operation. With apparent production capability in the range of 2.5 to 2.6 million tons a year, capacity utilization in 1974 was about 80 per cent. Realistically, production capacity could be increased especially in certain regions where supply has been running close to demand.

Atlantic provinces. In 1968, at Aguathuna, near Stephenville on the west coast of Newfoundland, Sea Mining Corporation Limited constructed a new plant designed to produce magnesium hydroxide from seawater. Although the plant never operated commercially, a rotary kiln, which was installed to produce lime for captive use in the extraction process, was put into service during 1969 and 1970 to supply some quicklime for waste neutralization application on the island's east coast. This market is now supplied by Quebec-based lime producers.

Havelock Lime Works Ltd. began production of a high-calcium quicklime early in 1971, utilizing a newly installed, 100-ton-a-day rotary kiln at the company's quarry site at Havelock, New Brunswick. Markets currently include mineral processing operations; pulp and paper industries, mainly within the province; and a growing export trade. Havelock Processing Ltd. now operates the company's crushed limestone plant which has been expanded to offer a range of products from coarse aggregate through washed and screened sizes for asphalt and concrete application to finely pulverized filler material. Snowflake Lime, Limited which, for many years, produced lime at Saint John, has not rebuilt its lime-making facility following a fire in 1968. The quarries are still supplying crushed stone to the local construction industry.

During the last few years the possibility of establishing a lime producer in the northeast region of New Brunswick has been periodically investigated. Limestone in sufficient quantity and of acceptable quality has been proved in the Elm Tree area but, although market projections indicate an increasing demand for lime in the mining and pulp and paper industries in this area, the amount in total does not yet appear to warrant a second plant within the province.

Studies have been made to determine the viability of a lime manufacturing plant in Nova Scotia associated with existing and planned steel producing facilities. Limestone and dolomite for the Sydney steel plant currently come from Irish Cove and Frenchvale, respectively.

Quebec. At Joliette, Domtar Chemicals Limited, Lime Division, produces quicklime and hydrated lime from a high-calcium Trenton limestone for the steel and pulp and paper industries. Shipments are made to Atlantic

Table 1. Canada, lime production and trade, 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Production[1]				
By type				
Quicklime	1,631,579		1,822,824	
Hydrated lime	259,011		265,176	
Total	1,890,590	28,421,000	2,088,000	33,447,000
By province				
Ontario	1,228,000	19,036,000	1,354,000	21,665,000
Quebec	316,000	4,264,000	407,000	5,899,000
Alberta	132,000	2,385,000	155,000	2,931,000
Manitoba	. .	1,228,000	. .	1,125,000
New Brunswick	. .	630,000	. .	1,000,000
British Columbia	47,000	878,000	44,000	827,000
Total	1,890,590	28,421,000	2,088,000	33,447,000
Imports				
Quick and hydrated				
United States	16,208	518,000	23,147	754,000
France	40	21,000	24	15,000
United Kingdom	—	—	4	1,000
Total	16,248	539,000	23,175	770,000
Exports				
Quick and hydrated				
United States	372,126	5,497,000	425,509	7,857,000
Panama	200	7,000	700	28,000
Greenland	684	37,000	—	—
Bermuda	40	1,000	—	—
Other countries	32	1,000	—	—
Total	373,082	5,543,000	426,209	7,885,000

Source: Statistics Canada.
[1] Producers' shipments and quantities used by producers.
p Preliminary; . . Not available; — Not applicable.

Table 2. Canada, lime, production, trade and apparent consumption, 1965-74

	Production[1]					
	Quick	Hydrated	Total	Imports	Exports	Apparent Consumption[2]
				(short tons)		
1965	1,340,386	280,018	1,620,404	25,334	239,334	1,406,404
1966	1,293,982	261,055	1,555,037	29,249	180,864	1,403,422
1967	1,178,109	244,790	1,422,899	22,113	90,125	1,354,887
1968	1,219,271	236,742	1,456,013	24,770	85,263	1,395,520
1969	1,388,109	246,753	1,634,862	41,226	195,160	1,480,928
1970	1,401,008	246,946	1,647,954	33,785	200,614	1,481,125
1971	1,379,113r	264,465r	1,643,758r	26,445	283,738	1,386,285r
1972	1,486,021r	258,135r	1,744,156r	28,679	296,136	1,476,699r
1973	1,631,579	259,011	1,890,590	16,248	373,082	1,533,756
1974	1,822,824	265,176	2,088,000	23,175	426,209	1,684,966

Source: Statistics Canada.
[1] Producers' shipments and quantities used by producers. [2] Production plus imports less exports.
r Revised.

consumers as well as to Quebec and Ontario.

Dominion Lime Ltd. produces high-calcium quicklime and hydrated lime from Silurian limestone at Lime Ridge, near Sherbrooke. Additional production capacity was activated during 1973, resulting in an increase in output of over 30 per cent. Markets include steel, pulp and paper, construction and agricultural industries.

A high-calcium Ordovician limestone of the Beekmantown Formation has been mined for many years by Shawinigan Chemicals Division of Gulf Oil Canada Limited, near Bedford, for use in the company's carbide plant at Shawinigan. The quality of the limestone makes it a highly acceptable material for the production of calcium carbide. Hydrated lime made during calcium carbide-acetylene manufacture is sold for commercial use.

Ontario. Domtar Chemicals Limited, Lime Division, operates a limestone quarry and a lime plant at Beachville. The high-calcium limestone is mined, crushed, screened and used primarily as feed to the lime plant which has both vertical and rotary kilns. At Hespeler, Domtar produces lime, crushed stone and agricultural limestone. The lime plant has vertical kilns and produces high-quality, white quicklime. Both plants also produce hydrated lime.

The Beachville plant of Cyanamid of Canada Limited, containing a rotary kiln and a calcimatic kiln, was sold to Dominion Foundries and Steel, Limited (Dofasco), Hamilton in 1973. Major renovations increased the plant's lime-producing capacity in order to supply increased demands for lime by Dofasco's basic oxygen furnaces. The plant is known as Beachvi-Lime Limited. Cyanamid discontinued production from its Niagara Falls plant, the decision being influenced, at least in part, by the necessity to install a dust collecting system in order to remain in production. Limestone for use as open-hearth and blast-furnace flux, for portland cement manufacture and as a pulverized stone is also produced at Beachville.

Through a subsidiary, Chemical Lime Limited, The Steel Company of Canada, Limited, Hamilton is supplied with flux stone and high-calcium lime from a quarry and lime plant near Ingersoll. Vertical kilns were installed at the lime plant in 1959. A new rotary kiln of 325-ton-a-day capacity was installed in 1971 to supply projected requirements of the company's steel manufacturing facilities at the Hilton Works.

Near Amherstburg, Allied Chemical Canada, Ltd. mines a high-calcium limestone for the production of lime which is used, along with salt from a nearby brine field, in the manufacture of soda ash. Canadian Gypsum Company, Limited produces a dolomitic lime near Guelph. Bonnechere Lime Limited, which operated kilns at Carleton Place and Eganville for many years, discontinued the manufacture of lime in mid-1970.

Early in 1969, Reiss Lime Company of Canada, Limited began construction of docking facilities on Lake Huron, just west of Spragge, to import limestone from the Rogers City area in Michigan for the manufacture of lime to be used in uranium processing. Production of high-calcium lime began in mid-1970 at an initial capacity of 65,000 tons a year. The company is owned by Denison Mines Limited and C. Reiss Coal Co., Wisconsin, U.S.A.

Steetley of Canada (Holdings) Limited produces dead-burned dolomite at Dundas for refractory uses.

Western provinces. Steel Brothers Canada Ltd. operates limestone quarries at Spearhill and Falconer in Manitoba, at Kananaskis, Alberta and at Pavilion Lake in British Columbia. The Spearhill operation produces a white, high-calcium lime, and limestone from Falconer, trucked to Fort White, is processed using conventional equipment before introduction to a vibratory grate calciner. Quicklime is supplied to chemical, metallurgical and construction industries as well as to a growing market in the waste treatment field. Limestone is supplied to The Manitoba Sugar Company, Limited from the Manitoba quarries.

The limestone quarry at Kananaskis is about seven miles west of the lime plant and provides kiln feed for the production of quicklime and hydrated lime. A second rotary kiln went on stream early in 1972, doubling the production capacity of the plant.

The new rotary kiln plant at Pavilion Lake, on stream in early 1975, is equipped with the latest preheater design and will be capable of producing approximately 300 tons a day of high-calcium lime for the mining and forestry industries in the British Columbia interior.

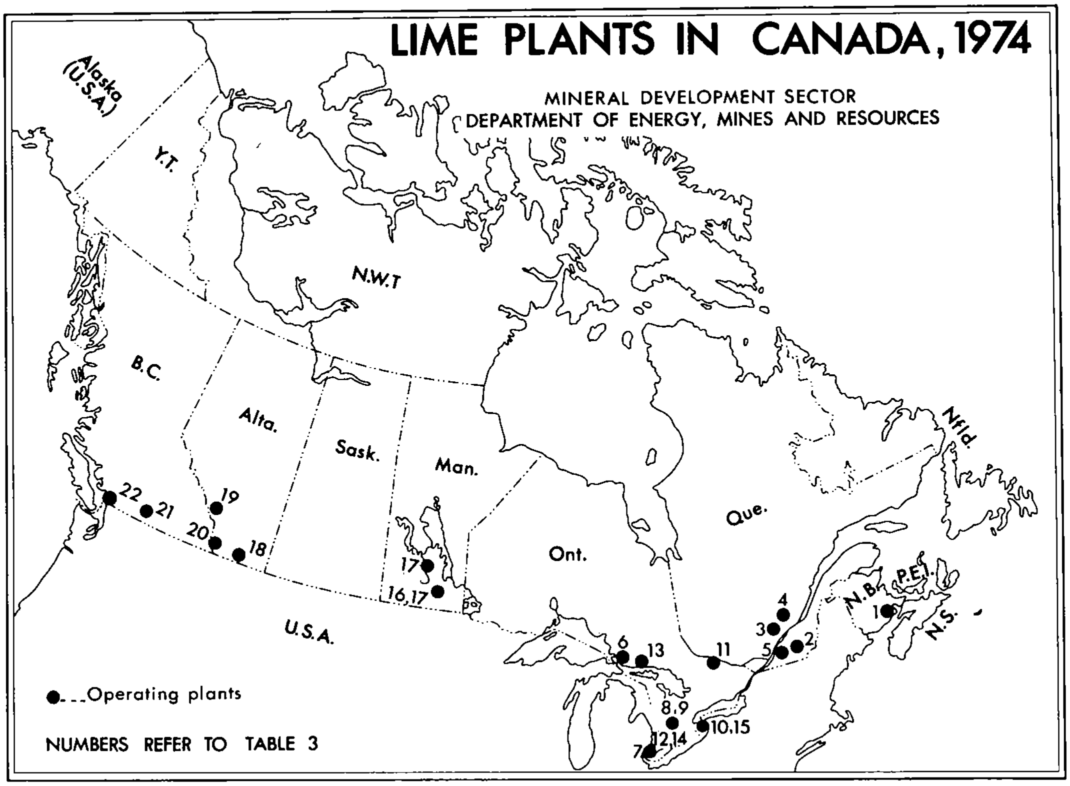
Summit Lime Works Limited, near Crowsnest, produces high-calcium limestone for use at sugar refineries, dolomitic and high-calcium stone for metallurgical use, high-calcium quicklime and hydrated lime for the chemical, metallurgical and construction industries.

During 1971 Texada Lime Ltd. constructed a calcimatic-kiln lime plant at Fort Langley, British Columbia capable of producing up to 200 tons a day. Limestone is barged from Texada Island and the product – a high-calcium quicklime – is marketed

Table 3. Canadian lime industry, 1974

Company	Plant Location	Type of Quicklime
New Brunswick		
1. Havelock Lime Works Ltd.	Havelock	High-calcium
Quebec		
2. Dominion Lime Ltd.	Lime Ridge	High-calcium[2]
3. Domtar Chemicals Limited	Joliette	High-calcium[2]
4. Gulf Oil Canada Limited Shawinigan Chemical Division	Shawinigan	High-calcium[2]
5. Quebec Sugar Refinery[1]	St-Hilaire	High-calcium
Ontario		
6. The Algoma Steel Corporation Limited[1]	Sault Ste. Marie	High-calcium
7. Allied Chemical Canada, Ltd.[1]	Amherstburg	High-calcium
8. BeachviLime Limited[1]	Beachville	High-calcium
9. Canadian Gypsum Company, Limited	Guelph	Dolomitic[2]
10. Cyanamid of Canada Limited[1]	Niagara Falls[3]	High-calcium
11. Chromasco Limited[1]	Haley	Dolomitic
12. Domtar Chemicals Limited	Beachville	High-calcium[2]
	Hespeler	Dolomitic[2]
13. Reiss Lime Company of Canada, Limited	Spragge	High-calcium
14. The Steel Company of Canada, Limited (Stelco)	Ingersoll	High-calcium[2]
15. Steetley of Canada (Holdings) Limited	Dundas	Dolomitic
Manitoba		
16. The Manitoba Sugar Company, Limited[1]	Fort Garry	High-calcium
17. Steel Brothers Canada Ltd.	Spearhill	High-calcium
	Fort Whyte	High-calcium and dolomitic
Alberta		
18. Canadian Sugar Factories Limited[1]	Taber	High-calcium
	Picture Butte	High-calcium
19. Steel Brothers Canada Ltd.	Kananaskis	High-calcium
20. Summit Lime Works Limited	Hazell	High-calcium and dolomitic
British Columbia		
21. Steel Brothers Canada Ltd.	Kamloops	High-calcium
22. Texada Lime Ltd.	Fort Langley	High-calcium

[1] Production for captive use. [2] Hydrated lime produced also. [3] Now idle.



throughout the mining and pulp and paper producing regions of British Columbia. The plant went on stream in February 1972. MacDonald Consultants Ltd. of Vancouver, in partnership with M C Q Industries of Columbus, Ohio, were responsible for the design and development of the project. In late 1973 Texada Lime Ltd. was sold to Columbia Lime Products Limited.

Markets, outlook and trade

The metallurgical industry provides the largest single market for lime. With the increased application of the basic oxygen furnace (BOF) in the steel industry, lime consumption increased greatly in certain areas of the United States and Canada.

The pulp and paper industry is the second largest consumer of lime, most of which is used in the preparation of digesting liquor and in pulp bleaching.

The uranium industry uses lime to control hydrogen-ion concentration during uranium extraction, to recover sodium carbonate and to neutralize waste sludge. In the production of beet sugar, lime is used to precipitate impurities from the sucrate. It is used also in the manufacture of many materials such as calcium carbide, calcium cyanamide, calcuim chloride, fertilizers, insecticides, fungicides, pigments, glue, acetylene, precipitated calcium carbonate, calcium hydroxide, calcium sulphate, magnesia and magnesium metal.

The rapidly growing concern for care and treatment of water supplies and the appeal for enforced antipollution measures should result in greater use of lime for water and sewage treatment. The removal of SO_2 from hydrocarbon fuels either during the burning procedure or from the stack gases by either wet or dry scrubbing will necessitate the use of lime and will undoubtedly develop a major market for this commodity as SO_2 emission regulations are developed. Lime is effective, inexpensive and can be regenerated in systems where the economics would so dictate.

Soil stabilization, especially for highways, offers a potential market for lime. However, not all soils have the physical and chemical characteristics which react properly with lime to provide a dry, impervious, cemented and stable roadbed. Hydrated lime added to asphalt hot-mix prevents the asphalt from stripping from the aggregate. This could become more important as new technologies relating to asphalt maintenance and repair are adopted and as the sources of good clean aggregate become scarce.

The use of lime-silica bricks, blocks, and slabs has not been as popular in Canada as in European countries although lightweight, cellular, insulating

Table 4. Canada, consumption of lime, quick and hydrated, 1972-73

(producers' shipments and quantities used by producers, by use)

	1972		1973p	
	(short tons)	($000)	(short tons)	($000)
Chemical and Metallurgical				
Iron and steel plants	596,509	8,397	674,043	9,866
Pulp mills	190,253	3,065	228,283	4,039
Nonferrous smelters	65,714	974	88,792	1,517
Sugar refineries	30,116	544	37,635	742
Cyanide and flotation mills	47,702	633	52,629	747
Water and sewage treatment	69,152	1,113	94,148	1,651
Uranium plants	61,739	886	49,293	757
Other industrial[1]	461,537	7,114	563,381	9,448
Construction				
Finishing lime	46,993	1,389	47,919	1,526
Mason's lime	24,347	479	25,713	531
Sand-lime brick	22,481	325	24,273	353
Agricultural	10,352	218	10,906	251
Road stabilization	13,317	271	15,299	332
Other uses	103,944	1,252	60,999	774
Total	1,744,156	26,660	1,973,313	32,534

Source: Statistics Canada.
[1] Includes glass works, fertilizer plants, tanneries and other miscellaneous industrial uses.
p Preliminary.

Table 5. World production of quicklime and hydrated lime, including dead-burned dolomite sold and used, 1972-73

Country	1972	1973p
	(thousand short tons)	
U.S.S.R.	24,000	24,000
United States	20,290	21,090
Japan	11,166	13,024
West Germany	12,030	12,386
Poland	7,210	8,483
France	5,330	5,500
Italy	4,400	4,400
Belgium	3,559	3,800
East Germany	3,235	3,300
Czechoslovakia	2,668	2,903
Romania	2,684	2,800
Brazil	2,200	2,200
Canada	1,730	1,826
Republic of South Africa	1,317	1,459
Other countries	11,747	11,649
Total	113,566	118,820

Sources: U.S. Bureau of Mines, *Minerals Yearbook* Preprint 1972; and Statistics Canada.
p Preliminary.

masonry forms have many features attractive to the building construction industry.

Although quicklime and hydrated lime are not of relatively high monetary value, they are transported considerable distances in bulk or in packages if a market exists. Freight costs can represent a large part of the consumer's cost. Production costs have been significantly increased as a result of higher energy costs. Limestones are well distributed in Canada, but it does not necessarily follow that a lime-consuming industry will produce lime for captive use — lime producers will usually offer competitive prices. Nevertheless, some major users do produce lime for their own use and, especially in the United States in recent years, iron and steel producers have integrated backwards into lime manufacture.

Canada is a net exporter of lime.

Prices

Quoted prices for both quicklime and hydrate vary greatly throughout the country, reflecting the costs of production and the influence of nearest competition. In early 1975 quicklime, per ton, bulk, f.o.b. plant was quoted as follows: Quebec $29, Ontario $22.50, Alberta $26, British Columbia $30. Hydrate prices ranged from 50¢ to $1.00 over those for quicklime.

Tariffs

Canada					United States		
Item No.		British preferential	Most Favoured Nation	General	Item No.		
29010-1	Lime	free	free	25%	512.11	Lime, hydrated	free
					512.14	Lime, other	free

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Lithium

G.H.K. PEARSE

Lithium, having a specific gravity of 0.534, is the lightest element that is solid at ordinary temperatures. It is a soft, ductile, silvery-white metal that oxidizes rapidly in air and reacts readily with water. Lithium finds a diversity of specialized uses as mineral, industrial compound and metal. The principal ore minerals are spodumene, petalite, lepidolite and amblygonite occurring in pegmatite bodies.

Lithium deposits have been mined in the United States since 1889 and in Europe and Africa since the early 1900s. Lithium was used solely in a pharmaceutical preparation until near the end of the 19th century when it became important as an ingredient in special glasses. The Edison cell storage battery using lithium hydroxide was invented in 1908. Shortly after The First World War a hardened lead-base bearing alloy containing 0.04 per cent lithium was developed in Germany. Very little further research and development was done on lithium until The Second World War. During the war and continuing to the present, uses have multiplied dramatically, and consumption has increased more than twentyfold in the last 25 years.

Canada's only significant producer of lithium, Quebec Lithium Division of Sullivan Mining Group Ltd., near Amos, Quebec, began production in 1955. The mine was finally closed in 1965 in the face of a strike and reduced markets and prices. A high-grade lithium zone at Tantalum Mining Corporation of Canada Limited's mine at Bernic Lake, Manitoba has been evaluated and is slated for production by early 1977.

Consumption of lithium products is increasing steadily under the stimulus of aggressive research and development by major producers in the United States. However, reserves of lithium in the United States, by far the world's principal consumer, are considerable; making access to that market from outside difficult.

Occurrences, production and developments in Canada

There are five known areas in Canada where substantial reserves of lithium occur. The Val d'Or – Amos area in northwestern Quebec, in which the Quebec Lithium mine is located, has been the principal producer. Numerous spodumene-bearing pegmatites occur in northwestern Ontario, principally in the Nipigon district. Small amounts of amblygonite and lepidolite have been produced in the Winnipeg River district of southeastern Manitoba since their discovery in 1924. More recently, in this area, Tantalum Mining Corporation of Canada Limited has delineated large reserves of spodumene ore at its Bernic Lake tantalum deposit. Several deposits have been explored in the Herb Lake area of northern Manitoba.

Amblygonite was recovered from two deposits in the Yellowknife – Beaulieu district, Northwest Territories, and small shipments were made between 1945 and 1955. Deposits in this district are currently considered too remote to be commercially viable.

Quebec. *Sullivan Mining Group Ltd., Quebec Lithium Division, Amos Mines Limited.* The Quebec Lithium property is underlain by numerous parallel pegmatite dykes trending easterly in a zone some 8,000 by 2,000 feet in the contact area between greenstones and granodiorite of the Lacorne batholith. Individual dykes are up to 2,000 feet long and 100 feet wide. Total reserves have not been made known by the company but are probably over 20 million tons, grading 1.2 per cent Li_2O. Plant start up was in 1955. By 1957 a throughput of 1,000 tons of ore a day was achieved; the product being shipped to the United States under contract with Lithium Corporation of America. Upon cancellation of the contract, production was temporarily suspended in 1959 and resumed at a reduced rate of about 250 tons a day in 1960 to supply the newly built lithium chemical plant. A strike curtailed production in October 1965 and, in the face of dwindling markets and prices, management decided to close down operations and await more favourable developments in the industry. Stocks on hand were disposed of over the following two years. Total production from the mine was around 1 million tons of ore.

Other lithium properties of interest occur in the area.

Ontario. *Lithium deposits of the Nipigon district.* The first of numerous spodumene pegmatites southeast of Lake Nipigon was discovered in 1955. Exploration activity which followed outlined several deposits with significant tonnages and grades. The principal property in the area is that of Big Nama Creek Mines Limited near

Beardmore which is underlain by an *en echelon* dyke set totalling 2,800 feet in length and averaging 60 feet in width, and a parallel dyke to the south 800 by 60 feet. Diamond drilling to date has indicated 4.2 million tons grading 1.06 per cent Li_2O to a depth of 1,000 feet. Jean Lake Lithium Mines Limited and Ontario Lithium Company Limited have outlined 1.7 million tons grading 1.3 per cent and 2 millions tons grading 1.09 per cent Li_2O, respectively. Other deposits of less than one million tons, which carry values up to 2 per cent lithia, occur in the district.

Development work done by Big Nama Creek Mines included the construction of a headframe, surface buildings, and the sinking of a shaft to 503 feet. Work was suspended in 1957. However, renewed interest has been shown in the deposits by an European group, and metallurgical test work conducted by Lakefield Research was started in April 1975.

Other occurrences. Other properties of interest have been explored in northwestern Ontario; one in particular near Lac La Croix, about 70 miles east-southeast of Fort Frances, has an indicated 1.5 million tons grading 1.20 per cent lithia over a strike length of 1,600 feet to a depth of 500 feet.

Manitoba. *Tantalum Mining Corporation of Canada Limited, (Tanco) Bernic Lake.* Numerous complex, zoned pegmatites, bearing a variety of minerals are known in the Cat Lake–Winnipeg River district of southeastern Manitoba. Tantalum Mining Corporation's deposit at Bernic Lake has the double distinction of being the world's largest tantalum deposit and the only known commercial deposit of pollucite, the principal source of cesium. A spodumene zone containing 5 million tons of 3 per cent Li_2O over a width of 30 feet occurs in the main pegmatite sill, and exploratory drilling underground penetrated a hitherto unknown spodumene-bearing sill beneath the present workings. The main zone is possibly the richest orebody of its kind in the world and the product is extremely low in iron and other impurities. A few tons of lepidolite were shipped from the Bernic Lake property prior to the mid-1950s.

A loan from the Manitoba Development Corporation was secured by Tantalum Mining Corporation in February 1972, for the construction of a pilot mill to produce spodumene concentrates. Trial shipments to customers during 1973 confirmed the product's suitability for ceramic purposes. In May 1974, Kawecki Berylco Industries, Inc. of New York (KBI), acquired 24.9 per cent of Tanco. KBI, a major specialty metal producer, will assist in engineering feasibility studies for lithium production. The proposed facilities include a mill which will utilize heavy media and flotation for beneficiation and a lithium chemicals plant. Planned annual output is 6,000 to 7,000 tons of Li_2CO_3 and a ceramic grade product of 1,000 tons of Li_2O equivalent (15,000 tons) expected to start up in early 1977.

Several other occurrences in the Cat Lake–Winnipeg River district contain over 1 million tons of reserves grading 1.2 per cent or more lithia. Petalite, amblygonite, and other less common lithium minerals occur particularly at the east end of Bernic Lake. Beryllium, tin, columbium, tantalum, rare earths and other elements occur in the pegmatites of this area.

Herb Lake district. The two principal occurrences in the Herb Lake district of northern Manitoba contain 2 to 3 million tons of spodumene ore, grading 1.2 to 1.4 per cent Li_2O.

Northwest Territories. Many lithium-bearing pegmatites are known in the Yellowknife–Beaulieu district of the Northwest Territories. There are reserves of several tens of millions of tons in the district, principally of spodumene ore, but also including significant tonnages of amblygonite. The remote location and lithium market conditions preclude exploitation of these deposits at present.

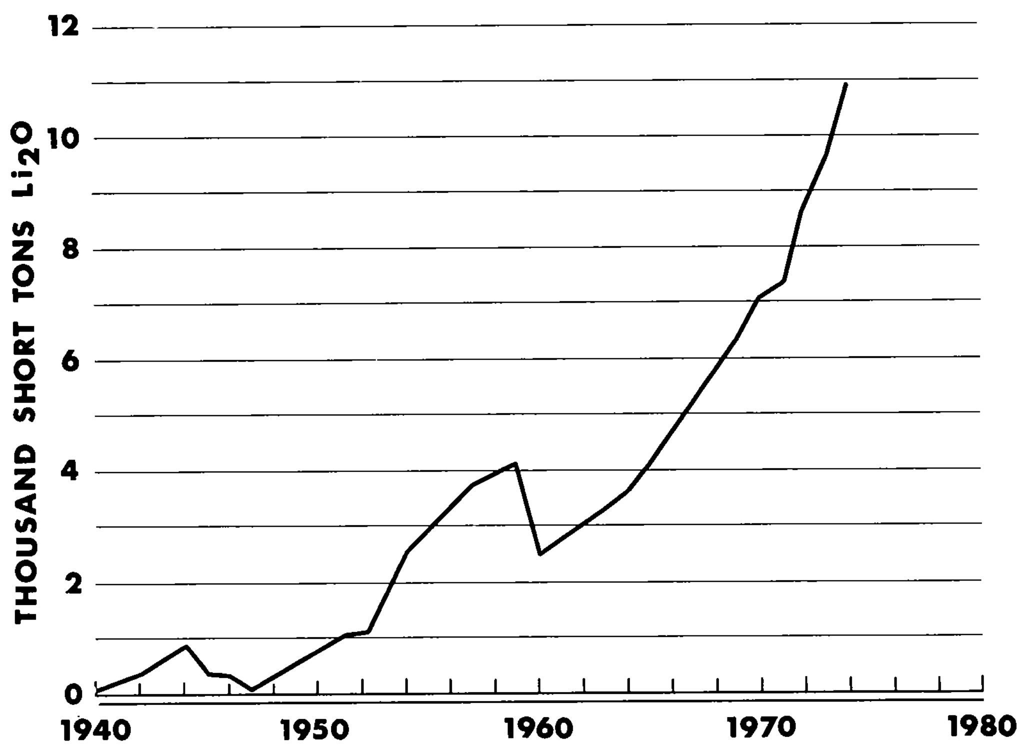
Other Canadian occurrences. Lithium pegmatites are known in several localities in the Appalachians, and two occurrences are reported from the Revelstoke district in British Columbia. These are currently of mineralogical interest only.

Uses

The unique physical and chemical properties of lithium and its compounds have given rise to a diversity of uses which continue to increase. The metal is employed in metallurgical applications as an alloy constituent and as a scavenger and deoxidizer of other metals. Lithium is the most electro-positive of the elements, which, with its light weight, makes it attractive as an anode material in batteries. This application is actively being explored and, within the last two years, several promising developments have been reported. The minerals lepidolite, petalite and spodumene find use as constituents in special glasses, ceramics, enamels and as welding and brazing fluxes. Lithium chemicals are used in the manufacture of lubricating greases; as a catalyst in numerous organic chemical processes, e.g., rubber and vitamin manufacture; as a dry chlorine vehicle for sanitation purposes; and in pharmaceutical preparations. The use of lithium carbonate in aluminum production cells increases recovery, reduces power requirements and reduces fluorine gas emission. Growing acceptance of lithium carbonate by the aluminum industry has been the main factor in the increasing demand for lithium in recent years. Other lithium chemical applications include use in air conditioning, generation of oxygen and as an electrolyte in batteries.

U.S. LITHIUM CONSUMPTION
(Li_2O equivalent)

MINERAL DEVELOPMENT SECTOR
DEPARTMENT OF ENERGY, MINES AND RESOURCES



Sources: Various, including U.S. Bureau Mines Publications, and Mineral Development Sector estimates.

World review

The United States is the world's principal producer and by far the greatest consumer of lithium products. Prior to the start of The Second World War production was little more than 100 tons of lithia (Li_2O) equivalent a year*. In 1974, world production was estimated to be 15,800 tons, almost two thirds of which was consumed by the United States.

All three producers in the United States also manufacture lithium chemicals. Foote Mineral Company mines spodumene at Kings Mountain, North Carolina and recovers lithium carbonate from brines at Silver Peak, Nevada. In May 1973, Foote opened a plant at Kings Mountain to produce low-iron spodumene by its recently developed thermal process. In March 1974, the company announced plans to construct a 6,000-ton-a-year lithium carbonate plant at Kings Mountain slated to start up in 1976. The Silver Peak operation was expanded to 7000 tons a year in late 1974. American Potash and Chemical Corporation recovers lithium carbonate from brines at Searles Lake, California. Lithium Corporation of America, a subsidiary of Gulf Resources & Chemical Corporation,

*Production and consumption figures given are short tons of Li_2O equivalent except where otherwise indicated. These figures can be converted to lithium metal equivalent by dividing by 2.153. Lithium carbonate figures can be converted to lithium metal equivalent by dividing by 5.323.

Table 1. United States consumption of lithium[1], 1968 and 2000

	1968	2000 (ranges)
	(short tons Li_2O)	
Ceramics, glass	1,700	2,100 – 7,100
Grease	1,420	5,800 – 8,600
Humidity control	730	1,400 – 2,600
Welding, brazing	900	3,750 – 6,400
Alloying, etc.	620	2,000 – 4,100
Other	280	1,200 – 1,700
Total	5,650	16,250 – 30,500

Source: *Mineral Facts and Problems, 1970.*
[1] Figures converted to Li_2O equivalent.

mines spodumene at Bessemer City, North Carolina and plans recovery from Great Salt Lake near Ogden, Utah. Gulf's North Carolina chemical plant was expanded in 1974 from 12,000 tons to 13,500 tons of lithium carbonate a year.

The United States also imports lithium in the form of chemicals and minerals such as petalite and lepidolite for use in special glasses. Imports reached some 800 tons a year by 1967 and have since dropped to approximately 200 tons in 1974. Exports of lithium products are about 1,200 tons a year.

Rhodesia was producing as much as 4,000 tons a year and was the primary supplier of United States import requirements until the United Nations embargo. Under this pressure, production tapered off to about 650 tons a year in 1972 and 1973. The sole producer, Bikita Minerals (Private) Ltd., closed its mine in 1974.

Other major producers include the U.S.S.R., the People's Republic of China, and Southwest Africa. Although the U.S.S.R. is thought to have cut back production because of a reported major reduction in exports, it is quite possible that domestic consumption has risen sharply, especially for aluminum production. Nonetheless, 700 tons contained in chemicals was exported to Japan in 1974. This tonnage alone is approximately half of total exports to the western world in the last few years.

World reserves of lithium were estimated by the United States Bureau of Mines in 1968 to be about 6 million tons of contained lithium (12.9 million tons Li_2O), 5.25 million tons of which occur in the United States. Re-evaluation of the brine resources by Foote Mineral Company reduces this latter figure to 1.95 million tons. Total world reserves are more than adequate to meet anticipated requirements well into the 21st century.

Canada's reserves were estimated to be about 200,000 tons. More recent figures and the addition of reserves known in Ontario, the Northwest Territories and other localities in Manitoba, which were not included, raise known reserves to near 400,000 tons of contained lithium (1 million tons Li_2O).

Table 2. World lithium production, 1972-74

	1972[e]	1973[e]	1974[e]
		(short tons Li_2O)	
United States	10,000	10,700	11,900
Argentina	7	10	10
Australia	49	10	—
Brazil	280	300	320
Mozambique	6	—	—
People's Rep. of China	700	700	700
Portugal	50	50	50
Southwest Africa	360	240	110
Rhodesia	650[e]	650	210
U.S.S.R.	1,750[e]	2,500[e]	2,500
Total	13,900	15,160	15,800

Sources: Various, including U.S. Bureau of Mines Commodity Data Summaries, January 1973 to 1975, Australian Bureau of Mineral Resources, Estatisticas Industriais (Portugal) and Mineral Development Sector estimates.
[e] Estimated; — Nil.

Outlook

The lithium industry is small in comparison with other segments of the mining and chemical industries. However, it has grown steadily since the end of The Second World War and continued growth at moderate rates is assured for the long-term. Annual consumption of lithium in the United States by the year 2000 was estimated to be between 16,250 and 30,500 tons based on projections made by the U.S. Bureau of Mines in 1968. It is noteworthy that "other uses" were expected to expand from 280 tons in 1968 to as much as 1,700 tons by the year 2000.

Since the 1968 forecast, several breakthroughs in battery technology have been announced and the potential for such use as a power source for automobiles and for peak power generation has become evident. One estimate for peak power installation requirements is an initial 5,400 tons of lithia. Annual requirements for electric automobiles, could reach 30,000 tons by the turn of the century. World energy requirements will have to be met ultimately by thermonuclear reactors, the simplest form of which would utilize lithium, both as a heat transfer medium and a source of tritium for the reaction. The first practical plant is unlikely to be constructed until after the end of the century, but research requirements in this area may well expand significantly before that. The surge of lithium consumption in the United States during the 1950s, which peaked in 1959, was undoubtedly due to procurements for thermonuclear research. Consumption figures for this purpose are kept secret, but an estimate of over 7,000 tons between 1953 and 1959 can be made from the accompanying graph, which was constructed from numerous sources of qualitative and quantitative information. Fusion research uses may, therefore, easily exceed 1,000 tons a year during the 1990s. Given these developments, consumption in the United States could well exceed 50,000 tons a year by 2000 or double the forecast high made in 1968.

During 1974 world lithium supplies were tight as a result of reduced exports from the U.S.S.R., closure of Bikita Minerals (Private) Ltd.'s mine in Rhodesia and increased demand in aluminum production. Despite softened markets for aluminum, consumption of lithium in the industry should continue to increase as its use becomes more general. Expansion of lithium output capacity during 1974 and new facilities scheduled for 1976 and 1977 in Canada and the United States should raise world capacity over the next three years by 40 per cent.

Magnesium

M.J. GAUVIN

Magnesium is the eighth most abundant element in the earth's crust, in terms of parts per million, and the third most abundant of those that are used for structural purposes. It is found in naturally occurring minerals such as dolomite, magnesite, brucite and olivine; and in seawater, brines and evaporite deposits. Magnesium is consumed mostly in the form of nonmetallic compounds, principally magnesium refractories. Metal represents only about 10 per cent of consumption on a magnesium content basis.

The metal is produced by two basic processes. The first is by electrolysis of magnesium chloride derived from seawater and brines. The second is a silicothermic process whereby magnesium ore, such as dolomite or magnesite, is mixed with ferrosilicon and reduced at high temperatures. All Canadian production is by the latter method, which is more suitable for smaller plants. The electrolytic method has risen to prominence because of large-scale plants utilizing low-cost electric power. Electric power requirements to produce magnesium electrolytically are 8–9 kWh per pound, even higher than the 7–8 kWh required to produce a pound of aluminum by the conventional Hall–Heroult process, and considerably higher than for the silicothermic process, including production of the ferrosilicon.

Canada

The only Canadian producer of primary magnesium is Chromasco Corporation Limited. This company (formerly Dominion Magnesium Limited) has operated a mine and smelter at Haley, Ontario, 50 miles west of Ottawa, since 1942.

A high-quality (98% pure) dolomite, low in impurities such as silica and the alkali metals, is mined from an open pit and calcined in a rotary kiln to produce dolime. Using the silicothermic process (Pidgeon process), dolime is mixed with ferrosilicon at a ratio of about 5 to 1. This mixture is charged in batches into retorts which are externally heated in furnaces, using natural gas as the main fuel. Under vacuum and at high temperature, the magnesium content is reduced and accumulated as crystalline rings known as "crowns" in the water-cooled head sections of the retorts. The plant has an annual capacity of 12,000 tons* of magnesium metal, but operated at only about 54 per cent capacity in 1974. A minor amount of this furnace capacity was used in the production of calcium.

The company produces ingots of magnesium metal in the following grades and purities: commercial 99.90 per cent; high purity 99.95 per cent; and refined 99.98 per cent. Magnesium alloys are produced to all specifications. Other magnesium products include master alloys, rods, bars, wire and structural shapes. The Pidgeon process is particularly suited for production of the purer forms.

To produce commercial-grade magnesium, the crowns are simply remelted and cast into ingots. This grade is suitable for general fabrication purposes and for alloying with aluminum, and represents the major proportion of production. The high-purity grade is mostly used for the formation of Grignard reagents (alkyl–magnesium–halides which react to form a variety of organic and inorganic compounds). The refined grade is in demand for chemical laboratory use and as a reducing agent for titanium, zirconium, uranium and beryllium.

Production of magnesium in 1974 was 6,535 tons, valued at $9,073,000 compared with 6,840 tons in 1973 valued at $5,482,588. Production was well below the 10,637-ton output reached in 1969.

In 1974, domestic consumption of magnesium was 6,853 tons, a 6 per cent decrease from the 7,292 tons consumed in 1973. The aluminum alloy industry was again the predominant outlet for magnesium, but the casting industry also consumed appreciable amounts of the metal.

Imports of magnesium metal and alloys were 7,697 tons in 1974, a substantial increase over the 5,606 tons imported in 1973. Exports of Canadian magnesium in 1974 were 3,521 tons, slightly less than the 3,562 exported in 1973. Exports of magnesium metal have entered the United States duty free under the Canada–United States Defence Production Sharing Program, which has recently been operating on a small scale. Although the United States duty on magnesium ingots and further-processed products has been progressively reduced in accordance with the Kennedy Round of trade negotiations under the General

*The short ton (2,000 pounds) is used throughout unless otherwise stated.

Agreement on Tariffs and Trade, only in certain highly pure items can the Canadian product find a market in the United States except under the above-mentioned program. In the form of ingots, a 20 per cent United States tariff remains whereas the comparable Canadian tariff is 5 per cent.

Table 1. Canada, magnesium production and trade, 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Production[1] (metal)	6,840	5,482,588	6,535	9,073,000
Imports				
Magnesium metal				
United States	5,050	3,817,000	6,465	6,667,000
Netherlands	—	—	328	441,000
Japan	—	—	55	91,000
Other countries	...	1,000	38	103,000
Total	5,050	3,818,000	6,886	7,302,000
Magnesium alloy				
United States	435	505,000	558	910,000
United Kingdom	121	330,000	165	471,000
Switzerland	—	—	88	140,000
West Germany	...	2,000	...	2,000
Total	556	837,000	811	1,523,000
Exports				
Magnesium metal				
United States	536	781,000	609	2,440,000
United Kingdom	970	701,000	2,016	2,282,000
Switzerland	310	218,000	335	397,000
France	100	72,000	132	170,000
Japan	—	—	128	159,000
Israel	46	78,000	55	151,000
Brazil	54	40,000	143	114,000
Australia	42	60,000	32	54,000
West Germany	197	132,000	23	27,000
Argentina	98	69,000	20	27,000
Colombia	33	45,000	17	26,000
Spain	—	—	4	11,000
Uruguay	2	6,000	2	9,000
Philippines	—	—	4	6,000
Belgium and Luxembourg	—	—	...	2,000
Leeward and Windward Islands	—	—	1	2,000
India	34	26,000	—	—
Singapore	1	1,000	—	—
People's Republic of China	1,121	779,000	—	—
South Korea	16	14,000	—	—
New Zealand	2	3,000	—	—
Total	3,562	3,025,000	3,521	5,877,000

Source: Statistics Canada.
[1] Magnesium metal in all forms and in magnesium alloys produced for shipment, less remelt.
p Preliminary; — nil; ... less than one ton.

World review

World production of primary magnesium in 1974 was 272,500 tons, compared with 262,000 tons in 1973. The United States retained its dominant position, accounting for almost half of world production, followed by the U.S.S.R. and Norway. Secondary magnesium adds to the effective supply in some countries, notably the United States which produced an estimated 20,000 tons of secondary metal in 1974. Japan produced some 8,600 tons of secondary metal in the fiscal year 1973–74. West Germany also recovers substantial amounts of magnesium from secondary sources.

During the past ten years, noncommunist world consumption has exceeded production. The market has been held in balance by sales from the United States government stockpile and exports from the U.S.S.R. During 1974, the General Services Administration (GSA) sold 20,981 tons of metal and completed the disposal of all magnesium metal in the government stockpile.

The world's largest producer is The Dow Chemical Company in the United States which has a capacity of 120,000 tons a year at its Freeport, Texas plant. Dow has plans to increase its capacity, probably by 50,000 tons in 1980.

NL Industries, Inc. started production at its Rowley, Utah plant in 1972 and expected to have the plant producing at its designed capacity of 45,000 tons a year by 1975. However, many technical problems have kept production at less than one fifth of its design capacity.

The Snyder, Texas plant of American Magnesium Company closed in 1971 and reopened in 1973. It is operating at 50 per cent of its 10,000-ton-a-year capacity because of pollution control problems. New pollution controls which are scheduled to come on stream in 1975 should allow the plant to operate at capacity. In addition, the company will expand its facilities to produce 30,000 tons a year.

Northwest Alloys, Inc., a subsidiary of the Aluminum Company of America (Alcoa), is building a 40,000-ton-a-year magnesium plant at Addy, Washington. The plant is scheduled to begin producing magnesium early in 1976 and will use the Magnotherm process patented by Pechiney Ugine Kuhlmann Development, Inc. The plant will also produce ferrosilicon for use by Alcoa and other metal producers. In Norway, Norsk Hydro-Elektrisk Kvaelstofaktieselskab plans to expand its plant at Heroya to 55,000 tons from 40,000 tons of magnesium output a year. The company also announced plans to construct and have a 50,000-ton-a-year magnesium plant at Mongstad, Norway in operation by 1980. For the fiscal year 1973–74, Japanese production of primary magnesium was 10,990 tons, a slight increase over the previous year. Total production of primary and secondary metal was 21,590 tons.

Statistics on world consumption of magnesium metal are incomplete. Consumption of magnesium in the noncommunist world in 1974 was estimated to be 280,000 tons. The United States was by far the largest world consumer of the metal and accounted for 127,000 tons of the world's total. For the fiscal year 1973–74, total consumption in Japan was 27,500 tons, an increase of 4.6 per cent over the previous year. The consumption of magnesium in West Germany is

Table 2. Canada, magnesium production, trade and consumption, 1964-74

	Production[1] Metal	Imports Alloys	Imports Metal	Exports Metal	Exports Metal	Consumption[2] Metal
	(short tons)	(short tons)	(short tons)	(short tons)	($)	(short tons)
1964	9,353	187	1,594	..	3,951,386	3,762
1965	10,108	166	1,641	..	4,456,255	4,499
1966	6,723	330	3,011	..	3,452,000	5,137
1967	8,887	206	1,493	..	3,696,000	5,054
1968	9,929	302	2,403	..	4,261,000	5,654
1969	10,637	431	2,023	..	4,726,000	5,672
1970	10,353	256	2,036	7,669	5,562,000	4,937
1971	7,234	152	1,827	2,917	2,227,000	6,276
1972	5,924	352	4,457	2,872	2,175,000	5,923
1973	6,840	556	5,050	3,562	3,025,000	7,292
1974p	6,535	811	6,886	3,521	5,877,000	6,853

Source: Statistics Canada.
[1] Magnesium metal in all forms and in magnesium alloys produced for shipment, less remelt. [2] Consumption as reported by consumers.
p Preliminary; .. Not available.

Table 3. Canada, consumption of magnesium, 1964 and 1969-74

	1964	1969	1970	1971	1972	1973	1974p
				(short tons)			
Casting[1]	334	793	850	1,316	1,110	1,001	1,284
Extrusions[2]	347	529	474	375	494	232	204
Aluminum alloys	2,494	3,710	3,123	3,972	3,924	4,317	3,975
Other uses[3]	587	640	490	613	395	1,742	1,390
Total	3,762	5,672	4,937	6,276	5,923	7,292	6,853

Source: Statistics Canada.
[1] Die, permanent mould and sand. [2] Structural shapes, tubing, forgings, sheet and plate [3] Cathodic protection, reducing agents, deoxidizers and other alloys.
p Preliminary.

Table 4. World primary magnesium production

	1964	1973	1974e
	(thousands of short tons)		
United States	79.5	122.4	133.0
U.S.S.R.	35.0	63.0	63.0
Norway	24.3	40.8	41.0
Japan	3.2	12.3	12.0
Italy	6.6	7.9	8.0
Canada	9.4	6.8	6.5
Other noncommunist countries	7.2	7.7	8.0
Other communist countries	1.0	1.1	1.0
Total	166.2	262.0	272.5

Sources: Statistics Canada; U.S. Bureau of Mines.
e Estimated.

unknown, but the automotive industry in Germany is a large consumer. A large part of Norway's magnesium production is exported to West Germany.

Technology

Three recent technological developments are expected to have an impact on the growth of the magnesium industry. The first is fluxless melting. To prevent melted magnesium from oxidizing, a salt flux cover may be used. Associated with fluxing are undesirable effects such as hydrochloric acid fumes and metal losses due to entrapment in a sludge which sinks to the bottom of the melt. Fluxless melting uses a heavy inert gas, sulphur hexafluoride (SF_6) in place of a flux. At Volkswagen's Hannover plant in West Germany, eight melting furnaces are melt-protected by this method and metal loss in the furnace is about 0.35 per cent. Research at Battelle Memorial Institute in the United States indicates that fluxless melting of magnesium will receive wide acceptance but will not completely replace flux protection.

The second development is the hot-chamber die-casting machine. It was developed in West Germany and Italy, and is being used commercially in Europe. Cost reduction through faster cycling, lower metal loss and thinner walled castings is claimed for these machines. Technology developed to date indicates that the main application of hot-cast machines will be for casting of small parts, especially those having shapes that are difficult to cast. Cold-cast machines will continue to be used for large castings.

The third development is the use of magnesium as a desulphurizer in the steel industry. This could develop into a significant market for magnesium.

Uses

The major use of magnesium is in aluminum alloys where it provides hardness and strength. More magnesium is utilized in aluminum alloys than in magnesium alloys. Because of its high strength-to-weight ratio, magnesium is used in structural applications; i.e., those which involve load-carrying components. Although magnesium weighs only two thirds as much as aluminum, the latter metal can be substituted for magnesium in most structural applications, and a higher price has often placed magnesium at a disadvantage.

Typical structural uses of magnesium are in aircraft (particularly helicopters), missiles and space exploration vehicles, luggage frames, and materials-handling equipment such as gravity conveyors and hand trucks. Magnesium castings are used extensively in power lawnmowers, chain saws, typewriters and electronic equipment. The European automotive industry utilizes considerable quantities of magnesium for engine blocks and other castings. The metal has not been used

Table 5. Estimated world primary magnesium capacity 1974

	Company	Location	Annual Capacity
Canada	Chromasco Corporation Limited	Haley, Ontario	12,000 (F)
France	Société Générale du Magnesium (Pechiney Group)	Marignac	9,900 (F)
Italy	Societe Italiana per il Magnesio e Leghe di Magnesio, Milan	Bolzano	10,000 (F)
Japan	Furukawa Magnesium Company	Koyama	7,300 (F)
	Ube Kosan K K	Yamaguchi	6,600 (F)
Norway	Norsk Hydro-Elektrisk Kvaelsto-faktieselskab	Heroya, near Porsgrund	48,000 (E)
United States	The Dow Chemical Company	Freeport, Texas	120,000 (E)
	NL Industries, Inc.	Rowley, Utah	45,000 (E)
	American Magnesium Company	Snyder, Texas	10,000 (E)
U.S.S.R.	Various		65,000[e](E)

Sources: Société français de minerais & métaux, and various other sources.
Process: (F) Ferrosilicon; (E) Electrolytic.
[e] Estimated.

extensively in the North American automotive industry because of its high cost. Nevertheless, the increased weight of automobiles due to the addition of safety and pollution control devices provide increased opportunities for utilization of magnesium. New technical developments in fluxless melting and die casting could make magnesium more competitive.

Nonstructural applications, which have grown more quickly than structural uses, account for about 75 per cent of the consumption of magnesium. A rapidly growing sector of this market is for aluminum alloy beverage cans which contain about 2.5 per cent magnesium. Other important nonstructural uses of magnesium are as an alloying element for ductile iron, as a reducing agent in the production of titanium for cathodic protection, in the chemical industry for Grignard reagents, and an antiknock fuel additive.

The use of magnesium as a desulphurizer in the manufacture of steel is a potential use in which no secondary material would be generated. This might result in sales of magnesium to the steel industry of up to 40,000 tons a year.

Prices

Magnesium prices changed frequently during the year. The following table lists the 1974 prices of Canadian and United States magnesium ingots. The Canadian domestic quotation is in Canadian cents per pound for carload lots of commercial grade magnesium, fob Haley, Ontario. The United States price is in United States cents per pound in 10,000 pound lots of 99.8% metal, fob Freeport Texas.

	Canada	United States
	¢/lb	¢/lb
January 1 – May 31	55	
January 1 – March 10		42
March 11 – April 30		47
May 1 – June 30		55
June 1 – July 15	60	
July 1 – July 31		65
July 15 – September 16	75	
August 1 – December 31		75
September 17 – October 31	85	
November 1 – December 31	91	

Prices of magnesium alloys underwent similar changes. In the United States the price of die-casting alloy AZ91B was 42 cents a pound on January 1 and 80 cents on December 31. In Canada, magnesium alloys were 56 cents a pound January 1 and 95 cents on December 31.

Outlook

At the end of 1974 magnesium was in short supply and, while the demand eased somewhat early in 1975, a tight supply situation will probably continue. If magnesium consumption continues its long-term growth rate of 8 per cent, production through 1980 will probably fall short of demand. The new plant of NL Industries, Inc., has been plagued with technological problems and no new large productive capacity except Alcoa's is foreseen until the late seventies or early eighties. The GSA stockpile in 1962 was equivalent to the total of the noncommunist world's yearly productive capacity. This stockpile which previously helped overcome annual production deficits has now been depleted and any future market production shortfall will see consumers competing for the available supply.

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
		(%)	(%)	(%)
35105-1	Magnesium metal, not including alloys, in lumps, powders, ingots, or blocks	5	5	25
34910-1	Alloys of magnesium, ingots, pigs, sheets, plates, strips, bars, rods and tubes	5	5	25
34915-1	Magnesium scrap	free	free	free
34920-1	Sheet or plate, of magnesium or alloys of magnesium, plain, corrugated, pebbled, or with a raised surface pattern, for use in Canadian manufactures (expires 31 October 1975)	free	free	25
34925-1	Extruded tubing, of magnesium or alloys of magnesium, having an outside diameter of five inches or more, for use in Canadian manufactures (expires 28 February 1975)	free	free	25

United States

Item No.		On and After January 1	
		1971	1972
628.55	Magnesium, unwrought, other than alloys; and waste and scrap (duty on waste and scrap suspended to June 30, 1973)	24%	20%
628.57	Magnesium, unwrought alloys, per lb on Mg content	9.5¢+4.5%	8¢+4%
628.59	Magnesium metal, wrought, per lb on Mg content	8¢+4%	6.5¢+3.5%

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Manganese

R.F. JOHNSON

Canada has no economically mineable deposits of manganese. The largest use for manganese products in Canada is in the steel industry. Two companies in Canada process imported ore into ferromanganese and as a result, Canada is basically self-sufficient in ferromanganese. Other manganese products such as manganese metal and chemicals are imported.

World manganese ore demand was in balance with supply in 1974. A potential shortage was nullified by increased releases from government stockpiles in the United States. Ferromanganese was in short supply as demand from the steel industry exceeded capacity. Manganese metal was in short supply also. Prices rose during the year, with part of the increase being attributable to increased power costs in some countries.

Demand will weaken in 1975 with the general downturn in world steel production. Demand should recover with the predicted increase in steel production in 1976. Through the late 1970s a shortage may occur as transportation problems within producing countries may limit increases in production.

Canada

Of all the important additives used in steelmaking, the only ones not produced in Canada as ores are manganese and chromium. Although several manganese deposits have been identified in Canada, the deposits are not mineable under current technology and at current prices. Because manganese is of strategic importance to Canada and the United States, research has been directed towards the exploitation of low-grade domestic ores and, while processes have been developed to utilize these ores, the ores are not economically competitive with existing mines and deposits in other parts of the world. In the past, small amounts of manganese ore have been mined from scattered occurrences in Nova Scotia, New Brunswick and British Columbia. Canada's largest occurrence is a low-grade deposit near Woodstock, New Brunswick that contains an estimated 50 million tons, grading 11 per cent manganese and 14 per cent iron.

Canada has two principal consumers of metallurgical grade ore, namely Union Carbide Canada Limited and Chromasco Limited; and three major consumers or battery-grade ore, namely Ray-O-Vac Division of ESB Canada Limited, Mallory Battery Company of Canada Limited and Clerite Burgess.

In late 1973, Union Carbide started production of standard-grade ferromanganese at a new furnace in Beauharnois, Quebec. The furnace, which can produce about 350 tons a day of standard ferromanganese, is the largest furnace of its type in the western world. The plant was struck on January 19, 1975 and there appeared to be little hope for an early settlement. The plant has been a major supplier to the Canadian steel industry, and the strike has caused a sharp reduction in stocks held by both Union Carbide and its consumers. Union Carbide has arranged to import ferromanganese from other sources to meet consumer requirements, albeit at an additional cost of $20 – 30 a ton because of transport costs and duties. Mallory Battery Company of Canada Limited is undertaking an expansion of its Toronto battery plant that is to be completed in late 1975 or early 1976. The expansion will result in a small increase in manganese ore consumption.

The principal consumers of ferromanganese in Canada are: The Steel Company of Canada, Limited, Sydney Steel Corporation, The Algoma Steel Corporation, Limited, Dominion Foundries and Steel, Limited and Atlas Steels Division of Rio Algom Mines Limited. The major consumers of manganese metal are: Atlas Steels, Aluminum Company of Canada, Limited and Reynolds Aluminum Company of Canada Ltd. Among the major consumers of high-purity manganese dioxide are Canadian Electrolytic Zinc Limited, Ecstall Mining Limited and Cominco Ltd.

World production and trade

In 1973, world production of manganese ores and concentrates was some 24 million short tons (21.5 million metric tons). Production by country is shown in Table 3. Estimated world trade in manganese ores and concentrates in 1973 is shown in Table 4.

A manganese deposit at Tamao in Upper Volta is scheduled to come on stream in 1980. The deposit contains about 14 million tons on manganese oxides 54 per cent Mn that overlie about 13 million tons of manganese carbonates grading between 35 and 49 per cent Mn. Planned production is in the vicinity of 620,000 tons a year. Of this, 383,000 tons a year will be exported to Japan; 115, 000 tons a year to the Federal Republic of Germany (West Germany); 89,000 tons a year to the United States; and 38,000 tons a year to France. The deposit will be developed by a company in which the government of Upper Volta holds 51 per cent, a consortium of Japanese ferroalloy producers 30 per cent, August Thyssen-Hutte AG 9 per cent, Union Carbide Corporation 7 per cent and Société du Manganese 3 per cent. The long development period is necessary to build about 1,000 miles of rail line from Tambao to the port of Abidjan in the Ivory Coast. The rail line will be financed by Japan, West Germany, France, the World Bank, the African Development Bank, Rumania and the European Development Fund.

Gabon has awarded a contract to a consortium of European companies to build about 400 miles of rail lines to connect the mineral-rich interior with the port of Lebreville. Currently, manganese is the only mineral

Table 1. Canada, manganese, trade and consumption, 1973-74

	1973		1974^p	
	(short tons)	($)	(short tons)	($)
Imports				
Manganese in ores and concentrates[1]				
Gabon	38,504	2,418,000	40,356	3,706,000
Brazil	25,579	1,308,000	34,266	2,750,000
United States	49,511	2,306,000	35,867	2,732,000
Zaire	16,124	611,000	10,443	1,147,000
Other countries	17,327	762,000	16,970	1,255,000
Total	147,045	7,405,000	137,902	11,590,000
Manganese				
South Africa	3,424	1,549,000	3,337	1,785,000
United States	849	612,000	635	479,000
West Germany	—	—	116	188,000
Japan	360	158,000	188	168,000
Belgium-Luxembourg	—	—	66	108,000
Total	4,633	2,319,000	4,342	2,728,000
Ferromanganese including spiegeleisen[2]				
South Africa	—	—	9,450	2,204,000
United States	12,130	2,511,000	3,625	1,558,000
France	5,613	837,000	5,674	1,416,000
Other countries	8,768	1,532,000	95	70,000
Total	26,511	4,880,000	18,844	5,248,000
Silicomanganese including silico spiegeleisen[2]				
United States	7,285	1,448,000	471	180,000
South Africa	1,147	139,000	126	21,000
Norway	1,213	198,000	—	—
Other countries	1,105	223,000	—	—
Total	10,750	2,008,000	597	201,000
Exports				
Ferromanganese[2]				
United States	3,177	530,000	11,068	2,938,000
Jamaica	156	35,000	148	47,000
Total	3,333	565,000	11,216	2,985,000
Consumption				
Manganese ore				
Metallurgical grade				
Battery and chemical grade	188,072	..	232,142	..

Source: Statistics Canada.
[1]Mn content; [2]Gross weight.
^{p} Preliminary; — Nil; .. Not available.
Other countries include: South Africa, U.S.S.R., Mexico, Norway, Yugoslavia and Korea.

produced in the interior and is shipped via an aerial cableway from Moanda to Point Noire. Completion date for the project is 1981. Once the rail line is completed, an eventual increase in production to over 5 million tons a year is expected. Proven reserves at Moanda translate into over 250 million tons of saleable manganese; i.e., 50 per cent Mn. The manganese is mined by Compagnie Minière de l'Ogooué in which United States Steel Corporation has the largest interest, 49 per cent. The Gabonese government and two

Table 2. Canada, manganese imports, exports and consumption, 1964-74

	Imports			Exports	Consumption	
	Manganese Ore[1]	Ferro-manganese	Silico-manganese	Ferro-manganese	Ore	Ferromanganese and Silicomanganese
	(gross weight, short tons)					
1964	62,813	21,830	1,744	3,359	138,959	66,203
1965	89,480	34,562	787	3,817	119,289	61,352
1966	184,103	49,118	1,931	5,722	152,536	68,360
1967	82,659	16,044	4,202	4,339	137,395	61,667
1968	69,209	27,941	1,344	1,018	124,904	71,470
1969	107,954	24,524	4,599	5,512	168,485	70,305
1970	126,823	19,721	1,075	562	169,586	82,356
1971	110,885	21,558	1,790	381	174,761	76,420
1972	98,177	18,895	16,637	2,278	183,175	76,371
1973	147,045	26,511	10,750	3,333	188,072	83,787
1974^p	137,902	18,844	597	11,216	232,142	..

Source: Statistics Canada.
[1]From 1964, Mn content, prior years gross weight.
^{p}Preliminary; .. Not available.

Table 3. World production of manganese ores

	Mn^e	1971	1972	1973^p
	(per cent)	(thousands of short tons)		
Country				
U.S.S.R.	..	8,067	8,619	8,818
Republic of South Africa	30+	3,567	3,606	4,603
Brazil	38-50	2,868	2,268	2,378
Gabon	50-53	2,057	2,135	2,115
India	10-54	2,029	1,810	1,692
Australia	46-49	1,158	1,287	1,678
People's Republic of China	30+	1,100	1,100	1,100
Mexico	35+	294	326	401
Zaire	42+	363	407	368
Ghana	32-50+	660	549	351
Japan	28-45	314	287	208
Hungary	30 –	250	207	207
Morocco	53	112	106	161
Thailand	40-50	17	22	40
Bulgaria	30+	45	33	33^e
Italy	30 –	34	28	28
Other countries[4]		243	200	109
Total		23,178	22,990	24,290

Source: US Bureau of Mines *Minerals Yearbook* Preprint.
[4] Includes 20 countries each producing less than 28,000 tons a year.
^{e} Estimated; ^{p} Preliminary; .. Not available.

Japanese companies, Okura Trading Company and Nippon Kokan Kaisha, will undertake a study to determine the feasibility of establishing an export-oriented ferromanganese plant. Planned capacity of the plant is 150,000 tons a year.

Groote Eylandt Mining Company Proprietary Ltd., a subsidiary of The Broken Hill Proprietary Company Limited of Australia, is currently in the midst of an expansion program that will increase production to 1.8 million tons a year in 1975 and 2 million tons a year in 1976. Reserves at the mine are in excess of 100 million tons. Two strikes at Groote Eylandt in late 1974 resulted in a production loss of an estimated 140,000 tons. Another Broken Hill subsidiary, Tasmanian Electro-Metallurgical Company, Ltd. is expanding its ferromanganese and silicomanganese production at Bill Bay. The expansion, scheduled for completion in late 1975, will increase production of ferromanganese by 85,000 tons a year. The expansion at Groote Eylandt will supply the increased ore requirements. Longreach Metals NL is attempting to negotiate a ten-year contract to supply 5 million tons of ferruginous manganese ore to Nippon Steel Corporation of Japan. The deposit is located in the Pilbara region, and tentative arrangements have been made with the iron ore mining companies to use their rail and port facilities. Reserves are estimated to be 70 million tons. Hancock and Wright are setting up a pilot plant at Bunbury to test a new process for producing high-grade manganese dioxide from low-grade manganese ores and the ferrous sulphate content of effluent from a titanium oxide plant. Bell Brothers' manganese mine near Port Hedland has ceased production. Production from the mine has been declining and, in recent years, the production loss amounted to approximately 50,000 tons a year.

The Brazilian government is concerned that the reserves of the manganese mine of Industria e Comercio de Minerios S.A. (Iocmi) in Amapa may be exhausted relatively soon. At present mining rates, the reserves at Amapa will be exhausted in ten years and Amapa is the only known high-grade manganese deposit in Brazil. Prospecting for high-grade manganese deposits and research on methods of upgrading the widespread low-grade manganese deposits is being carried out. If this program is unsuccessful, the Amapa reserves will be declared a strategic reserve and export controls will be introduced. The concern is to provide an assured source of high-grade manganese for the expected increase in ferromanganese requirements of Brazil's steel industry. Shipping costs from the mine, located in northern Brazil, have been prohibitive for most Brazilian consumers and manganese has generally been imported from Africa.

The Indian government has decided to progressively cut back exports of manganese ore in order to conserve ores and meet growing demand within the country. Exports of ore containing less than 35 per cent will be held at 1971–72 export levels, ore grading 35-45 per cent was set at 60 per cent of 1971–72 export level for 1974–75 and exports of high-grade (45 per cent +) manganese ore have been banned except for prior commitments.

In 1973, the Ghanian government set up a crown corporation, Ghana Manganese Corporation. The objectives of the new corporation are: (1) mining of manganese ore and the allied or associated minerals of all qualities and grades; (2) the carrying out of beneficiation of low-grade manganese ores and allied or associated minerals; (3) the processing of manganese ore into ferroalloys, chemically pure manganese dioxide and their products; and (4) the marketing of manganese ore and other products in Ghana. Simultaneously, the government was made the sole purchasing authority of all manganese ores produced in Ghana, and the Ghana Manganese Corporation was selected as the government agent. The government will purchase all manganese ores and pay in Ghanian currency at the fob prices of contracts existing in 1973. The government appointed a new marketing agent, Caemi International of the Netherlands, and nullified any other existing arrangements.

Hungarian production has been about 200,000 tons a year in recent years with about 80 per cent of the output being oxide ores. However, the oxide deposits are nearly worked out and the carbonate ores, which account for about 20 per cent of production, cannot be used economically, so production of them has been limited. In the next several years, production in Hungary is expected to decline to about 50,000 tons a year.

In Italy, there is one manganese mine at Gambatesa. The reserves are almost exhausted and production will probably cease in the next few years. In Greece, the government signed an agreement with two Japanese companies, Tekkosha Company and Mitsubishi Corporation, approving the establishment of a company, Tekkosha Greece that will produce electrolytic manganese dioxide. The company will produce 12,000 tons a year of manganese dioxide and will probably take advantage of Greece's associate status with the European Common Market to export to European countries. Mitsui Mining and Smelting Company, Limited will complete construction of a 12,000-ton-a-year electrolytic manganese dioxide plant at Cork City, Ireland in August 1975. Trial operation will begin in September with commercial production likely beginning in early 1976. Production will be exported to other European Common Market countries.

Minera Autlan and Ferroaleaciones Tezuitlan of Mexico merged during 1974. Autlan is Mexico's largest manganese producer and Tezuitlan is Mexico's principal producer of ferroalloys. Autlan plans to double ore production from the current 300,000 tons a year to 600,000 tons a year in 1979. Reserves at the present mine, an open pit, will be exhausted by 1980 and a new underground mine, scheduled for completion in 1979, will provide the increase in production capacity. Autlan will also construct an additional ferromanganese

Table 4. Estimated world trade in manganese ores and concentrates, 1973

	Importing Region				
	Western Europe[1]	North America	Japan	Communist bloc	Total
	(000 metric tons)				
Exporting countries					
South Africa	1,705	120	1,475	—	3,300
Gabon	1,300	390	210	—	1,900
Australia	315	110	624	—	1,050
Brazil	675	595	30	—	1,300
India	—	—	700	—	700
Zaire	230	80	10	—	320
Ghana	260	35	20	—	315
Morocco	120	25	—	—	145
Mexico	50	85	60	—	195
U.S.S.R.	170	5	55	1,070	1,300
Hungary	15	—	—	—	15
Other	15	—	185	—	200
Total	4,855	1,445	3,370	1,070	10,740

[1] Includes Yugoslavia.
— Nil.

furnace at Tamas with a capacity of 50,000 tons a year. Start up is scheduled for late 1975 and, with this addition, Autlan's ferromanganese capacity will rise to 200,000 tons a year. Mexico's projected 10 per cent tax on mineral exports has been postponed because of declining metal prices in 1975.

Table 5. Breakdown of long-term General Services Administration manganese ore contracts

Company	Contract Tonnage	Grade
	(long dry tons)	
Philipp Bros.	1,008,369	42.25-58.03
Division of	216,802	50.96
Englehard Min.	179,571	50.33
& Chem. Corp.		
Union Carbide	413,479	44.75-5.96
Corporation	247,669	50.96
	208,154	40.64-50.47
	82,289	51.28
Worore	486,404	49.72-51.9
	94,383	50.64
U.S. Steel	217,329	44.27
	125,694	41.31
Ralston Trading	59,511[1]	49.68

Source: *Metals Week*, August 26, 1974.
[1] Long wet tons.

South African Iron and Steel Industrial Corporation Limited (ISCOR), the state-owned steel company, has acquired effective control of South African Manganese Limited (Samangan), South Africa's largest producer of manganese ore. ISCOR held a 25 per cent interest in Samangan through a subsidiary, Amcor Limited, which is South Africa's largest ferromanganese producer. After a rights issue of Samangan shares to ISCOR and the transfer of Amcor's assets to Samangan, Amcor is an operating subsidiary of Samangan and ISCOR has effective control of Samangan (about 45 per cent of the common stock). In all probability, the Republic of South Africa will expand its ferromanganese production because of these recent moves. Delta Manganese Proprietary started production of electrolytic manganese metal at Nelspruit in 1974. Initial output is 16,000 tons a year of manganese metal and the output is to be exported to Canada (Aluminum Company of Canada, Limited) and to Japan and Australia.

The U.S.S.R. is asking for bids on a ferroalloy project which will include a ferromanganese plant capable of producing in excess of 1 million tons of standard grade ferromanganese. Technical and financial assistance for the project is being sought from major United States and Western European ferroalloy producers. The U.S.S.R. is also seeking financial assistance from the U.S. Export-Import Bank and from similar export subsidy programs in Western Europe. Some of the companies approached report that the U.S.S.R. would like to repay part of the cost of financial and/or technical assistance with some of the ferroalloys produced. The expected completion date for the project is 1980.

Despite increased ore requirements in the United States, imports of manganese ore declined from 1.5 million tons in 1973 to 1.2 million tons in 1974. Exports increased from 57,448 tons in 1973 to 223,088 tons in 1974. The reduction in imports and increase in exports have been caused by the disposal of manganese ore under long-term contract by the General Services Administration (GSA). Existing contracts for manganese ore are summarized in Table 5. The maximum release rate under the contracts is governed by the authorized disposal rate which currently stands at 750,000 long tons a year. United States Steel has resumed blast furnace ferromanganese production at its National Works at McKeesport, Pennsylvania. Estimated production is 800 to 1,000 tons a day. It is unknown whether U.S. Steel will undertake to supply other companies as it did previously or if production will be for its own consumption only.

Uses

In excess of 90 per cent of the manganese consumed is used in the steel industry. Manganese acts as a desulphurizer, a deoxidizer and is an addition agent that hardens steel and reduces the plasticity of steel.

In steelmaking furnaces, manganese is primarily added in the form of ferroalloys. The principal manganese ferroalloys are shown in Table 6. In addition, some manganese is added as manganese metal. Manganese metal is principally used in specialty steel manufacture where adjustment of manganese content in the late stages of refining precludes the use of manganese ferroalloys because of their associated impurities. Some reduction in the amount of manganese ferroalloys required in the steelmaking furnaces can be realized by adding manganiferous iron ores in the blast furnace. However, no empirical relationship has been developed to determine the precise savings. Current practice in Canada indicates about 14 pounds of manganese are used in the production of one ingot ton of steel exclusive of any manganese contained in iron ores charged to blast furnaces.

Table 6. Principal manganese ferroalloys

	Manganese	Silicon	Carbon
	(per cent)		
Ferromanganese			
High-carbon	74-82	1.25 max	7.5 max
Medium-carbon	74-85	1.50 max	1.5 max
Low-carbon	80-85	7.00 max	0.75 max
Silicomanganese	65-68	18-20 max	0.6-3.0
Spiegeleisen	16-28	1.0-4.5	0.65 max

Source: Mineral Development Sector.

The property which makes manganese irreplaceable is its excellence as a desulphurizer. Steels which contain too much sulphur tend to crack or tear during rolling. Excess sulphur also tends to create surface imperfections during fabrication because the sulphur is usually not disseminated uniformly throughout the steel and, thus, creates a difference in properties in various parts of the steel. Manganese also has some deoxidizing power, but a number of other elements such as silicon have a greater affinity for oxygen. Any manganese oxide and manganese sulphide produced by these scavenging reactions form a fluid slag which is readily separable from the steel.

As mentioned previously, manganese when added to plain carbon steels will increase hardness, reduce plasticity and increase strength. Manganese is also a common constituent of iron castings. Manganese is used to control the sulphur content since sulphur, if not neutralized by manganese, creates surface imperfections, creates areas of dissimilar properties in the iron and increases the shrinkage of iron, which makes accurate casting difficult. Manganese is added to specialty steels primarily to increase strength and/or reduce ductility. One group of alloy steels, known as Hadfield steels, contains 10 to 14 per cent manganese. Hadfield steels are extremely hard and tough and find their chief applications in parts subject to severe mechanical service conditions, such as rock crushers and teeth on excavating equipment.

Electrolytic manganese (99.8 per cent Mn) is used as a deoxidizing agent and as a constituent of nonferrous metals to improve their properties when a minimum of iron and carbon are desired; i.e., instead of manganese ferroalloys. As an alloying agent in nonferrous alloys, manganese improves the strength, ductility and hot-rolling properties. It is used as an alloying element and a cleanser in aluminum alloys, aluminum-bronze alloys, bronze alloys and nickel-chromium superalloys.

The most important use of manganese chemicals is in dry-cell batteries. A dry-cell battery consists of a zinc can, which acts as the anode, and a cathode material (the mix core) which consists of manganese dioxide, carbon and an aqueous electrolyte. The manganese dioxide-zinc cell may assume greater importance in the future. This cell can be made into small wafer types suitable for use in hearing aids and for incorporation into home appliances. Its principal advantage is its ability to work with high efficiency under high-drain conditions.

Manganese dioxide is also used as an oxidant in the processing of several minerals. Manganese dioxide is used in some hydro-metallurgical processes for uranium, in the production of electrolytic zinc, to remove iron in magnesium refining and in the recovery of noble metal values from copper refinery slimes. Manganese dioxide is also used in fluxes and welding rods.

Manganese chemicals have a small but widespread use in plating, as an oxidant and purifier of liquid organics to produce products for the pharmaceutical and chemical industries, in fertilizers, in the manufacture of dyes and pigments, as a drier in paint and as a catalyst in the synthetic fibre and plastics industry. Manganese chemicals are also used as colouring agents in glass and enamel products, ceramics, and cement and bricks.

Prices

Manganese prices exhibited a steady increase through 1974. Ferro-manganese prices almost doubled during the year and this was mainly a reflection of a general shortage although the increases in power costs, caused by the increase in mineral fuel prices, had a significant effect. Ore prices remained relatively stable until the end of the year when a shortage of high-grade manganese began to become apparent and ore prices rose some 15 to 20 per cent. Manganese metal prices increased approximately 50 per cent during the year and, while this was partially caused by a tight market, a significant portion of the price increase is attributable, in some cases, to increases in power costs.

New contracts signed by Japan in 1975 with Gabon, Australia and the Republic of South Africa have price increases. The fob mine price in all cases is about $58 a metric ton of ore grading 48 per cent Mn. These higher prices in the prospect of a balanced market indicate that there may have been some consultation among producers regarding price. This is especially true considering the differentials in transport costs to Japan from these countries.

Outlook

Manganese demand and prices will decline in 1975 as a result of the decrease in world steel production. Ferromanganese and manganese metal prices will not decline to previous price levels because of the increases in power costs. Demand will recover with the general economic recovery predicted for 1976.

In the next few years there will be a shortage of high-grade manganese, not because of a shortage in reserves but because of internal transportation problems in some of the major producing countries, notably Gabon and the Republic of South Africa. The completion of the proposed rail lines in Gabon and Upper Volta and the completion of new port facilities at Saldanka Bay in the Republic of South Africa should alleviate any transport problems by the mid-1980s, at the latest. The supply situation could be severely compounded by export controls on Iocomi's mine in Brazil. Increased ferromanganese production in Australia and Gabon would not appear to be a major factor in determining future supply; however, the potential for increased ferromanganese production in the Republic of South Africa following the corporate realignment there could create potentially serious supply problems. When the port facilities at Saldanka Bay are completed ferromanganese facilities could be built to supply both the planned steel complex there and export markets.

The construction of a ferroalloy plant in the U.S.S.R. capable of producing 1 million tons a year of ferromanganese would not appear to have any bearing on ore supplies in markets outside the Communist bloc. In recent years, the U.S.S.R. has not been a major supplier of ores to western markets and, if this project is realized, the product will probably be consumed within the Communist-bloc countries.

Four countries, namely Gabon, Australia, Republic of South Africa and Brazil produce about 75 per cent of the world's manganese exclusive of the Communist-bloc countries. As mentioned previously, the manganese produced in the Communist-bloc countries is largely consumed internally; so, in western markets, these four producers dominate. India produces the bulk of the remainder but, since it is only exporting lower grade ores, it is not a significant factor. The four countries can, therefore, control the market in high-grade manganese and it appears as if there is currently some corporate contact among them concerning prices. In all probability, manganese ore prices will increase and the prices will exhibit more stability than they have in recent years. This will ultimately lead to increases in ferromanganese prices.

Manganese metal, which has been in tight supply during the year, will continue its strong growth. However, the opening of Delta Manganese in the Republic of South Africa and planned expansions in the United States may well lead to an oversupply in the short-term.

United States prices in U.S. currency, published by Metals Week of December 1973 and December 1974.

	December 1973	December 1974
	(¢)	(¢)
Manganese ore, per long-ton unit (22.4 lb) cif U.S. ports, Mn content		
Min. 48% Mn (low impurities)	85.95	1.10-1.18
Ferromanganese, fob shipping point, freight equalized to nearest main producer, carload lots, lump, bulk per long ton of alloy		

United States prices (concl'd)

	($)	($)
Standard 78% Mn	400.0	400.0
Medium-carbon, per lb. Mn	37.5-49.0	37.5-49.0
Ferromanganese silicon	32.0	32.0
Silicomanganese, per lb. of alloy, fob shipping point, freight equalized to nearest main producer, carload lots, lump, bulk 16-16 1/2% Si, 2%C	11.23	21.5
Manganese metal, electrolytic metal, 99.9%, per lb. Mn, boxed fob shipping point		
Regular	33.25	54.00
6% N	36.25	57.0

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
			(¢)	(¢)
32900-1	Manganese ore	free	free	free
33504-1	Manganese oxide	free	free	free
35104-1	Electrolytic manganese metal	free	free	20%
37501-1	Ferromanganese, spiegeleisen and other alloys of manganese and iron, not more than 1% Si, in the Mn content, per lb.	free	0.5	1.25
37502-1	Silicomanganese, silico spiegel and other alloys of manganese and iron, more than 1% Si, on the Mn content, per lb	free	0.75	1.75

United States

Item No.		On and After Jan. 1, 1972
		(¢ per lb on Mn content)
601.27	Manganese ore (duty temporarily suspended to end of June 1973)	0.12
607.35	Ferromanganese, not containing over 1% C	0.3 + 2%
607.36	Ferromanganese, containing over 1% but not over 4% C	0.46
607.37	Ferromanganese containing over 4% C	0.3
632.32	Manganese metal, unwrought, waste and scrap (duty temporarily suspended on waste and scrap to end of June 1973)	1.5¢ per lb +10% ad. val.

Sources: The Custom Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. Tariff Schedules of the United States, Annotated, (1975), TC Publication 706.

Mercury

J.G. GEORGE

The Pinchi Lake mine of Cominco Ltd., some 30 miles north of Fort St. James, British Columbia, was again in 1974 the sole source of Canada's mine output of mercury. In 1974, the Pinchi Lake mill processed 173,000 tons* of cinnabar ore compared with 163,000 tons in 1973. Production was again restricted in 1974 to meet market requirements. About 56 per cent of the ore was derived from underground operations with the remainder coming from an open pit operated during the summer. Beneficiation of the ore involves concentrating it by flotation, and then roasting the concentrate to produce a mercury vapour which, in turn, is cooled and condensed to produce liquid metallic mercury. In 1974, the roaster produced about 14,000 flasks** of refined mercury. The Pinchi Lake mine's ore reserves at the end of 1974 were 1,300,000 tons containing 110,000 flasks of mercury compared with 1,600,000 tons of ore containing 120,000 flasks of mercury on December 31, 1973.

At its electronic materials plants at Trail, British Columbia, Cominco Ltd. also produced high-purity mercury metal with metallic impurities totalling ten parts per billion, or less. This specialty metal product was manufactured mainly for special applications in the electronics industry, such as advanced radiation detector materials.

Little exploration and development work was done in 1974 at Canadian mercury mining prospects because the demand for the metal continued to remain at relatively low levels.

Canadian imports of mercury metal in 1974, at 239,900 pounds, were more than double the 106,200 pounds imported in 1973. Consumption of mercury metal in Canada, as reported by Statistics Canada, was 83,304 pounds in 1974 or somewhat higher than the 72,663 pounds consumed in 1973. Actual consumption in both years was, however, believed to be considerably higher.

World review

Estimated world mine production of mercury in 1974 was 262,286 flasks, only slightly less than the 268,265 flasks produced in 1973. Spain continued to be the world's largest mine producer of mercury and, together with Italy, accounted for almost 44 per cent of the total output. The eight countries with the largest production, in declining order of output, were Spain, U.S.S.R., People's Republic of China, Italy, Mexico, Yugoslavia, Canada and Algeria.

According to preliminary statistics for 1974, Spanish mine output of mercury was little changed from that of the previous year. On the other hand, Italian mercury output declined almost 24 per cent from that of 1973, partly because of lower quantity and grade of ores mined and the existence of substantial stocks.

In Spain, the Minas de Almaden Company, whose Almaden mine is the largest mercury producer in the world, continued construction of a new plant at Almaden which is scheduled for completion late in 1974. The plant will use a new process for treating waste residues from its roaster to yield an additional 5,000–10,000 flasks of mercury a year. The current stockpile of residues could reportedly provide an additional 200,000–300,000 flasks. Increased production should also come from Algeria where del Monego, an Italian company, is expected to build a new mercury extraction plant near Annaba. It is scheduled to come on stream about the end of 1974. The U.S.S.R., which continued to increase its mercury production in 1974, plans to build a large mercury mining and metallurgical complex near Magadan on the Chukota Peninsula, in eastern Siberia. Construction plans were reportedly authorized after discovery of a deposit of mercury in commercial quantities.

In Yugoslavia, the Bosnian mining enterprise, Srednobosanski Rudnici Uglija, will develop mercury deposits discovered over a five square mile area at Drazevici, near Srednje in the Ozren mountains. About $1 million has already been spent on prospecting work. The main mineral in the ore is cinnabar and it has been reported that the deposits contain some 300,000 metric tons, sufficient to support a ten-year mining operation. The ore has been estimated to grade between 0.35 and 9.0 per cent mercury with a

* Wherever used in this review, the term 'ton' refers to the short ton of 2,000 pounds avoirdupois, unless otherwise stated.

** The flask containing 76 net pounds avoirdupois is used throughout.

mean of about 1.4 per cent.

In Italy, Monte Amiata, the country's largest mercury producer, was sold to the Italian government, apparently because it had been in financial difficulty for the past few years. The "Monte Amiata" group comprises several mines, in a radius of some 15 miles of a central processing plant, located in the district of Tuscany about 125 road-miles northwest of Rome. The mines are operated by EGAM which is a holding company controlled by Instituto Reconstruction Industrial (IRI). IRI reports to the Italian government's "Ministry of State Participation" which owns and controls many Italian firms producing a wide variety of products.

Mine production of mercury ceased in Japan at the end of September 1974 when the country's sole producer, Hokushin Mining, suspended operations at its Ryushoden mercury mine in Hokkaido. The mining company is a subsidiary of Nippon Mining Co. Ltd.

Because of the relatively low prices that again obtained in 1974, production at almost all mercury mines in Mexico remained unprofitable. To aid the industry, which is almost entirely privately owned, the Mexican government was reported to have granted certain tax benefits to a confederation of mercury producers. This group of producers was established under the name "National Union of Mercury Producers." Some of its aims were to enable direct selling of mercury on the international market, to increase mercury production, and to establish secondary industries requiring mercury.

By late 1972 Chinese mercury was reported to be slowly moving into western markets, including the United States. Since then it is believed that increasing amounts of Russian, as well as Chinese mercury, have been sold to western countries. Such sales have had a depressing effect on the mercury market and prices.

Mine output of mercury in the United States continued its decline in 1974 and, at 2,189 flasks, was 38 flasks less than in 1973 and was the lowest since record keeping began in 1850. In the fourth quarter of 1974 production of prime virgin mercury was only 287 flasks, derived from five primary producing mines. These were the Guadalupe, Oat Hill, Knoxville, Manhattan-One Shot and New Almaden, all in California. Byproduct mercury continued to be recovered from the Carlin gold mine in Nevada.

United States mine output of mercury is expected to increase substantially in 1975 because of the anticipated bringing into production of the new McDermitt

Table 1. Canadian mercury production, trade and consumption, 1973-74

	1973		1974p	
	(pounds)	($)	(pounds)	($)
Mine production	950,000	..	1,064,000	..
Imports (metal)				
Spain	23,500	88,000	128,800	201,000
United States	43,300	157,000	36,700	144,000
Mexico	3,800	14,000	30,400	114,000
Italy	—	—	21,300	77,000
Peru	5,700	22,000	7,800	29,000
Netherlands	29,300	101,000	7,500	27,000
Yugoslavia	—	—	6,500	23,000
Switzerland	—	—	600	1,000
United Kingdom	600	2,000	300	1,000
Total	106,200	384,000	239,900	617,000
Consumption (metal)				
Heavy chemicals	55,170	..	60,357	..
Electrical apparatus	9,648	..	12,299	..
Gold recovery	860	..	427	..
Miscellaneous	6,985	..	10,221	..
Total	72,663		83,304	

Source: Statistics Canada, except for mine production figures which represent output by Cominco Ltd. as reported in its annual report.
p Preliminary; — Nil; .. Not available.

Table 2. Canadian mercury production, trade and consumption, 1965-74

	Production, Metal	Imports Metal	Imports Salts	Exports, Metal	Consumption, Metal
	(pounds)	(pounds)	($)	(pounds)	(pounds)
1965	1,520	1,071,900	..	..	415,996
1966	—	404,600	..	..	171,588
1967	—	356,300	..	..	245,121
1968	430,160	197,900	..	..	327,939
1969	1,603,600	133,600	..	..	308,814
1970	1,854,400	153,300	..	..	340,558
1971	1,406,000	122,000	..	..	193,968
1972	1,109,600	174,700	..	..	114,636
1973	950,000	106,200	..	..	72,663
1974^p	1,064,000	239,900	..	..	83,304

Source: Statistics Canada for all figures with the exception of metal production statistics for 1968 to 1974 inclusive which were obtained directly from Cominco Ltd. and represent output from its Pinchi Lake mine in British Columbia.
^{p} Preliminary; — Nil; .. Not available.

Table 3. World production of mercury

	1970	1973	1974^p
		(flasks)	
Spain	45,552^r	60,076	60,200^e
U.S.S.R.^{e}	48,000	52,000	54,000
People's Republic of China^e	20,000	26,000	26,000
Italy	44,470^r	32,692	24,950^e
Mexico	30,256^r	21,640[1]	21,200^e
Yugoslavia	15,461	15,606	15,838
Canada	24,400	12,500	14,000
Algeria	—	13,300	13,300^e
Turkey	8,592	8,439	8,400^e
Czechoslovakia	4,815	6,991	7,100^e
West Germany	..	4,700	4,930^e
Peru	3,196^r	3,581	3,800^e
Philippines	4,648	2,160	2,300^e
United States	27,296	2,227	2,189
Japan	5,170	3,742	1,409
Ireland	1,304	1,345	1,360^e
Other countries	854	1,266	1,310^e
Total	284,014^r	268,265	262,286

Sources: 1972 U.S. Bureau of Mines, *Minerals Yearbook*, for 1970 statistics. U.S. Bureau of Mines, *Mineral Industry Surveys*, for 1973 and 1974 figures.
[1] Exports.
^{p} Preliminary; ^{e} Estimated; ^{r} Revised; — Nil; .. Not available.

mercury property in northern Humbolt County, Nevada. The mine is expected to come on stream about mid-1975 and eventually produce refined mercury at a rate of 20,000 flasks a year. The property will be mined by open-pit methods, and the ore will be processed in a 700-ton-a-day concentrator with the flotation concentrate being furnaced in a system containing a multiple-hearth roaster and equipped with emission control devices. Ore reserves have been reported to be in excess of 3,000,000 tons, grading 0.5 per cent mercury. The primary mineral is cinnabar (HgS), but an unusual feature of the deposit is that about 10 to 30 per cent of the cinnabar in the orebody has been replaced by an uncommon mercury mineral known as corderoite ($Hg_3S_2Cl_2$). The McDermitt mine is about 2,000 feet north of the Cordero mine which, along with adjacent properties, produced over 115,000 flasks of mercury from 1941 to 1970. Development costs to bring the new mine into production have been reported to be some $9.7 million. Placer Amex, Inc., a wholly-owned subsidiary of Placer Development Limited, has a 51 per cent interest in the McDermitt property with Mineral Exploration Company of New Jersey holding the remaining 49 per cent interest. Noranda Mines Limited holds a 31.5 per cent direct interest in Placer Development Limited.

The United States is believed to be the world's largest consumer of mercury, but has always produced less than its requirements. Total consumption in 1974 in the United States of primary, redistilled and secondary mercury was estimated at 60,070 flasks, an increase of almost 11 per cent over the 54,283 flasks consumed in 1973. A large portion of the U.S. requirements was again derived from imports which totalled

52,102 flasks* in 1974, an increase of 13 per cent over the 46,076 flasks imported in 1973. The largest suppliers in 1974 in declining order of amount supplied were Canada, Mexico, Algeria, Spain and Yugoslavia. Together these countries accounted for more than 93 per cent of total imports by the United States. Imports from Canada itself amounted to 16,973 flasks or almost 33 per cent of the total.

The largest increases in United States mercury consumption in 1974 were noted in the metal's uses in the electrolytic preparation of chlorine and caustic soda, for electrical apparatus and for catalysts.

Table 4. United States mercury consumption, by uses, primary and secondary in origin

	1970	1973	1974p
		(flasks)	
Agriculture[1]	1,811	1,830	980
Amalgamation	219	—	—
Catalysts	2,238	673	1,296
Dental preparations	2,286	2,679	2,722
Electrical apparatus	15,952	18,000	18,888
Electrolytic preparation of chlorine and caustic soda	15,011	13,070	16,813
General laboratory use	1,806	658	357
Industrial and control instruments	4,832	7,155	5,581
Paint			
Antifouling	198	32	6
Mildew-proofing	10,149	7,571	6,925
Paper and pulp manufacture	226	—	—
Pharmaceuticals	690	606	586
Other[2]	5,858	1,913	2,150
Total known uses	61,276	54,187	60,070[3]
Unknown uses	227	96	..
Grand Total	61,503	54,283	60,070[3]

Sources: 1973 U.S. Bureau of Mines, *Minerals Yearbook*, for 1970 and 1973 statistics. U.S. Bureau of Mines, *Mineral Industry Surveys*, "Mercury in the First Quarter 1975," for 1974 statistics.

[1] Includes fungicides and bactericides for industrial purposes. [2] Includes mercury used for installation and expansion of chlorine and caustic soda plants. [3] The individual figures do not add up to the total which has been increased to cover approximate total consumption.
p Preliminary; — Nil; .. Not available.

* Reported in United States Department of the Interior, Bureau of Mines, *Mineral Industry Surveys*, "Mercury in the First Quarter 1975."

World consumption of mercury in 1974 is reported to have been about 250,000 flasks, or only slightly more than that of 1973. This smaller than expected increase resulted partly because of the continuing general public outcry against environmental pollution. In some large industrial nations, including the United States, the use of mercury in some of its applications continued to be adversely affected by this unfavourable publicity. One of the metal's two major uses, as a cathode in the electrolytic preparation of chlorine and caustic soda, continued to be a principal target of the ecologists because of the danger of pollution from the effluents. The danger of mercury poisoning has also continued to cut into other outlets for the metal, such as in agricultural, pulp and paper, and paint industries.

In order to try to bring about more stability to the mercury market, partly by agreeing on concerted measures to control supplies and regulate prices, delegates from the major mercury-producing countries met on several occasions during 1973. At the October meeting in Queretaro, Mexico (located in Mexico's major quicksilver producing region), representatives of that country, as well as of Algeria, Italy, Spain, Turkey and Yugoslavia, met and signed an agreement to pursue market stability. This agreement provided for a common pricing policy which established floor prices for mercury and stipulated that the producers would sell only to agents who would agree to follow their marketing policy. The producers also decided to sponsor a study of the supply and demand situation for mercury and set up an international research institute to investigate new uses for mercury to offset cutbacks in industry because of environmental pollution.

In mid-May 1974 the mercury producers' group held another meeting in Algeria which was attended by representatives from Algeria, Italy, Mexico, Spain, Turkey and Yugoslavia. At this meeting it was agreed to establish a floor price of $350 a flask for mercury. The producers also planned to uphold the floor price by stockpiling metal and thereby withholding some supplies from the market. Following announcement of the floor price the New York and European mercury prices increased between $40 and $50 a flask by late June 1974, but the following month a decline set in and a downward price trend prevailed until year-end.

The First International Congress on Mercury was held May 6–10, 1974 in Barcelona, Spain. The papers presented at the meeting covered many aspects of the mercury industry, including economics, geology, mining, metallurgy, biological effects and uses. More than one speaker suggested that the beneficial aspects of mercury should be stressed and that renewed efforts be made to develop new applications for the metal. It was admitted that some of the producers and consumers of mercury could improve their operations so as to reduce the hazards to humans and the environment from mercury pollution.

One of the speakers at the Congress forecast a growth of only ten per cent in world consumption of mercury from 1972 to 1980, increasing from 245,000 flasks in 1972 to 270,000 flasks in 1980. This forecast was predicated on a decline of 25 per cent in the use of mercury in the production of chlorine and caustic soda from 1972 to 1980, and an increase of about four per cent a year in all other uses of mercury. Another speaker forecast that overall consumption of mercury would increase at an annual rate of 2.2 per cent from 1974 to 2000, with the cumulative world demand reaching nine to ten million flasks by the end of the 20th century. World mine reserves of mercury together with recycled metal were considered sufficient to meet this demand.

At the end of 1974, United States government strategic stockpiles contained a total of 200,105 flasks of mercury, with no disposals from these stocks being made in that year. The strategic stockpile objective remained at the 42,700-flask level which had been established in April 1973. A bill, H.R. 7153, was introduced in the House of Representatives on April 18, 1973 to grant authorization for release of the total surplus of 157,405 flasks. The bill was referred to a subcommittee of the House Armed Services Committee but, as of December 31, 1974, no action had been taken by the Congress on the bill, and, therefore, the proposed stockpile reduction and the rate of its disposal have yet to be determined. Such stocks are exclusive of excess mercury held by the United States Atomic Energy Commission (USAEC). In June 1969, these surplus USAEC stocks, which do not require Congressional authorization prior to being sold, were declared to be 15,000 flasks. Between then and the end of 1973, a total of 10,372 flasks were sold or released to other government agencies, leaving a surplus of 4,628 flasks of USAEC mercury available for disposal at December 31, 1973. General Services Administration (GSA) continued its offerings of such stocks in 1974 at the rate of 500 flasks (maximum) a month, with metal so released being restricted to domestic consumption. GSA released a total of 2,353 flasks in 1974, leaving a surplus of 2,275 flasks of USAEC mercury at December 31, 1974.

In March 1974, the U.S. Environmental Protection Agency (EPA) promulgated its final effluent limitation guidelines for existing and new sources in the inorganic chemicals manufacturing category. The daily effluent limitation is 0.00028 pound of mercury per 1,000 pounds of product for mercury-cell plants in existence since March 1974. The limitation is 0.00014 pound of mercury per 1,000 pounds of product for new-producing plants. One of the stated goals of the Federal Water Pollution Control Act of 1972 is the elimination of all pollutant discharges by 1985.

On April 6, 1973 the U.S. Environmental Protection Agency (EPA) published the final air emission standard for mercury at 5.1 pounds a day, per plant, released to the atmosphere. In 1974, EPA proposed an amendment to the emission standard for hazardous air pollutants in which mercury emissions from the incineration and drying of wastewater treatment plant sludges would be limited to a maximum of 3,200 grams (7.05 pounds) per day. Furthermore, the National Institute for Occupational Safety and Health submitted criteria for a recommended standard on the occupational exposure to inorganic mercury.

In October 1974, the Environmental Protection Agency opened hearings on the cancellation of biocidal uses of mercury, including mildewcides, in paint. The hearings were recessed until February 1975 when witnesses for the registrants were scheduled to appear.

In Canada, legislation, known as the "Chlor-Alkali Mercury Regulations" (P.C. 1972-576), was passed by the federal government March 28, 1972 and became effective 60 days after that date. This legislation restricted the quantity of mercury that may be discharged in the effluent from any chlor-alkali plant in Canada using the m rcury cell process. It stipulates that mercury in the ıiquid effluent, from any such chlor-alkali plant, deposited in any one day in waters frequented by fish shall not exceed 0.005 pound per ton of chlorine produced by the plant in that day.

Also in Canada, the Food and Drugs Act, a federal statute (Chapter F-27 R.S.C., 1970, as amended) is designed, among other things, to protect Canadians against health hazards related to foods. The Act is administered by the Health Protection Branch of the Department of National Health and Welfare. Section 4 (a) of the Act provides legal authority for the Branch to determine those levels in foods of substances such as mercury, which are considered to represent a hazard to human health, and to prohibit the sale of foods containing unsafe levels of the substances in question. After a study of the available data on the toxic effects to humans of mercury-contaminated fish, the consumption of fish by Canadians, and action taken by other countries on this matter, the Health Protection Branch decided in 1969 that, as a temporary measure, it would take no exception to the sale of fish containing not more than 0.5 part per million (ppm) of mercury determined on a wet basis. In effect, this 0.5 ppm mercury level represents an administrative guideline applicable to fish only and legally binding only at the point of sale. Apparently this same 0.5 ppm mercury level in fish was subsequently adopted by the United States government authorities.

Outlook

The New York and European mercury prices reached highs of \$350 and \$325 a flask, respectively, in June 1974 following establishment of a floor price of \$350 a flask by the world producers' group in May of the same year. The higher price levels were short-lived as a decline soon set in and continued to year-end. Because of a poor demand resulting from depressed world economic conditions, excessive stocks and adverse publicity from ecological sources, mercury prices continued to decline through much of 1975.

In 1976, mercury prices could strengthen somewhat partly due to higher costs of production, but mainly because of the upturn in the United States economy and the anticipated improvement in the economies of Europe and Japan. In the next few years mercury prices are expected to show the same distortions as in the past because of erratic demands. Much will depend on the continued determination of the major producers to control offerings to the market and, hence, prices. There is also the risk that rising prices, if sustained for any period, might lead to the reopening of mines that cannot be operated economically under present conditions.

Overhanging the mercury market is the substantial quantity of over 200,000 flasks in the United States government's strategic stockpile and the relatively large unsold stockpiles reportedly held by the Italian producers. The appearance of up to 20,000 flasks a year from the new McDermitt mine in the United States could have serious repercussions on an already oversupplied market. Another bearish factor is the likelihood of increasing quantities of Russian and Chinese mercury being disposed of in western Europe, but not in the United States because of higher import duties obtaining there against imports of mercury from communist countries. The market could also be faced with increased offerings from Turkey, because of new cinnabar discoveries and modernization of its existing mines. Any significant increase in Yugoslavian mercury output would worsen the current depressed state of the quicksilver market.

Because of environmental factors, another bearish influence on the mercury market in the medium-term, (up to 1980) is the trend to greater use of the diaphragm cell (which requires no mercury) in the electrolysis of brine to produce chlorine and caustic soda. At present, more than two thirds of the chlorine produced in the United States is made in diaphragm cells, whereas in western Europe about 80 to 90 per cent is made in mercury cells. While the short chlorine supply situation envisaged by the industry over the next few years will continue to spur expansion of chlor-alkali plants in the United States, none of the half dozen or more such plants which were expected to come on stream in 1974–75 will use the mercury cell. The new $30-million chlor-alkali plant that Canadian Industries Limited has under construction at Becancour, Quebec, and planned to start up early in 1975, will use the diaphragm cell. Also, some of the existing plants in the United States, Canada and Japan that were using the mercury cell have either dismantled their facilities, or converted to the diaphragm cell. The excess secondary mercury released for recycling by such dismantled plants or those making the change-over has a further depressing effect on the market. Countering this general switch to the diaphragm cell are new chlor-alkali plants being constructed in Rumania and Venezuela that are using the mercury cell. Imperial Chemical Industries Limited is also using the mercury cell in a major new extension it is making to its Runcorn chlor-alkali plant in Britain. Insofar as the choice of process is concerned, the quality of chlorine produced by the two types of electrolytic cell is similar but, whereas the mercury cell produces 50 per cent by-product caustic soda of high purity, the diaphragm cell produces about 11 per cent caustic soda, with a substantial impurity of salt. If the diaphragm cell caustic soda is to be sold it has to be concentrated and this requires the use of steam as an evaporator. The mercury cell, however, requires substantially more power than the diaphragm cell.

Although environmental problems will continue to check the growth in the overall use of mercury until about 1980, there is one bright spot in the outlook for the metal. Its consumption in the electrical apparatus industry is growing substantially and is likely to continue to do so for an indefinite period. Also, an increase in demand could eventually result from the concerted efforts expected to be made by the mercury producers' group to find new uses and markets for the metal and its compounds. The development of improved antipollution technology could help the metal achieve a better image.

The coming into production in June 1975 of the McDermitt mercury mine in Nevada, U.S. could have had a bearing on Cominco Ltd.'s decision in August 1975 to suspend operations indefinitely at its property at Pinchi Lake, B.C. because a substantial portion of the Pinchi Lake output of refined mercury had been marketed in the United States. In 1974, almost 33 per cent of United States' mercury imports came from Canada.*

Uses

One of the oldest but now relatively unimportant applications of mercury is for recovering gold and silver from their ores by amalgamation. The two major uses in recent years have been for electrical apparatus and for the electrolytic production of chlorine and caustic soda, although the latter use has been declining. Together these two uses accounted for almost 60 per cent of mercury consumed in the United States in 1974. Electrical uses include mercury lamps, batteries, rectifier bulbs, oscillators, and various kinds of switches including "silent" switches for use in the home. Because mercury lamps are adaptable to higher voltage supply lines than those used with incandescent lamps, they are used as fluorescent lamps and for industrial and street lighting purposes. The mercury battery invented in 1944 is basically a dry-cell type battery. It has a relatively long shelf life and can withstand high tem-

* Based on figures contained in the U.S. Bureau of Mines, *Mineral Industry Surveys,* Mercury in the Fourth Quarter 1974.

perature and high humidity. It is used in Geiger-Muller counters, portable radios and two-way communications equipment, digital computers, electronic measuring devices, hearing aids, guided missiles, and spacecraft.

Other applications are in mildew-proofing paints, industrial and control instruments, pharmaceuticals, insecticides, fungicides, bactericides, and dental preparations, although in some countries some of these uses have already been restricted or banned by governmental regulations. Several mercury compounds, especially chloride, oxide and sulphate, are good catalysts for many chemical reactions, including those involved in the making of plastics. Because of its capacity to absorb neutrons the metal has been used as a shield against atomic radiation. One of the more recently developed applications for mercury is in frozen mercury patterns for manufacturing precision or investment castings. Here, mercury is superior to wax, wood or plastic materials because of its smooth surface and uniform expansion upon heating. New technologies could open up new areas of use in the nuclear, metal-chloride vapour, plastic, chemical, amalgam and ion exchange fields. Substitutes for mercury include nickel-cadmium or other battery systems for electrical apparatus, diaphragm cells for mercury cells in the chlor-alkali industry, organotin compounds in paints, and solid-state devices for industrial and control instruments.

Prices

Mercury prices fluctuated in a relatively narrow range from the beginning of 1974 until the last week of May, when they turned sharply upward and reached a peak of $350 a flask early in June after announcement of a floor price at the same level was made at the producers' meeting in Algeria. This floor price prevailed until almost mid-July when a significant downward trend began which continued until year-end. A steep decline in prices in December 1974 was attributed by dealers to a significant movement of Russian and Chinese mercury into the European market. The price of mercury per flask, fob New York, as quoted in *Metals Week,* ranged in 1974 between a high of $350 in June and a low of $190 in December. Average for the year was $281.69 a flask compared with an average of $286.23 for 1973. In 1974, the cif main European port price, as quoted in *Metal Bulletin* (London), ranged between a high of $325 (U.S.) a flask in June and a low of $150 (U.S.) in December.

Table 5. Average monthly prices of mercury in 1974 at New York and cif main European port

		Cif main European port[2]	
	New York[1]	Low	High
	($ U.S./flask)		
January	275.545	266.444	271.667
February	284.222	265.250	270.250
March	288.286	268.222	273.222
April	282.318	264.750	270.625
May	294.318	270.875	278.000
June	335.000	310.000	321.250
July	317.500	300.000	308.889
August	289.091	270.000	278.125
September	279.150	269.375	274.375
October	265.364	256.222	262.889
November	254.944	243.111	247.889
December	214.524	191.375	204.125

Sources: *Metals Week* for New York prices; *Metal Bulletin* (London) for cif main European port prices.
[1] Prime virgin metal. [2] Prices are cif main European port, min. 99.99 per cent.

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
92805-2	Mercury metal	free	free	free
92828-4	Mercury oxide for manufacture of dry-cell batteries (expires February 28, 1977)	free	free	25%

United States

Item No.		
601.30	Mercury ore	free
632.34	Mercury metal, unwrought, and waste and scrap	12.5 cents per pound*

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

* The duty applicable to mercury waste and scrap was suspended until June 30, 1975. Also, mercury metal entering the United States from the U.S.S.R. and other communist countries is subject to the statutory import duty of 25¢ per pound (equivalent to $19.00 a flask).

Molybdenum

MICHEL A. BOUCHER

Canadian shipments of molybdenum products including molybdenum concentrates, molybdic oxide and ferromolybdenum were less in 1974 than in 1973, but higher prices were paid for the products.

For the second consecutive year, world demand for molybdenum exceeded world supply, and prices were raised three times during the year. The deficit was made up by releases from the U.S. Government's General Services Administration stockpile which, at the end of the year, was essentially depleted and by a reduction of producers' stocks. Production from the United States, Canada and Chile in 1974 was 155 million pounds of molybdenum (Mo) as compared with about 159 million pounds in 1973. Consumption in the noncommunist world was reported to have exceeded mine production by some 15 – 20 million pounds. In contrast to some other metals which have been affected by the economic slowdown, molybdenum consumption is somewhat insulated from the general downturn that is affecting metals dependent on the automotive industry because molybdenum is primarily used in nonautomotive steels that continued to be in strong demand.

Canadian production

Canadian molybdenum shipments of oxide, ferromolybdenum and sulphides in 1974 amounted to 29,603,000 pounds of contained Mo valued at $57,992,000 compared with 30,391,463 pounds valued at $51,851,509 in 1973.

About 50 per cent of domestic production comes from the Endako Mines Division of Placer Development Limited who, along with Brenda Mines Ltd., are the only primary concentrate producers: the remainder of molybdenum production comes principally from four large tonnage copper mines as a byproduct of copper concentrating operations.

Noranda Sales Corporation Ltd. is the marketing agent for pooled production of molybdenum in concentrates and oxide from four Canadian producers, namely Endako Mines Division of Canex Placer, Brenda Mines Ltd., Gaspé Copper Mines, Limited, and K R Ç Operators Ltd.

Apart from producing concentrates of MoS_2, Canada produces molybdic oxide (MoO_3). In British Columbia, Endako Mines Ltd. operates a roaster at Endako that has a production capacity of about 15 million pounds Mo contained in MoO_3. In Quebec, Fundy Chemical International Ltd. operates a roaster that has a production capacity of 20 million pounds of Mo a year.

Ferromolybdenum is produced by Masterloy Products Limited at Gloucester, near Ottawa, Ontario and by Fundy Chemical International at Duparquet, Quebec. The production capacity of these plants is difficult to estimate because the furnaces can be used to make any of the following types of ferro alloys: ferromolybdenum, ferrovanadium, ferrocolumbium and ferrotungsten. Sodium molybdate is also produced in small quantities by Dominion Colour Corporation Limited with a plant at Ajax, near Toronto and by Hercules Canada Ltd., with a plant at St. Jean d'Iberville, Quebec. Both plants produce sodium molybdate for their own consumption.

Trade

Almost all Canadian production of molybdenum is exported in the form of concentrates or oxides. Very little is exported as ferromolybdenum and none as metal. Most is exported to Europe and Japan. Access to the United States market is restricted by a tariff of 12¢ a pound on Mo content of ores and concentrates, and 10¢ a pound plus 3 per cent *ad valorem* for oxide and ferromolybdenum. Canadian producers follow the Climax Molybdenum Company price for domestic sales, and the United States tariff effectively prohibits sales of Canadian molybdenum in the United States. Canadian exports of molybdenite concentrates, oxide and scrap increased from 24.89 million pounds in 1973 to 27.37 million pounds in 1974. Because of a strong demand for molybdenum, the Canadian producers of oxide purchased large quantities of molybdenite ores and concentrates from the General Services Administration of the United States in 1974. Imports of ores and concentrates increased from 1.36 million pounds in 1973 to 2.23 million pounds in 1974. Imports of ferromolybdenum from the United States also increased considerably from 0.22 million pounds in 1973 to 0.59 million pounds in 1974. In 1974, imports of molybdenum alloy wire from the United States amounted to 43,193 pounds and were valued at $494,066.

Table 1. Canada, molybdenum production, trade and consumption, 1973-74

	1973		1974p	
	(pounds)	($)	(pounds)	($)
Production (shipments)[1]				
British Columbia	30,391,463	51,851,509	29,238,000	57,277,000
Quebec	—	—	365,000	715,000
Total	30,391,463	51,851,509	29,603,000	57,992,000
Exports				
Molybdenum in ores and concentrates and scrap[2]				
Belgium-Luxembourg	8,941,000	16,947,000	10,765,800	21,280,000
Japan	7,177,400	15,031,000	6,863,100	16,655,000
United Kingdom	4,048,700	7,645,000	2,552,000	4,883,000
West Germany	1,167,400	1,394,000	2,651,300	4,194,000
Brazil	551,500	1,191,000	708,700	1,571,000
Austria	122,200	236,000	552,300	1,182,000
Sweden	322,600	427,000	803,800	982,000
Australia	380,600	690,000	409,000	981,000
France	638,200	1,065,000	534,100	863,000
Netherlands	118,100	168,000	449,200	772,000
India	186,800	388,000	172,300	486,000
Other countries	1,237,200	2,411,000	904,700	1,354,000
Total	24,891,700	47,593,000	27,366,300	55,203,000
Imports				
Molybdic oxide (gross weight)	199,400	246,000	189,400	268,000
Molybdenum in ores and concentrates[3] (Mo content)	1,364,335	2,204,715	2,229,757	4,232,509
Ferromolybdenum[3] (gross weight)	220,075	309,098	588,731	975,314
Consumption (Mo content)				
Ferrous and nonferrous alloys	4,290,537	..	3,491,481	..
Electrical and electronics	16,713	..	13,284	..
Other uses[4]	127,464	..	183,890	..
Total	4,434,714	..	3,688,655	..

Source: Statistics Canada, except where noted.
[1] Producers' shipments (Mo content) of molybdenum concentrates, molybdic oxide and ferromolybdenum. [2] Includes molybdenite, molybdic oxide in ores and concentrates. [3] United States exports of molybdenum to Canada, reported by the U.S. Bureau of Commerce, Exports of Domestic and Foreign Merchandise (Report 410), value in U.S. currency. These imports are not available separately in official Canadian trade statistics. [4] Chiefly pigment uses.
p Preliminary; .. Not available.

Consumption

Canadian consumption decreased from 4,434,174 pounds of contained Mo in 1973 to 3,688,655 pounds in 1974. Most of the molybdenum consumed by the steel industry is added as molybdic oxide, because molybdic oxide is not as expensive as ferromolybdenum and is more readily available.

The major consumers of molybdic oxide and ferromolybdenum in Canada are as follows:

Molybdic Oxide

Atlas Steels Division of Rio Algom Mines Limited.
The Algoma Steel Corporation, Limited.
The Steel Company of Canada, Limited (Stelco).
Colt Industries (Canada) Ltd.
Dominion Colour Corporation Limited.
Ford Motor Company.
Dominion Foundries and Steel, Limited (Dofasco).
Dominion Engineering Works, Limited.
Abex Industries Ltd.

Esco Limited.
Welmet Industries Limited.
Fahralloy Canada Limited.

Ferromolybdenum

Atlas Steels Division of Rio Algom Mines Limited.
The Steel Company of Canada, Limited.
Canron Limited.
Dominion Engineering Works, Limited.
Colt Industries (Canada) Ltd.
The Indiana Steel Products Company of Canada Limited.
The Canadian Iron and Foundries Company (Limited).
Fahralloy Canada Limited.

Even though Canada produces only molybdenite concentrates, molybdic oxide, ferromolybdenum and, to a smaller extent, sodium molybdic oxide, Canadian industries consume several other products as follows:

Molybdic oxide
(purified grade)

Cyanamid of Canada Limited.
Alchem Limited.

Molybdenum disulphide
(lubricant grade)

Oil Companies.
Canadian National Railways.
Forsyte Lubrication Associates Limited.

Ammonium molybdate

Mallinckrodt Canada Ltd.
Canadian Scientific Products Ltd.
A&K Petro-Chem Industries Limited.

Molybdenum metal powder, bar, sheet

Deloro Stellite Division of Canadian Oxygen Limited.
Varian Associates of Canada Ltd.
The Indiana Steel Products Company of Canada Limited.
Welmet Industries Limited.
Fahralloy Canada Limited.

Molybdenum wire

Canadian General Electric Company Limited (CGE).
Westinghouse Canada Limited.
Sylvania Electric (Canada) Ltd.

Canadian developments

The Boss Mountain molybdenum mine of Brynnor Mines Limited, a wholly-owned subsidiary of Noranda Mines Limited, commenced production in January 1974 after being shutdown since December 3, 1971 because of a decrease in demand for molybdenum. Ore reserves at the end of 1971 were 2.7 million tons grading 0.25% Mo. The mine is equipped with a 1,000-ton-a-day concentrator.

On October 11, 1974, a strike was called at Endako by the Canadian Association of Industrial, Mechanical

Table 2. Canada, molybdenum production, trade and consumption, 1964-74

	Production[1]	Exports[2]	Imports		Consumption[5]
			Molybdic oxide[3]	Ferro-molybdenum[4]	
			(pounds)		
1964	1,224,712	. .	490,500	271,605	1,261,454
1965	9,557,191	. .	759,500	398,460	1,702,589
1966	20,596,044	. .	665,500	522,800	1,261,387
1967	21,376,766	23,792,700	452,600	316,692	1,430,895
1968	22,464,273	22,704,500	1,359,300	284,600	1,543,432
1969	29,651,261	25,672,600	76,600	482,609	1,808,772
1970	33,771,716	30,334,000	73,900	65,299	2,286,061
1971	22,662,732	22,944,800	64,600	183,156	1,814,586
1972	28,493,007	31,329,300	26,700	74,201	2,708,059
1973	30,391,463	24,891,700	199,400	220,075	4,434,714
1974p	29,603,000	27,366,300	189,400	588,731	. .

Source: Statistics Canada.
[1] Producers' shipments (Mo content) molybdenum concentrates, oxide and ferromolybdenum. [2] Mo content, ores and concentrates. [3] Gross weight. [4] U.S. exports to Canada reported in United States Exports of Domestic and Foreign Merchandise, gross weight. [5] Mo content of molybdenum products reported by consumers.
p Preliminary; . . Not available.

and Allied Workers Union. A *force majeure* was declared on October 17 on deliveries of molybdenite concentrates and roasted molybdenite concentrates. Also affected by the *force majeure* were deliveries of ferromolybdenum that Endako produced from roasted molybdenite concentrates. The strike was settled by mid-December.

The Granby Mining Company Limited, continued its option on the Carmi molybdenum property of Vestor Explorations Ltd. near Kelowna, British Columbia. Dynamic Mining Explorations Ltd. and its partners in the Thelon-Dazan project expanded their holdings in the Baker Lake area of the Northwest Territories. The property contains uranium and molybdenum. However, more ore must be found to make the property economic.

Because of an expected strong demand for molybdenum in Japan, the Japanese Molybdenum Producers Association sent a mission to the United States and Canada during the year to negotiate long-term contracts for molybdenum ores over the next five years. In the past, the Japanese producers imported molybdenum concentrates essentially on the basis of spot purchases or short-term annual contracts. The mission met with representatives from Noranda Mines Limited and Placer Development Limited but, apparently, the Japanese did not succeed in obtaining any long-term contracts.

During 1974, Noranda continued its research in leaching of molybdenum ores.

Foreign developments

Ore production from the underground Henderson mine in Colorado of Amax Inc. is scheduled for 1977 at a rate of 30,000 tons a day. The mine has reserves of over 300 million tons grading 0.49 per cent MoS_2.

Amax is the price leader and currently provides about 35 per cent of the world's molybdenum. Amax closed its Urad molybdenum mine in Colorado in December 1974 as a result of exhausted reserves; the mine's production of 7 million pounds a year will be compensated for by the open-pit expansion of the company's Climax mine.

Ore production at Climax will rise from 43,000 to 60,000 tons a day. Amax intends to double its molybdenum conversion plant capacity in Rotterdam from 15 million pounds a year to 30 million pounds in 1977.

Corporacion del Cobre de Chile (Codelco), a Chilean government agency, is constructing a new 18-million-pound-a-year molybdenum plant at its Chuquicamata copper complex. The plant, which will have a treatment capacity of up to 30 million pounds a year of molybdenum equivalent in molybdenite concentrates, will permit essentially the full recovery of byproduct molybdenum from the Chuquicamata concentrates.

Early in 1974, the General Services Administration (GSA) of the United States was given authority to sell

Table 3. Molybdenum production in ores and concentrates, 1972-74

	1972	1973	1974^e
	(Mo content, '000 pounds)		
United States	112,138	115,859	115,000
Canada	28,493	30,391	29,603
U.S.S.R.	18,100	18,700	. .
People's Republic of China	3,300	3,300	. .
Chile	13,045	12,974	10,000
Peru	1,712	1,592	2,000
Japan	494	346	. .
Bulgaria	310	310	. .
Norway	414	289	. .
Australia	130	130	. .
South Korea	110	112	. .
Mexico	172	90	. .
Other free world	—	—	1,000
Total	178,418	184,093	157,603

Sources: U.S. Bureau of Mines, *Minerals Yearbook, 1973;* U.S. Commodity Data Summaries, January 1975; for Canada, Statistics Canada.
^{e} Estimated; . . Not available; — Nil.

Table 4. United States consumption of molybdenum by end use, 1973

	('000 pounds contained molybdenum)
Carbon steel	1,399
Stainless and heat resisting	8,476
Full alloys[1]	21,596
High-strength, low-alloy	2,717
Electric	608
Tool steel	4,992
Cast irons	4,370
Superalloys	3,059
Welding and hardfacing rod and materials	349
Other alloys and nonferrous alloys	901
Mill products made from metal powder	2,997
Chemical and ceramic uses:	
Pigments	1,249
Catalysts	2,341
Other	1,059
Miscellaneous and unspecified	936
Total	57,049

Source: United States *Bureau of Mines Minerals Yearbook, 1973 Preprint.*
[1] A steel in which the maximum of the range given for the content of alloying elements exceeds one or more of the following limits: Mn 1.65 per cent; Si 0.60 per cent; Cu 0.60 per cent.

36.5 million pounds of Mo. At the end of the year, stocks were essentially depleted. Stocks at mines and plants in the United States at the end of 1973 were almost 22 million and had dropped to 19 million in September 1974. Noranda estimates that stocks held by the United States and GSA, Noranda, European converters and Chile were in the order of 148 million pounds (Mo content) at the end of December 1972 and that these were reduced to 139 million pounds at the end of 1973.

Products and uses

The steel and iron industries are the principal consumers of molybdenum, accounting for over 80 per cent of total consumption. The principal reason for the use of molybdenum in steel is that it increases strength, even at high temperatures, and increases resistance to corrosion. In low concentrations, molybdenum is used for tool steel. With concentration of 4 per cent, molybdenum is used for corrosion resistant stainless steels and with a concentration of up to 8.5 per cent it is used for highspeed tool steels. The balance of molybdenum consumption is used as catalysts in the petroleum and chemical industries to desulphurize petroleum products and chemicals, and as metal and base alloys in high-temperature applications, thermocouples, electronics, missile parts and structural parts of nuclear reactors. Molybdenum is also used in the production of pigments for inks, lacquers and paints. Between 60 – 70 per cent of Canadian and U.S. molybdenum consumption is in the form of molybdic oxide, 20 – 25 per cent in the form of ferromolybdenum and about 5 per cent as powder.

In 1974, molybdenum consumption continued to grow in high-strength, low-alloy steels (HSLA) containing manganese, molybdenum and columbium. HSLA pipeline steel containing 0.3 per cent molybdenum and 0.052 per cent carbon can be welded under Arctic conditions which makes it applicable for use in pipelines under low-temperature conditions.

Chromium molybdenum ferritic stainless steels containing 1 – 2 per cent molybdenum and 18 – 29 per cent chromium are growing in importance because of their excellent resistance to corrosion and attractive price.

The use of molybdenum in iron and steels that resist abrasion is growing rapidly. Labour costs continue to rise sharply, and the cost of replacing worn parts in machinery that operates in abrasive environments also continues to rise proportionately. It therefore becomes more important to specify good wear-resistant materials even though first costs may be high. Molybdenum contributes to the abrasion resistance of these materials because of its influence on hardenability and carbide morphology.

Ore occurrences and grade

Molybdenum does not occur in the metallic form. Production is from deposits carrying the sulphide mineral molybdenite, MoS_2; other molybdenum-bearing minerals are relatively rare and of minor importance. More than 60 per cent of world production of molybdenum comes from mines where molybdenite is the principal mineral produced. Most of the balance comes as a byproduct or coproduct from copper-molybdenum deposits; some comes from tungsten-molybdenum mines, and a minor amount comes from molybdenum-bearing uranium ores.

Molybdenite (MoS_2) contains 60 per cent molybdenum (Mo) but the content of mineable ores is generally relatively low, ranging down from 0.05 per cent MoS_2, or 6 pounds of Mo per ton, to about 0.15 per cent MoS_2, or 1.3 pounds of Mo per ton, among producers whose principal or only product is molybdenite, to as low as 0.015 per cent MoS_2 in some copper-molybdenum deposits now being prepared for production of both metals. A few small, vein-type deposits have limited ore zones with one or two per cent MoS_2.

Prices

Sharply increasing operating costs combined with large capital investments and a strong demand for molybdenum in 1974 raised the price of molybdenum. By December 1974, prices for molybdenum products had risen approximately 40 per cent above the levels of the previous year.

Outlook

In 1975, production and consumption of molybdenum will probably decrease slightly. About 50 per cent of world production of molybdenum is a byproduct of copper mining and copper production is expected to decrease as a result of a lower demand associated with the world economic slowdown. Consumption of molybdenum is also expected to decrease because over 80 per cent of the molybdenum produced is consumed by the steel industry and production of steel will be lower in 1975. Prices will probably be increased in 1975 in order to support the large capital investments required to assure availability of supplies of molybdenum.

Molybdenum's broad consumption base, particularly in the area of energy generation and transmission, suggests that molybdenum demand throughout the world will be strong for many years.

Prices

Prices in U.S. dollars a pound of contained molybdenum, fob shipping point, as reported in Metals Week.

	Dec. 30, 1973 (U.S.)	Dec. 30, 1974 (U.S.)
Molybdenum concentrates Guaranteed Mn 85% MoS_2	1.72	2.43
Molybdic oxide (MoO_3) in cans	1.92	2.69
Ferromolybdenum, 0.12-0.25% C 5,000 lb lots		
Lump	2.21	3.25
Powder	2.27	3.19

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
32900-1	Molybdenum ores and concentrates	free	free	free
35120-1	Molybdenum and alloys in powder, pellets, scrap, ingot, sheets, strip, plate, bars, rods, tubing and wire for use in Canadian manufactures (expires October 31, 1975)	free	free	25%
37506-1	Ferromolybdenum	free	5%	5%
37520-1	Calcium molybdate	free	free	5%
92828-1	Molybdenum oxides and hydroxides	10%	15%	25%

United States

Item No.		
418.26	Calcium molybdate	10¢ per lb. on Mo content +3%
419.60	Molybdenum compounds	10¢ per lb. on Mo content +3%
601.33	Molybdenum ores and concentrates	12¢ per lb. on Mo content
607.40	Ferromolybdenum	10¢ per lb. on Mo content +3%
628.70	Molybdenum metal, waste and scrap (expires June 30, 1975)	free
628.72	Molybdenum metal, unwrought	10¢ per lb. on Mo content +3%
628.74	Molybdenum metal, wrought	12.5%

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Natural Gas

W.G. LUGG

The dynamic growth that featured the Canadian natural gas industry during the 1960s was not sustained in the early 1970s and virtually ceased in 1974. A 7 per cent increase in domestic sales was offset by a 1 per cent decline in exports to the United States and, as a result, net reservoir withdrawals declined by 1 per cent to 8,447 MMcf/d.*

The most encouraging circumstance during the year was that additions to reserves exceeded production by 4.25tcf** the largest increase since 1969. The increase was due to a combination of events, among which the successful exploration in Alberta and the inclusion, for the first time, of Mackenzie Delta gas reserves, were most prominent. More favourable prices for natural gas contributed indirectly to increased reserves, in that gas reserves previously considered to be non-economic are now included in the Alberta totals.

Although exploratory activity declined somewhat in 1974, the success ratio, particularly in the frontier areas, remained encouraging as several significant gas discoveries were made there. The Mackenzie Delta continued to be the focal point of industry attention and it was in this region that their efforts were most successful. The absence of new discoveries in the Arctic Islands in 1974 was compensated for by two significant gas discoveries on the Labrador Shelf, a relatively new exploratory basin in the eastern offshore. Encouraged by success in 1974, industry activity is expected to accelerate in this area during the 1975 drilling season.

Successful ventures, essentially in offshore regions, will affect the long-term gas supply situation in Canada; short-term supplies will depend on exploratory success in the more accessible land regions of western Canada. In 1974 a fair degree of success was attained in Alberta, particularly in the southern areas of the province where significant reserves of gas were outlined in the low yield, shallow producing trends.

Pipeline construction was again at a relatively low level and confined mainly to small-diameter pipe. The lack of discovery of major new gas reserves in established producing regions and unsettled conditions in supply and demand contributed to the decline in pipeline growth.

Gas processing plant capacity increased minimally for the second consecutive year, with construction confined to expansions of existing plants and the addition of a few smaller units. The last major gas processing plant built in Canada was at Ram River, Alberta in 1972. Since then, no significant gas discoveries have been made.

Outlook

The future of the Canadian natural gas industry hinges on its ability to improve its supply situation both now and in the future. In the short-term, these supplies will have to be made available from western Canada sources where the reserve base improved somewhat in the past year and probably will continue to improve in 1975. However, the improvement is more apparent than real, as much of the growth has been due to development of semi-proven, high-cost reserves from the low yield reservoirs of southern Alberta as a direct result of substantial increases in the field price of natural gas. The addition of new reserves from new discoveries has not kept pace with production in recent years and, unless this trend is reversed, the current tight-supply situation can be expected to continue.

Despite potential shortfalls in supply, there is no immediate danger that most of the market requirements for natural gas will not be satisfied in 1975. Domestic sales will continue at a growth rate of about 6 per cent in the coming year, increasing by about 200 MMcf/d to a total of 3,800 MMcf/d. The increase will be equally distributed between the residential, commercial and industrial sectors. Export sales to the United States will again decline, as it is unlikely that any new export contracts will be approved and export volumes under existing contracts are diminishing. Current exports of 2,632 MMcf/d will probably decline by 6 per cent to 2,470 MMcf/d. With domestic sales growth slightly exceeding the decline in export sales, annual net withdrawals can be expected to increase by about 2 per cent to 3.2 tcf.

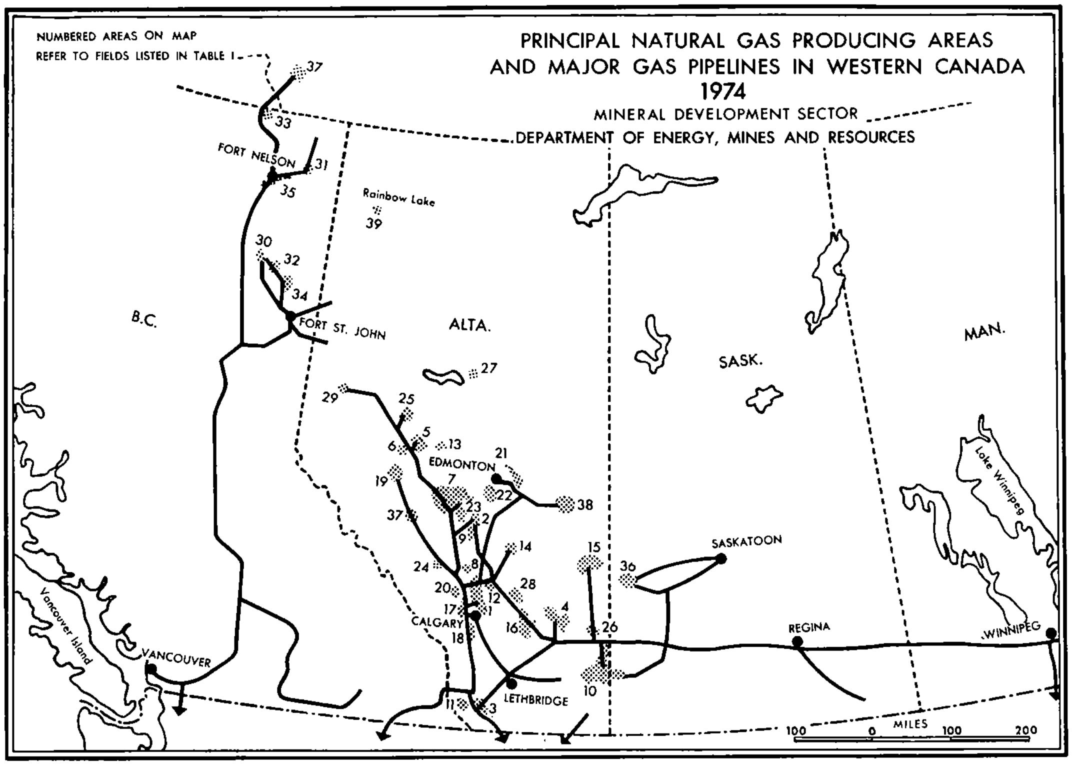
In the longer-term, supply shortages will probably intensify as western Canadian productive capabilities will not likely keep pace with anticipated demand growth in Canada, notwithstanding possible reduction in exports to the United States. Nor will these supply shortages likely be alleviated before the early 1980s

* MMcf/d – 1,000,000 cubic feet a day.
** tcf – trillion cubic feet.

Table 1. Canadian natural gasfields producing 10 million Mcf or more, 1973-74[1]

(numbers in brackets refer to map locations)	1973 Mcf	1974 Mcf
Alberta		
Kaybob South (25)	267,225,694	262,667,175
Crossfield (1)	154,279,622	140,809,035
Waterton (11)	130,983,507	132,934,133
Edson (19)	113,778,479	116,191,565
Strachan (24)	107,699,917	109,680,237
Ricinus West (24)	98,203,952	92,129,210
Westerose South (2)	82,745,152	81,934,282
Medicine Hat (10)	69,646,474	78,865,302
Brazeau River (37)	53,639,078	76,696,176
Harmattan Elkton (8)	79,266,610	69,119,285
Harmattan East (8)	63,178,812	68,752,677
Carstairs (12)	49,000,161	52,116,846
Homeglen-Rimbey (9)	46,812,193	50,271,278
Gilby (9)	48,162,805	48,319,967
Dunvegan	32,566,544	44,383,784
Jumping Pound West (17)	40,887,844	42,764,350
Crossfield East (1)	44,199,096	42,526,812
Nevis (14)	46,093,473	40,059,711
Provost (15)	39,588,864	38,800,429
Cessford (4)	42,295,492	38,743,010
Pembina (7)	42,994,892	37,108,415
Windfall (5)	55,586,490	34,690,609
Ferrier (8)	34,756,330	34,499,175
Minnehik-Buck Lake (23)	31,528,694	33,927,968
Wildcat Hills (20)	35,722,376	33,690,218
Marten Hills (27)	45,651,078	32,894,237
Judy Creek (13)	34,887,249	30,868,041
Viking Kinsella (38)	22,477,067	29,729,013
Alderson (10)	22,087,214	28,681,565
Rainbow (39)	29,334,732	28,433,527
Kaybob (25)	29,302,526	27,925,530
Lone Pine Creek (1)	25,552,818	25,820,478
Sylvan Lake (2)	23,409,458	25,819,018
Westlock (21)	24,583,526	25,233,396
Swan Hills (13)	26,828,355	24,679,215
Pine Creek (6)	14,669,580	24,244,933
Ghost Pine (28)	25,203,076	23,787,554
Bonnie Glen (22)	19,767,603	22,274,707
Lookout Butte (3)	18,674,348	18,757,947
Ricinus	14,189,377	18,071,809
Jumping Pound (17)	18,530,232	17,924,664
Hussar (16)	18,611,439	16,238,009
Swan Hills South (13)	13,792,937	15,830,554
Burnt Timber (20)	13,749,591	14,926,521
Wimborne (12)	14,634,039	14,083,326
Fort Saskatchewan (21)	13,729,399	13,940,864
Bindloss (26)	13,589,702	13,511,945
Leduc-Woodbend (22)	13,444,312	13,405,612
Warwick	8,923,576	12,863,687
Countess (16)	13,552,944	12,674,741
Bigstone (25)	14,513,273	12,526,586
Simonette	7,902,725	12,408,017
Wizard Lake	13,721,735	12,250,277
Carson Creek North (13)	14,412,826	11,998,485
Olds (12)	11,667,330	11,886,044
Bantry	8,417,200	11,728,432
Wayne-Rosedale (3)	11,117,379	11,674,311
Craigend (27)	12,634,025	11,347,826
Whitecourt	11,197,435	11,381,196
Greencourt	9,639,968	11,258,510
Fairydell Bon Accord	9,312,285	10,782,760
Caroline	9,740,724	10,525,506
Carson Creek (13)	16,765,108	10,430,285
British Columbia		
Clarke Lake (35)	124,289,024	105,752,430
Yoyo (31)	71,990,208	74,661,386
Laprise Creek (30)	24,802,043	26,117,394
Sierra (31)	22,676,685	22,769,008
Rigel (34)	22,137,141	20,217,583
Beaver River (33)	58,151,696	16,203,477
Buick Creek (32)	12,400,690	14,103,027
Nig Creek (32)	14,177,853	13,225,693
Stoddart (34)	12,192,767	12,550,739
Jedney (30)	14,606,196	11,907,682
Siphon	13,315,732	11,352,760
Northwest Territories		
Pointed Mountain	34,261,563	32,010,480

Source: Provincial government reports.
[1] 14.65 pounds per square inch absolute.



when, hopefully, significant volumes of gas will be flowing south from the Mackenzie Delta. Although exploration has been encouraging in the Arctic Islands — and more recently on the Labrador Shelf — it would be optimistic to presume that production from these areas will be marketed much before the late 1980s. Common to the two latter areas is the problem of devising transportation systems capable of overcoming environmental obstacles along the proposed routes to market centres. Because of the remoteness of these newly discovered resources, the costs of developing and moving them to consuming centres will necessarily be high. These costs will ultimately be assumed by the consumer who will have to pay considerably more than the current retail prices, which have risen substantially in 1974 and will increase again in 1975. In 1974, the Alberta government, through an arbitration award, set the basic field price at 60 cents per Mcf* through to November 1, 1975, when it will rise to 73 cents covering a one-year period and from then on will be subject to contract redetermination at regular intervals.

In summary, marketers are not likely to obtain significant additional supplies of natural gas until the mid-1980s and consumers can anticipate substantial increases in the price of natural gas in both the short- and long-term.

Production

Field production of natural gas in 1974 averaged 9,685 MMcf/d, or 3.5 tcf annually. This is slightly less than in 1973, and represents the first decline in production in over 20 years. Net new supply, which is equivalent to gross new production after deductions for processing shrinkage, gas reinjected and gas flared at the wellhead, amounted to 7,204 MMcf/d, compared with 7,256 MMcf/d in 1973. More than 85 per cent of total Canadian production came from fields in Alberta. British Columbia accounted for more than 11.5 per cent of the Canadian total, with the balance coming from four other provinces and the Northwest Territories.

Table 2 shows the amount of gas injected into reservoirs, either as a conservation measure to increase the ultimate recovery of liquid hydrocarbons or as part of distributors' storage operations. The Kaybob South field in Alberta is an example of a conservation scheme to maximize ultimate recovery of the liquid consti-

* Mcf – 1,000 cubic feet.

tuents of field gas. Here, gas is produced and processed to remove the liquid hydrocarbons and sulphur, after which most of the residual gas is reinjected to maintain pressure in the reservoir. This operation is to ensure the maximum possible recovery of natural gas liquids, after which the relatively dry gas will be produced. A unique development in gas cycling technology occurred in 1974 when Texaco Exploration Canada Ltd. commenced operating its plant in the Bonnie Glen oil and gas field. This is the first plant in Alberta designed to process sour gas without removing hydrogen sulphide (H_2S). After stripping the liquid hydrocarbons from the gas stream, the gas is reinjected into the reservoir in its sour state. This method of processing should alleviate to some degree the problem of storing sulphur in Alberta. At the present time the Alberta stockpile of byproduct sulphur from natural gas production exceeds 14 million tons and is expected to increase until 1980, at which time demand probably will exceed production. By utilizing this method of stripping liquid hydrocarbons from the gas stream, in new plants at least, sulphur may be stored directly in the reservoir until such time as current inventories are eliminated. Similarly, natural gas may be temporarily reinjected into producing oil reservoirs, thereby maintaining reservoir pressure to maximize production of crude oil where this is possible. The volumes shown as distributors' storage represent gas which is stored by gas utilities during low demand periods, usually in summer, and is later withdrawn as required to meet peak demand in winter. This helps to level out the utilities' demand on the trunk carriers over the year. In Alberta and Ontario most of the gas is stored in former producing fields that have been depleted. However, in Saskatchewan much of the storage is in large man-made subsurface caverns which have been leached from salt beds specifically to provide storage facilities near major consuming areas.

Exploration and development

Alberta. In Alberta both the number of wells and footage drilled declined in 1974. Drilling statistics show aggregate drilling decreased 6 per cent to 11.99 million feet, with the bulk of the decrease occurring in the exploratory drilling category. The decline in overall drilling occurred despite a large upswing in development drilling in the shallow gas fields in southern Alberta. These fields occur in low-yield, relatively-poor reservoirs which require much closer well spacing than the average gas field in order to maximize recovery of in-place reserves. The decline in exploratory drilling seems to be related more to industry lack of interest in exploring for oil, rather than gas, where it believes there is more likelihood of discovering major fields.

One of the most successful areas of exploration and development in southern Alberta was the British Block, formerly reserved for military training. The Block is an 8,000-square-mile area surrounded by many gas producing fields. Evaluation of the Block was carried out through a provincial government drilling program under direction of the Suffield Evaluation Committee of the Alberta government. In a report based on results of the evaluation drilling program of 77 wells, 76 wells were classed as commercial gas wells and one as a potential gas well. Of these, 65 were classed as dual completions and 12 as single zone completions. Estimated reserves of gas in the Block were set at 2.7 tcf, of which the Milk River zone accounted for 2.0 tcf.

In the Glendon area of east-central Alberta, a well drilled by Kissinger Petroleums Ltd. encountered significant volumes of gas in the Colony Sandstone of Cretaceous age. The well yielded large volumes of gas when tested and preliminary indications were that it may cover a fairly extensive area. Several follow-up wells are scheduled to delineate the true size of the field. Farther west, in the Greencourt region, Northern Terra Resources, Ltd. recorded a significant gas discovery in an as-yet-undisclosed formation. The well is located about two miles east of the Greencourt gas field limits.

In northwestern Alberta, Sundance Oil Canada Ltd. made a dual zone gas discovery in the Cretaceous Cadomin formation and the Golata formation of Mississippian age. Additional delineation drilling is being programmed by Sundance in this area. Farther south in the Foothills region, Husky Oil Ltd. discovered sour gas production from zones above and below the main producing zone of the Quirk Creek field. Substantial flows of gas were obtained from both Mississippian and Devonian formations and additional wells are contemplated to further evaluate the discovery, which should add substantially to the field's proven gas reserves.

Although much of the development drilling was confined to the shallow gas trends of southern areas, field boundaries in other areas of Alberta were substantially expanded. Probably the most important of these was the Martin Hills field of north-central Alberta where drilling has extended its boundaries to the north and east. Other fields which were enlarged by development drilling include the Medicine Hat and Alderson fields of southern Alberta.

British Columbia. Total footage drilled and the number of wells completed declined in 1974. A slight increase in development drilling was more than offset by a decline in exploratory drilling and, as a result, aggregate drilling declined by 7 per cent to 810,364 feet. Despite the slowdown in exploration, several significant gas discoveries were made.

Drilling results in the Tatoo region, 45 miles east of Nelson Forks in northeastern British Columbia, continued to point up the potential of this area to become a

Table 2. Pressure maintenance projects and storage of natural gas in Canada, 1973-74

	1973 Input	1974ᵖ Input		1973 Input	1974ᵖ Input
Alberta					
Aerial	259,921	210,503	Redwater	651,946	1,376,537
Ante Creek	1,508,881	1,475,753	Ricinus	11,156,048	13,062,601
Bellshill Lake	—	94,324	Rowley	66,416	78,159
Bigstone	626,909	6,296	Swan Hills South	5,674,945	14,826,000
Bonnie Glen	541,825	44,497	Turner Valley	152,727	5,181
Carson Creek	4,339,392	5,670,455	Waterton	15,772,679	15,955,532
Carstairs	1,877,144	295,913	Westerose South	6,374,755	2,549,137
Crossfield	1,076,590	1,008,602	Willesden Green	7,742,854	7,635,651
Crossfield East	1,092,130	1,462,395	Windfall	15,803,535	27,155,438
Duhamel	233,770	246,511	Wizard Lake	22,414,495	27,835,568
Golden Spike	17,600,060	22,493,951	Total (14.65 psia)	358,714,754	378,684,360
Harmattan East	32,774,770	30,851,289	Total (14.73 psia)	356,776,943	376,639,464
Harmattan Elkton	44,463,225	43,979,713			
Joarcam	1,580,071	1,944,894			
Judy Creek	3,983,181	2,188,012			
Kaybob South	134,856,639	128,466,652	**Ontario**	106,412,309	98,884,187
Leduc-Woodbend	5,284,052	5,701,030			
Mitsue	1,123,791	1,696,862	**Saskatchewan**	4,659,984	7,376,123
Pembina	2,044,287	2,017,318			
Rainbow	14,978,899	16,514,911			
Rainbow South	2,658,817	1,834,675	Total Canada (14.73 psia)	467,849,236	482,899,774

Source: Provincial government reports.
ᵖ Preliminary; — Nil.

major producing trend. During 1973 and 1974, five significant gas strikes were made here along a 20-mile northwesterly trend. Several drilling projects are either planned or under way in this region. Farther south, in the Fort St. John area, Sunningdale Oils Limited's exploratory well encountered commercial gas production potential in the area between the Boundary Lake oil field and the Siphon gas field. Details as to producing formation and productive capabilities have not been released by the operating company.

Ten miles south of the Petitot River gas field, British Petroleum Company Limited announced that its exploratory well, BP TRAIL D-7-J, has been completed as a commercial gas discovery. Producing formation, net pay, and other pertinent details are still being held confidential by the operator.

Farther south, and adjacent to the Alberta border, successful exploration is being maintained in the Grizzly Valley area. Exploration has been going on in this area for many years but it was not until 1964 that the first discovery was completed in the Nikanassin formation. Since then, several more gas discoveries have been made, the most recent being Quasar Grizzly a-3-A, drilled early in 1974. Currently, two more exploratory wells are being drilled in the area, and if successful, should substantially add to the proven reserves of the region. Thus far, proven reserves of natural gas are insufficient to justify the extension of existing pipeline facilities into the Grizzly Valley area.

Yukon Territory, Northwest Territories and Arctic Islands. Exploration in northern areas declined in 1974, nevertheless several important discoveries were made, particularly in the offshore areas. Sixty wells were drilled for a total footage of 503,227 feet compared with 101 wells and 741,217 feet in 1973. Fifty-six of these were classed as exploratory and 10 were classed as potential gas finds.

New technological advances in the construction of man-made islands composed either of gravel or ice have permitted northern operating companies to extend the search for oil and gas seaward and these ventures have met with considerable success. Research is now well advanced on a more portable type of

Table 3. Canada, production of natural gas, 1973-74[1]

	1973		1974p	
	(Mcf)	($)	(Mcf)	($)
Gross new production				
New Brunswick	81,008		83,000	
Quebec	197,337		185,000	
Ontario	9,258,000		6,952,000	
Saskatchewan	76,273,000		77,875,543	
Alberta	2,962,976,000		3,011,354,831	
British Columbia	515,874,000		405,603,788	
Northwest and Yukon Territories	1,721,000		33,277,537	
Total, Canada	3,566,653,345		3,535,331,699	
Waste and flared				
Saskatchewan	10,386,000		12,620,543	
Alberta	61,545,304		51,511,329	
British Columbia	5,660,235		4,568,774	
Northwest and Yukon Territories	1,445,515		791,537	
Total, Canada	79,037,054		69,492,183	
Reinjected				
Alberta	363,632,722		378,776,502	
British Columbia	4,362,741		3,685,014	
Northwest Territories and Yukon	—		—	
Total, Canada	367,995,463		382,461,516	
Net withdrawals				
New Brunswick	81,008	30,752	83,000	31,000
Quebec	197,337	28,149	180,000	28,000
Ontario	9,528,000	3,677,847	6,952,000	3,128,000
Saskatchewan	65,887,000	9,044,128	65,255,000	9,014,000
Alberta	2,537,797,974	388,696,255	2,581,067,000	595,809,000
British Columbia	505,851,024	50,345,297	397,350,000	74,719,000
Northwest Territories and Yukon	275,485	30,771	32,486,000	3,885,000
Total, Canada	3,119,617,828	451,853,205	3,083,378,000	686,614,000
Processing shrinkage				
Saskatchewan	2,016,144		1,794,108	
Alberta	420,875,323		408,126,153	
British Columbia	48,059,966		43,919,828	
Total, Canada	470,951,433		453,840,089	
Net new supply, Canada	2,648,666,395		2,629,537,911	

Source: Statistics Canada and provincial government reports.
[1] 14.73 psia.
p Preliminary; — Nil;

drilling platform, which will be capable of operating in deeper waters farther from shore. Work is also being done on sub-sea gathering systems that could move the oil or gas ashore either from a series of permanent gravel production platforms or sophisticated underwater installations.

Since large scale exploratory drilling began in the Mackenzie Delta in 1965, there have been several significant oil and gas discoveries. At least three gas fields and two oil-gas fields are rated in the major field category. One of these, the Taglu field on Richards Island, was discovered in 1971 and subsequent step-out drilling has verified that the field contains upwards of 3 tcf of gas. Another major field is apparently shaping up at the Shell Niglintgak discovery, made in 1973 and located about 11 miles southwest of the Taglu fields. A one mile step-out to the original discovery was drilled in 1974 and on test it was found that nine sandstone zones totalling about 500 feet were hydrocarbon-bearing. Five of these zones were gas-bearing and the remainder oil-bearing. Substantial flows of oil and gas were obtained when the formations were tested. Preliminary estimates based on both well and seismic data, place reserves of this field at about 1 tcf of gas and about 80 million barrels of oil.

Offshore from Richards Island another major oil and gas field is being developed about 10 miles out in the Beaufort Sea. This field was discovered in 1973 when the discovery well was drilled from an artificial island constructed by Imperial Oil Limited. A step-out well, also drilled from an artificial island located three miles south of the original discovery, encountered significant thicknesses of both oil- and gas-bearing reservoir in several sandstone formations at shallow to intermediate depths. The field is reported to have excellent reservoir characteristics, but further drilling is required to fully assess the true significance of the find.

Southeast of the Mackenzie Delta in the Northwest Territories, Ashland Oil Canada Limited drilled what could be a very significant gas discovery in the Tedji Lake region. When tested, the well is reported to have flowed substantial quantities of gas from a zone in the Basal Paleozoic. The discovery is considered important because of its location in a virtually untested region. However, it will likely be some time before the full potential of the find will be determined.

In the Arctic Islands, the pace of exploration declined from previous years and no new gas discoveries were made. Since 1969, when large-scale exploration began there, Panarctic Oils Ltd. has discovered and partly delineated five substantial gas fields, namely Drake Point, Kristoffer Bay, Thor, Hecla and King Christian. Dome Petroleum Limited has also discovered sizable gas reserves in two locations on King Christian Island.

Although there were no new discoveries in the Arctic Islands, 1974 was highlighted by the drilling of two successful step-out wells to previous discoveries on the east and west coasts of the Sabine Peninsula of Melville Island. Both wells were drilled from floating ice platforms in about 400 feet of water and are important from a technologic as well as a commercial point of view as they ushered in another major breakthrough in Arctic exploratory drilling technology. The first of these offset wells, Hecla N-52, located eight miles off the west coast of the Sabine Peninsula, encountered significant quantities of gas from the Borden sandstone of Jurassic age. The well was drilled to evaluate a structure on which two onshore gas discoveries had been drilled, and established the presence of another major gas field in the Arctic Islands. The second successful offshore step-out was drilled on the east coast of the Sabine Peninsula, also eight miles from shore. The well, Panarctic East Drake I-55, established a major extension to the already-sizable Drake Point gas field on the west coast of Melville Island. The Drake Point field has now been proven to be more than 25 miles long and there is no doubt that it can be classified in the major gas field category.

Saskatchewan. Both the number of wells and footage drilled declined considerably in Saskatchewan in 1974. The number of wells drilled was reduced from 657 to 285, and footage drilled declined from 1,752,056 to 706,133 feet. The decline was fairly evenly distributed between development and exploratory drilling. Successful gas well completions increased from 73 in 1973 to 126 in 1974 despite the slowdown in drilling. As in the previous year, most of the exploratory and development drilling was confined to the southwestern corner of the province where the productive shallow gas trends of Alberta extend into Saskatchewan. Although the Medicine Hat and Hatton fields continued to be enlarged, there were no noteworthy discoveries of new reserves in this area. Probably the most significant gas discovery in the province during 1974 was made by the Saskatchewan Oil and Gas Corporation (Saskoil). The discovery was drilled within the designated limits of the Fusilier oil and gas field of west-central Saskatchewan. The well was completed successfully in the Viking sandstone formation, and while relatively little information has been released, early indications are that it has good productive capability.

Eastern Canada. Offshore from the east coast, 19 wells were drilled for a total of 185,352 feet, compared with 30 wells, and 331,448 feet, in 1973. All wells drilled were exploratory. The decline in drilling is due mainly to the lack of significant exploratory success in this area. Since drilling commenced in 1966, a total of 103 wells have been completed, of which seven significant discoveries of oil and gas have been made. The three most important of these were made in 1974; two on the Labrador Shelf, and the third off the east tip of Prince Edward Island. The remainder were drilled in the

(text continued on page 332)

Table 4. Canada, production, trade and total sales of natural gas, 1964-74

		Net Withdrawals	Imports	Exports	Sales in Canada
1964	Mcf	1,327,664,338	8,046,365	404,143,095	504,503,380
	$	145,057,536	2,871,145	97,608,555	327,982,720
1965	Mcf	1,442,448,070	15,673,069	403,908,528	573,016,494
	$	158,938,464	5,809,335	104,279,744	369,307,232
1966	Mcf	1,341,833,195	43,550,818	426,223,806	635,514,622
	$	179,183,990	17,592,370	108,749,931	416,212,202
1967	Mcf	1,471,724,535	52,871,671	505,164,622	698,223,437
	$	197,983,450	19,914,301	123,663,828	454,722,005
1968	Mcf	1,692,300,787	88,227,825	598,143,763	765,786,814
	$	225,263,658	35,392,758	153,751,558	490,767,434
1969	Mcf	1,977,838,205	37,732,703	669,815,767	843,164,967
	$	262,332,030	16,025,449	176,187,766	537,186,938
1970	Mcf	2,277,108,791	11,877,827	768,112,547	917,440,879
	$	315,099,792	5,123,896	205,988,180	582,316,948
1971	Mcf	2,499,023,600	16,010,217	903,051,071	1,001,328,624
	$	342,548,891	7,021,000	250,719,000	641,898,026
1972	Mcf	2,913,047,178	15,759,538	1,007,053,829	1,145,797,145
	$	388,500,342	7,629,000	306,843,000	740,382,930
1973	Mcf	3,119,460,755	14,699,677	1,030,912,824	1,229,409,641
	$	451,853,205	7,793,000	350,745,000	797,855,930
1974p	Mcf	3,083,378,000	9,227,857	960,713,090	1,314,321,000
	$	686,614,000	5,777,000	493,640,000	980,395,000

Source: Statistics Canada. Figures in Tables 4 and 12 differ for imports and exports because of different reporting procedures and timing.
p Preliminary.

Table 5. Canada, liquids and sulphur recovered from natural gas, 1964-74

	Propane	Butane	Condensate Pentanes Plus	Sulphur
	(barrels)	(barrels)	(barrels)	(lt)
1964	6,515,222	5,529,455	25,264,469	1,472,583
1965	10,168,610	6,927,505	27,867,535	1,589,586
1966	12,473,645	8,177,144	29,365,322	1,729,455
1967	14,146,829	9,327,710	30,741,400	2,168,646
1968	15,855,467	10,421,958	33,202,168	3,042,105
1969	17,807,022	11,184,685	38,534,025	3,714,312
1970	21,274,353	13,203,744	44,151,409	4,240,982
1971	24,225,504	15,447,329	46,898,136	4,555,290
1972	29,540,846	19,458,808	60,829,459	6,617,216
1973	33,433,765	22,436,765	62,061,744	7,003,489
1974p	33,207,928	22,140,910	59,231,570	6,838,077

Sources: Statistics Canada and provincial government reports.
p Preliminary.

Table 6. Wells drilled by province, 1973-74

	Oil		Gas		Dry[1]		Total	
	1973	1974p	1973	1974p	1973	1974p10	1973	1974p
Western Canada								
Alberta	600	651	1,518	1,719	1,586	1,225	3,704	3,595
Saskatchewan	392	71	73	126	192	88	657	285
British Columbia	8	6	54	47	99	89	161	142
Manitoba	—	5	—	—	16	15	16	20
Yukon and Northwest Territories								
Arctic Islands	—	2	10	10	91	48	101	60
Westcoast Offshore	—	—	—	—	—	—	—	—
Subtotal	1,000	735	1,655	1,902	1,984	1,465	4,639	4,102
Eastern Canada								
Ontario	11	4	34	60	25	90	120	154
Quebec	—	—	–	—	3	6	3	6
Atlantic Provinces	—	—	—	—	2	—	2	—
Eastcoast Offshore	—	—	1	—	29	19	30	19
Hudson Bay Offshore	—	—	—	—	—	2	—	2
Subtotal	11	4	35	60	109	117	155	181
Total Canada	1,011	739	1,690	1,962	2,093	1,582	4,794	4,283

Source: Canadian Petroleum Association.
[1] Includes suspended and abandoned wells.
p Preliminary; — Nil.

Table 7. Footage drilled in Canada for oil and gas by province, 1973-74

	Exploratory		Development		All Wells	
	1973	1974p	1973	1974p	1973	1974p
Alberta	5,936,914	5,158,928	6,767,198	6,835,914	12,704,112	11,994,842
Saskatchewan	728,946	336,378	1,023,110	369,755	1,752,056	706,133
British Columbia	566,500	499,567	301,421	310,797	867,921	810,364
Manitoba	44,780	51,734	—	20,326	44,780	72,060
Territories and Arctic Islands	664,001	470,900	77,216	32,327	741,217	503,227
Westcoast offshore	—	—	—	—	—	—
Total Western Canada	7,941,141	6,467,507	8,168,945	7,569,119	16,110,086	14,036,626
Ontario	97,932	153,658	121,876	88,187	219,808	241,845
Quebec	26,560	27,705	—	—	26,560	27,705
Atlantic Provinces	22,469	—	—	—	22,469	
Eastcoast offshore	331,448	185,352	—	—	331,448	185,352
Hudson Bay offshore	—	9,511	—		—	9,511
Total Eastern Canada	478,409	366,007	121,876	132,295	600,285	464,413
Total Canada	8,419,550	6,833,514	8,290,821	7,701,414	16,710,371	14,501,039

Source: Canadian Petroleum Association.
p Preliminary; — Nil.

vicinity of Sable Island where the initial discovery was made in 1971 on the southwestern tip of the island. Six miles to the southwest, a gas condensate discovery was made a year later, and the third significant gas discovery was made 30 miles east of Sable Island when the Primrose N-50 well gave flows of gas with condensate from three separate zones. The other find was an oil discovery — the Cohasset D-42 well — located 25 miles southwest of Sable Island.

Although the results on the Scotian Shelf and Grand Banks have been disappointing, industry interest was revived by two significant discoveries on the Labrador Shelf. The first of these discoveries was the Gudrid H-55 well, located about 500 miles north of St. John's, Newfoundland. The second discovery was made by the Bjarni H-81 well, started and suspended in 1973, then re-entered and completed in 1974. Both of these discoveries are on large structures with excellent potential. When tested, they flowed large volumes of natural gas with condensate. Current plans are to drill four more wells with two self-positioning drill-ships during the 1975 drilling season. One other company has plans for drilling two wells with a dynamically positioning drill-ship during the summer of 1975. These vessels are capable of much quicker disconnection and re-connection than conventional semi-submersible drilling rigs, a feature which should speed exploration in an area where drifting icebergs often put a temporary stop to drilling operations. Nevertheless, bad weather and iceberg hazards still make this an extremely difficult area to work in, with a very short drilling season. It will therefore probably take several years before the full potential of the region is evaluated and several more years before it is developed.

In the Gulf of St. Lawrence, 17 miles northeast of Prince Edward Island, Hudson's Bay Oil and Gas Company Limited began drilling a well in 1973 but had to abandon it before completion because of bad weather. Last year they re-entered the well and drilled it to total depth. Subsequently, they announced the well had encountered encouraging shows of natural gas but further testing and drilling would be required to fully evaluate the find.

During the past year, 93 exploratory wells and 61 development wells were drilled in Ontario compared with 58 exploratory and 69 development wells drilled in 1973. Exploratory drilling was rewarded by the discovery of three gas-bearing Silurian reefs in Lambton County and an Ordovician gas discovery in Elgin County. Exploratory drilling footage increased by 57 per cent to 153,658 feet. Development drilling in Ontario decreased in 1974 to 61 wells and 88,187 feet compared with 69 wells and 118,391 feet in 1973. The bulk of the development drilling was concentrated in Silurian reef fields.

In Quebec, six dry exploratory tests were drilled in 1974. Four of these were Ordovician tests in the St. Lawrence Lowlands between Montreal and Quebec City. The others were drilled on Gaspé Peninsula and Anticosti Island.

Reserves

At the end of 1974 the Canadian Petroleum Association (CPA) estimated Canada's proven reserves of marketable natural gas at 56.7 tcf, 4.25 tcf more than in 1973. Using the 1974 level of production, i.e., net new supply from Table 12, the life index (reserves to production ratio) for natural gas rose to 21.5 years. Gross additions to reserves amounted to 6.6 tcf, including 284 bcf* attributed to new discoveries, 3.48 tcf to extensions of existing fields, and 2.86 tcf to revisions of existing field reserve estimates. The bulk of the reserve increase could be attributed to a substantial increase in reserves in Alberta and, for the first time, the inclusion of estimates of natural gas reserves in the Mackenzie Delta. Gross additions to marketable gas reserves in Alberta amounted to 3.58 tcf. Almost all of this was due to extensions of existing fields, primarily the shallow reserves of southern Alberta fields. Gross additions to gas reserves in the Northwest Territories amounted to 3.95 tcf and all of this was attributed to the newly-discovered fields in the Mackenzie Delta. Alberta, with 43.37 tcf of marketable gas reserves, accounted for 76 per cent of total Canadian reserves at the end of 1974, British Columbia 13 per cent and the Territories 9 per cent.

Natural gas processing

Gas processing capacity increased only marginally in 1973 and most of the increase was due to the construction of smaller units. Total gas processing capacity in Canada rose by 303 MMcf/d to 16,146 MMcf/d, the smallest increase in several years.

The largest unit that came on stream during the year was Amoco Canada Petroleum Company Ltd.'s sweet gas cycling plant at Ricinus which will be extracting 7,500 b/d** of natural gas liquids (NGL) mix from a raw gas stream of 75 MMcf/d. Four smaller plants also commenced operating, adding only a minor amount to new plant capacity. All of these plants are located in Alberta. Francana Oil and Gas Ltd. completed construction of their dehydration-compression type plant which will process gas from the Holmberg field. The plant has capacities of 12 MMcf/d of raw gas, 12 MMcf/d of residue gas and 15 b/d of pentanes plus. Western Decalta Petroleum Limited revamped its surplus gas processing plant at the Leduc field and moved it to the Rockford field where it is now processing 5 MMcf/d of raw gas to produce 4.9 MMcf/d of residue gas and 18 b/d of pentanes plus. Provident Resources Ltd. began operating its plant at Stanmore, Alberta which has a raw gas capacity of 3 MMcf/d. American Trading and Production Corporation's Oyen plant came on stream in December 1973 with a raw gas

* bcf – Billion cubic Feet. ** b/d — Barrels a day.

Table 8. Canada, estimated year-end marketable reserves of natural gas, 1973-74

	1973	1974
	(millions of cubic feet)	
Alberta	41,706,538	43,376,959
British Columbia	8,631,565	7,304,848
Saskatchewan	990,778	972,530
Eastern Canada	242,312	238,214
Northwest Territories	886,239	4,815,535
Total	52,457,432	56,708,086

Source: Canadian Petroleum Association.

processing capacity of 2.5 MMcf/d, yielding 2.5 MMcf/d of residue gas and 2 b/d of butane.

In addition to these new plants, capacity was added by the expansion of a number of existing plants. In British Columbia, Imperial Oil Limited added NGL facilities to its Boundary Lake plant and now recovers 700 b/d of propane 500 b/d of butane and, at the same time, increased pentanes plus production to 170 b/d from 100 b/d.

In Alberta, Chevron Standard Limited also added natural gas liquid processing capacity to its Kaybob South plant and now produces 20,000 b/d of propane-butane mix in addition to 33,840 b/d of pentanes plus. Imperial Oil completed the fourth phase in its round of expansion at the Judy Creek field, increasing raw gas intake by 50 MMcf/d to 225 MMcf/d. Plant No. 5 in

Table 9. Canada, natural gas processing plant capacities by fields, 1974

Main Gas Field Served	Raw Gas Capacity	Residue Gas Produced
	(million cf/day)	
Alberta		
Acheson	6	5
Alderson (2 plants)	24	24
Atlee, Buffalo	31	30
Alexander, Calahoo	36	35
Bassano	8	8
Big Bend	20	20
Bigoray	13	12
Bigstone	48	36
Black Butte	10	10
Birch Lake	25	25
Bonnie Glen	48	40
Boundary Lake South	17	13
Brazeau River	196	171
Brazeau South	66	60
Bruce	36	36
Burnt Timber	68	57
Cadomin	25	24
Calling Lake	18	18
Carbon	155	150
Caroline (2 Plants)	53	45
Carson Creek	100	62
Carstairs	334	280
Cessford (4 Plants)	190	184
Cessford North	7	6
Chigwell (2 Plants)	7	5
Connorsville, Cessford	5	5
Corbett Creek	9	9
Countess (3 Plants)	62	60
Crossfield (2 Plants)	315	215
Dunvegan	207	160
East Crossfield	146	87

Main Gas Field Served	Raw Gas Capacity	Residue Gas Produced
	(million cf/day)	
Alberta (cont'd)		
East Rainbow Lake	18	11
Edson	377	339
Enchant	5	5
Equity, Ghost Pine	16	15
Ferrier (2 Plants)	110	90
Ferrier South	20	19
Ferrybank	21	20
Figure Lake	12	12
Flat Lake	25	25
Ghost Pine	110	108
Gilby (6 Plants)	161	135
Gilby North	19	18
Gold Creek	56	15
Golden Spike	90	reinj
Greencourt	30	28
Hanna	12	8
Harmattan-Elkton (2 Plants)	535	315
Harmattan-Elkton South	5	4
Hatton	8	7
Holmberg	12	12
Homeglen-Rimbey	423	357
Hussar	100	90
Huxley	13	10
Innisfail	20	13
Joffre	8	5
Judy Creek, Swan Hills (3 Plants)	296	220
Jumping Pound	250	200
Kaybob	99	96
Kaybob South (3 Plants)	827	111

Table 9. (concl'd)

Main Gas Field Served	Raw Gas Capacity	Residue Gas Produced
	(million cf/day)	
Kessler	6	5
Keystone	8	7
Killam	10	10
Lac La Biche	18	18
Leduc Woodbend	30	35
Lone Pine Creek	67	54
Mannville	33	32
Marten Hills	133	130
Marten Hills South	24	24
Mikwan North	15	13
Minnehik-Buck Lake	108	100
Mitsue	21	15
Morinville, St. Albert-Big Lake	22	20
Nevis, Stettler (2 Plants)	225	182
Nipisi	25	15
Okotoks	30	13
Olds	100	76
Oyen (2 Plants)	5	5
Paddle River	30	28
Parflesh	2	2
Phoenix	3	3
Pembina (12 Plants)	142	101
Pincher Creek	105	80
Plain	40	40
Prevo	5	4
Princess (2 Plants)	15	15
Provost (4 Plants)	133	126
Quirk Creek	90	68
Rainbow Lake	85	reinj
Rainier	3	3
Redwater	22	8
Retlaw	7	7
Ricinus	75	60
Rockyford	5	5
Savana Creek	75	63
Sedalia	5	5
Sibbald	6	5
Simonette	37	27
South Lone Pine Creek	35	26
Stanmore	27	21
Strachan D-3	275	214
Strachan, Ricinus West	400	242
Strathmore	2	2
Sturgeon Lake South	23	17
Swalwell	4	4
Swan Hills	9	4
Sylvan Lake (2 Plants)	91	82
Three Hills Creek	10	9
Turner Valley	40	25
Twining Swalwell	10	9
Ukalta	6	6
Verger	6	5
Virginia Hills	12	10
Vulcan	25	22
Waite Court	65	61
Warwick	15	15
Waskahigan	16	14
Waterton	468	311
Wayne-Rosedale	68	62
West Viking	7	7
Wildcat-Hills	112	95
Willesden Green	17	15
Wilson Creek (2 Plants)	22	19
Wimborne	60	46
Windfall, Pine Creek	215	132
Wintering Hills	14	13
Wood River	5	5
Worsley	23	21
Pipeline at Ellerslie[1]	70	66
Pipeline at Empress[2] (2 Plants)	3,000	2,892
Pipeline at Cochrane[3]	1,000	970
Saskatchewan		
Cantuar	25	24
Coleville, Smiley	38	37
Hatton	8	7
Dollard	2	2
Milton	4	4
Smiley	2	1
Steelman	38	30
Totnes	7	7
West Gulf Lake	15	14
British Columbia		
Beaver River	240	240
Boundary Lake (2 Plants)	29	27
Clarke Lake	1,100	910
Fort St. John	500	440
Ontario		
Becher	1	1
Corunna (2 Plants)	5	5
Port Alma	16	16
Northwest Territories		
Pointed Mountain	189	189

Source: *Natural Gas Processing Plants in Canada* (Operators List 7) January 1973, Department of Energy, Mines and Resources.
[1] Plant reprocesses gas owned by Northwestern Utilities, Limited. [2] Plant reprocesses gas owned by TransCanada PipeLines Limited. [3] Plant reprocesses gas owned by exporting companies.

this complex is expected to be completed in 1975 with a raw gas capacity of 40 MMcf/d. Gulf Oil Canada Limited raised the raw gas capacity of its Strachan plant to 275 MMcf/d and made modifications to increase propane-butane production to 4,453 b/d. Hudson's Bay Oil and Gas Company increased the raw gas intake of its Brazeau River plant to 196 MMcf/d and doubled its output of pentanes plus to 2,662 b/d. Shell Canada Limited expanded its Simonette gas processing plant by increasing raw gas intake to 37 MMcf/d. During the overall expansion of the plant, facilities were also added so that the plant will produce 745 b/d of propane-butane mix. In the Rainbow field, Imperial Oil expanded its plant to 10.5 MMcf/d of raw gas intake. Both the residue gas and the condensate byproduct are reinjected into the four oil fields in the area to maintain reservoir pressure. Canadian Superior Oil Ltd. completed the major expansion of its Harmattan plant to produce 150 MMcf/d of sales gas from the Harmattan East field. The remainder of the residue gas is reinjected into the producing reservoirs.

Future plans by Amoco Canada Petroleum Company Ltd. call for the construction of a gas plant to serve the Nipisi field. The plant will process 25 MMcf/d of raw gas to produce 17.7 MMcf/d of residue gas and 7,304 b/d of NGL mix. Construction start is scheduled for 1974, with completion sometime in 1975. In British Columbia, Westcoast Transmission Company Limited will increase the capacity of its McMahon plant at Taylor to 515 MMcf/d and at the same time increase NGL production by 1,660 b/d. The Company's Fort Nelson plant is also being enlarged and a gathering system expansion, due to be completed in 1974, will connect the additional fields of Petitot, Cabin, Gote, and Louise. A sulphur plant is now under construction adjacent to the process plant and will begin operation in 1974 with an initial capacity of 400 long tons of sulphur daily.

Canadian Export Gas & Oil Ltd., plans to install a small gas processing plant on the southern edge of the Provost field in 1974. The plant will process about 5.5 MMcf/d of raw gas and recover small amounts of pentanes plus. The residue gas will be delivered to TransCanada PipeLines Limited. Gulf Oil Canada is expanding its gas processing plant in the Nevis field, with completion date scheduled for 1974. Both raw gas intake and liquid byproduct production will be increased.

In the Mackenzie Delta, where several major gas discoveries have been made, a proposal to build two gas processing plants with 1.5 bcf/d* capacity and a development drilling program for three gas fields has been submitted to the federal government by a joint development group conprising Gulf Oil Canada, Imperial Oil and Shell Canada. The $1 billion project would involve the construction of a 1 bcf/d gas plant to be located at the Taglu field to process gas from this field and the Niglintgak field 10 miles farther west. The second plant will be constructed at the Parsons Lake field, about 45 miles southwest of the Taglu field and 'ill have a capacity of 500 MMcf/d.

Transportation

Gas pipeline constructed in 1974 increased slightly over 1973 with the addition of 4,648 miles of pipeline to gas transmission distributing and gathering systems compared with 3,944 in 1973. By the end of 1974 total cumulative gas pipeline mileage was 75,892 miles.

Gas transmission and distribution lines accounted for the bulk of the increase. Gathering systems construction was confined mainly to Alberta, primarily in the shallow gas region of southern Alberta where 75 per cent of the successful development wells in Canada were drilled this year. Gas distributing pipeline increased this year by about 1,400 miles, and this figure does not include about 5,000 miles of plastic and aluminum pipe laid in Alberta under the rural gasification plan sponsored by the Alberta government.

Major gas transmission projects completed in 1974 include nine lateral lines constructed by The Alberta Gas Trunk Line Company Limited. Total length of these lines amounted to 112.7 miles of 6-through 12-inch pipe installed in varied localities in Alberta.

The largest gas pipeline construction project in 1974 was carried out by TransCanada PipeLines on its main line in northern Ontario and on the Prairies. In northern Ontario, TransCanada completed looping (twinning) its main natural gas pipeline from Winnipeg to Toronto late in October by installing 154 miles of 36-inch pipeline in 17 sections. Construction on the 1,209 mile loopline was started in 1967 and was designed to provide added security in the transmission of natural gas to eastern Canadian consumers. The total cost of the 36-inch second line was $430 million. Later in the year TransCanada installed 114.1 miles of 24-inch loop on its main line between Toronto and Montreal plus 19 1/2 miles of 16-inch parallel line addition to the Ottawa lateral. Rounding out its 1974 program, TransCanada added 15 miles of 42-inch line to its main line in Saskatchewan and Manitoba.

Smaller projects included Inland Natural Gas Co. Ltd.'s 33 miles of 12-inch main gas transmission line in the West Kootenay region of British Columbia. This is the first phase of a planned 93-mile, 12-inch line from Yahk to Trail. Elsewhere in British Columbia, a 4-mile, 24-inch main gas transmission line was constructed by the British Columbia Hydro and Power Authority. In Alberta, Northwestern Utilities Limited completed 24 miles of 24-inch gas transmission line from the Bonnie Glen gas plant to the Homeglen-Rimbey gas plant.

In 1974, three separate groups of companies were investigating the feasibility of building gas pipelines from the Canadian Arctic to southern markets. All are consortiums composed of pipeline and oil companies, and are chiefly concerned with solving the ecological

* bcf/d – Billion cubic feet a day.

and environmental problems of constructing and operating pipelines in permafrost areas.

The Canadian Arctic Gas Study Limited (CAGSL) is seeking to bring Mackenzie Delta and Alaska gas to market and has already spent about $50 million in economic, engineering and environmental studies related to its proposed line. The results of the studies showed that chilled natural gas could be transported by pipelines without damage to the permafrost. In March 1974, CAGSL filed an application with federal government regulatory authorities to build the $5.7 billion pipeline. The company still anticipates that much of the gas transported by the line will have to come from Prudhoe Bay in Alaska because Mackenzie Delta reserves alone are not yet sufficient to make the line viable.

Late in the year, The Alberta Gas Trunk Line Company Limited withdrew from the CAGSL consortium and was joined by Westcoast Transmission Company Limited as a partner in Foothills Pipe Lines Ltd. This company will also apply to build a pipeline (Maple Leaf Pipeline) to transport only Canadian natural gas from the Mackenzie Delta. The Foothills proposal is an all-Canadian, 820-mile, 42-inch line from the Delta to Alberta and British Columbia where it would connect with existing systems. Cost of the line is

Table 10. Gas pipeline mileage in Canada 1970-74

	1970	1971	1972	1973	1974e
Gathering					
New Brunswick	6	6	6	6	6
Quebec	1	1	1	1	1
Ontario	1,121	1,092	1,136	1,292	1,408
Saskatchewan	893	875	922	963	1,005
Alberta	4,049	4,243	4,202	4,881	5,050
British Columbia	718	948	989	1,083	1,185
Northwest Territories and Yukon	2	4	—	34	34
Total	6,790	7,169	7,256	8,260	8,689
Transmission					
New Brunswick	13	13	13	13	13
Quebec	148	148	148	148	148
Ontario	3,612	3,711	4,351	5,517	6,450
Manitoba	1,321	1,445	1,589	1,642	1,710
Saskatchewan	4,990	5,361	5,996	6,328	6,930
Alberta	6,782	7,206	7,815	8,072	2,075
British Columbia	2,372	2,653	2,967	3,085	3,300
Total	19,238	20,537	22,879	24,805	27,626
Distribution					
New Brunswick	32	32	32	32	32
Quebec	1,568	1,638	1,693	1,829	1,950
Ontario	15,610	16,080	16,664	16,418	16,700
Manitoba	1,513	1,630	1,708	1,771	1,845
Saskatchewan	2,236	2,355	2,547	2,711	2,950
Alberta	7,553	7,841	8,657	9,267	9,700
British Columbia	5,179	5,203	5,864	6,149	6,400
Total	33,709	34,779	37,165	38,178	39,577
Total Canada	59,737	62,485	67,300	71,244	75,892

Source: Statistics Canada.
— Nil; e Estimated by Mineral Development Sector.

estimated to be $1.75 billion, with an additional $1.6 billion required to expand existing southern systems. The CAGSL proposal on the other hand, features a 2,600-mile, 48-inch pipeline.

The third proposal is the Polar Gas Project which is researching the feasibility of constructing a 48-inch pipeline to deliver natural gas from the Arctic Islands. The major engineering challenge of this project is the laying of about 540 miles of pipeline underwater between the Arctic Islands at depths as great as 900 feet. An additional problem is the danger of ice scour from the bottom of large ice packs which gouge the ocean floors even at considerable depths. By the end of 1974 research had verified the fact that, although construction of the line would be difficult, technologically it would be possible.

All of these major pipeline projects will have to deal with complex engineering and ecological problems and meet stringent regulatory requirements before Arctic gas can be delivered to southern markets.

Markets and trade

Sales of gas to Canadian customers rose by 7 per cent to 3,600 MMcf/d in 1974, an increase of 232 MMcf/d. The volume of exports continued to decline, however, decreasing by 7 per cent to 2,632 MMcf/d — a 192 MMcf/d decline. As a result, total sales of Canadian natural gas increased by less than 1 per cent, averaging 6,196 MMcf/d in 1974 against 6,152 MMcf/d in 1973.

Commercial users in the domestic sector led the way in consumption growth rate with a gain of 12 per cent to 754 MMcf/d, while sales in the residential market rose by 8 per cent to 802 MMcf/d. Industrial users increased consumption by 5 per cent to 2,043 MMcf/d. Total revenue from all sales of gas in Canada amounted to $1,474 million in 1974 and of this amount, domestic sales accounted for $980 million — 23 per cent more than 1973 sales of $798 million. The value of export sales rose to $493 million, increasing by 41 per cent or $143 million over 1973 sales.

On a regional basis, eastern Canada had the highest growth rate with an increase of 241 MMcf/d to 2,003 MMcf/d for a 13.7 per cent gain over the previous year. Much of the increase reflected expanding demand in the industrial and commercial sectors, particularly in Ontario and Quebec. Ontario increased its consumption of natural gas by 198 MMcf/d to 1,784 MMcf/d for a 12.4 per cent rise, accounting for about 49.5 per cent of all gas used in Canada. Sales in Quebec increased 25 per cent to 220 MMcf/d. The sales agreement between Pan-Alberta Gas Ltd. of Calgary and Gaz Métropolitain, inc. of Montreal was approved too late in the year to have much of an impact on sales of Alberta gas in Quebec in 1974. Under the terms of this agreement, Pan Alberta will initially supply the Quebec market with 40 MMcf/d, deliveries to commence November 1, 1975. Future increases in the contracted volume will depend on supply-demand factors and the availability of adequate transportation facilities.

Pan Alberta is also conducting negotiations with Ontario's three major gas utilities with a view to supplying them with additional gas in 1975. At the same time the company cancelled its contract with Pacific Interstate Transmission Company to supply gas

Table 11. Canada sales of natural gas by province, 1974[p]

	MMcf	(000's)$	Average $/Mcf	Number of Customers Dec. 31/74
New Brunswick	66	188	2.85	778
Quebec	80,171	87,537	1.09	191,757
Ontario	651,200	566,343	.87	982,659
Manitoba	63,885	49,854	.78	152,388
Saskatchewan	92,670	49,072	.53	174,197
Alberta	297,397	105,793	.36	395,127
British Columbia	128,932	121,608	.94	322,643
Total Canada	1,314,321	980,395	.75	2,219,549
Previous totals				
1970	917,441	582,217	0.63	1,889,808
1971	1,001,329	641,898	0.64	1,958,083
1972	1,145,797	740,383	0.65	2,039,095
1973	1,229,409	797,856	0.65	2,131,090

Source: Statistics Canada.
[p] Preliminary.

to the United States' west coast. Pan Alberta is a wholly-owned subsidiary of The Alberta Gas Trunk Line Company Limited and was originated in 1972 to contract for excess gas production capability in Alberta and resell the gas on a short-term basis. In return, the customers are committed to resell equivalent quantities of gas to Pan Alberta from Alaska or other Arctic supplies in the 1980's or 1990's. The National Energy Board (NEB) has not granted an export gas permit since 1970, and since it is unlikely to do so in the near term, Pan Alberta was left without a major market for its newly acquired gas. Consequently it has been increasingly turning to the domestic market for its customers.

Gas sales in western Canada declined slightly to 1,596 MMcf/d. Alberta remained the second largest gas consuming province, increasing its consumption rate to 814 MMcf/d, 22.6 per cent of all gas marketed in Canada in 1974. The increase in consumption of gas in Alberta was mainly attributable to the provincial government's rural gasification program. Gas sales in British Columbia, on the other hand, declined by 14 per cent to 353 MMcf/d. The decline in consumption is partly a result of lessening demand and partly a result of the failure of British Columbia's two major sources of gas supply to produce up to expectations. The two fields, namely Beaver River in northeastern British Columbia, and Pointed Mountain in the Territories, have been experiencing reservoir technical problems which are still not resolved.

Sales in New Brunswick, never very substantial, increased slightly over the previous year. The remaining three provinces do not have natural gas service.

Export sales to the United States decreased by 7 per cent to 2,632 MMcf/d, due primarily to the inability of British Columbia gas fields to supply contracted volumes. Notwithstanding this factor, an increase in exports to the United States was not anticipated this year since the NEB has not authorized any export increases since 1970 when Westcoast Transmission Company Limited received permission to export additional volumes of gas to west coast United States consumers. Imports from the United States into Ontario averaged 36.7 MMcf/d, a decline of 3.5 MMcf/d from 1973.

In respect to gas exports, the NEB has commenced a series of public hearings into Canadian natural gas supply and future requirements. The thrust of the hearings is similar to that of the recently completed inquiry into oil, i.e., to determine the degree of Canadian gas self-sufficiency. The inquiry is also designed to assess the possible impact of requirements of future petrochemical requirements on Canada's existing proven natural gas reserves. Although the results of the inquiry were not made public by year-end, preliminary indications are that our gas supply position is not as favourable as previously believed, but probably not as gloomy as the oil supply situation as determined in the earlier NEB inquiry.

SUPPLY - DEMAND
of NATURAL GAS in CANADA

MINERAL DEVELOPMENT SECTOR
DEPARTMENT OF ENERGY, MINES AND RESOURCES

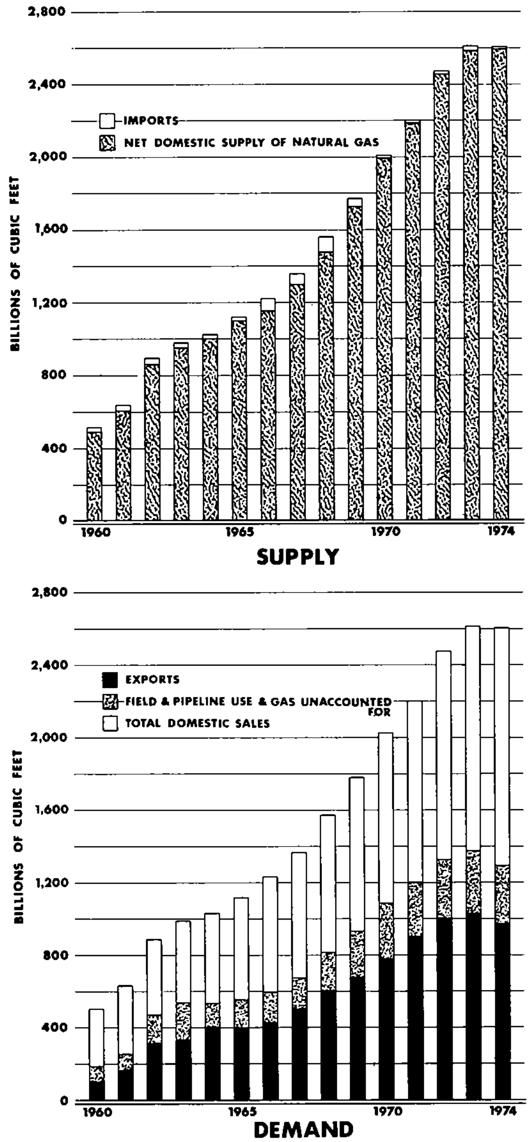


Table 12. Canada, supply and demand of natural gas

	1973		1974p	
	MMcf	MMcf	MMcf	MMcf
Supply				
Gross new production		3,566,653		3,535,332
Field waste and flared		-79,037		-69,492
Reinjected		-367,995		-382,462
Net withdrawals		3,119,621		3,083,378
Processing shrinkage		-470,951		-453,840
Net new supply		2,648,670		2,629,538
Removed from storage	74,504		101,076	
Placed in storage	-131,669		-135,674	
Net storage		-57,165		-34,598
Total net domestic supply		2,591,505		2,594,940
Imports		14,700		13,408
Total supply		2,606,205		2,608,348
Demand				
Exports		1,030,913		960,713
Domestic sales				
Residential	271,797		292,961	
Industrial	711,958		745,929	
Commercial	245,654		275,431	
Total		1,229,409		1,314,321
Field and pipeline use				
In production	207,807		201,320	
Pipeline	134,624		114,690	
Other	37,652		27,734	
Line pack changes	1,253		2,299	
Total field and pipeline use		381,336		346,043
Gas unaccounted for		-35,453		-12,729
Total demand		2,606,205		2,608,348
Total domestic demand		1,575,292		1,647,635
Average daily domestic demand		4,315		4,514

Source: Statistics Canada and provincial government reports.
p Preliminary.

During 1974, attention continued to be focussed on the question of natural gas pricing both at provincial and federal levels. This is not surprising, since most countries have had to re-examine their oil and gas policies in this new era of elevated energy prices. In the provincial domain, a new base wellhead price of 60 cents per Mcf was established in Alberta. This followed an arbitration board decision setting the price of purchase contracts between Gulf Oil Canada Limited and TransCanada PipeLines Limited. Based on the Board's decision, the field value of Gulf's 34 contracts was set at 60 cents per Mcf effective November 1, 1974 and to rise to 73 cents an Mcf on November 1, 1975. The estimated net wellhead price to producers in Alberta will average about 40 cents an Mcf when this new price schedule is initiated.

Continuing strong demand, reinforced by an Alberta government pricing policy based on fair commodity value in comparison to oil, has encouraged producing companies to continue to seek higher prices for natural gas over and above the price awarded to Gulf. The federal government, although willing to concede that both domestic oil and gas prices should be increased to reflect world prices more closely, was concerned that the increase would be instituted too quickly to be absorbed by the consumer without major disruption to the Canadian economy. In order to resolve this problem, a First Ministers' conference of the provincial and federal governments was scheduled for April 1975, to attempt to reach agreement in future oil and gas pricing policies in Canada. In the event that agreement may not be reached, it is conceivable that the federal government will eventually set prices unilaterally under provisions specified in its newly-proposed Petroleum Administration Act.

In respect to the export market, the federal government, acting on the recommendations of the NEB, increased the price of natural gas exported to the United States by 66 per cent from an average of about 60 cents an Mcf to $1 an Mcf. The increase became effective January 1, 1975 and, when announced, federal officials said that export gas prices will be increased in the future in such a way as to parallel the export price of oil, i.e. on an equivalent Btu basis. United States buyers of Canadian gas will be given the option of either agreeing to the new price increases and changing existing licenses, or continuing to pay the existing prices for two years. However, in the latter case, the export licenses would be terminated at the end of two years and the gas would be reallocated to use within Canada. It is anticipated that the gas producers will receive the bulk of the new price increase.

Composition and uses of natural gas

Marketed natural gas consists chiefly of methane (CH_4) but small amounts of other combustible hydrocarbons such as ethane (C_2H_6) and propane (C_3H_8) may also be present. Methane is nonpoisonous and odourless, but a characteristic odour is usually introduced into marketed natural gas as a safety measure. The heat value of natural gas averages about 1,000 British thermal units per cubic foot of gas.

Raw natural gas, as it exists in nature, may vary widely in composition. Besides the usually predominant methane, varying proportions of ethane, propane, butane and pentanes plus may be present. Water vapour is a normal constituent. Hydrogen sulphide, although not present in some Canadian natural gas, is commonly so abundant as to be an important source of sulphur. Other nonhydrocarbon gases which may be present, usually in small amounts, are carbon dioxide, nitrogen and helium.

The most important use of natural gas is as a fuel for space and water heating. Gas is now extensively used in cooking, but is becoming common as a fuel for air conditioners, incinerators, dishwashers and laundry equipment. In industrial areas, natural gas has been a boon to such industries as automobile plants, steel plants, metal-working firms, glass factories and food-processing industries. For example, in metallurgical processing, the clean, easily controlled flame of natural gas enables the desired temperatures to be attained in rolling, shaping, drawing and tempering steel. The constituents of natural gas have become major sources of raw material for the petrochemical industry. Ethane, seldom removed from natural gas at the field processing plant in the past, is an important petrochemical feedstock that, up until now, has been recovered from pipeline gas on a limited scale subject to market forces. Ethane recovery on a large scale is now predicted. With imminent prospects for major growth in the petrochemical industry, it is likely that most, if not all, of this valuable commodity will henceforth be recovered and used as a petrochemical feedstock. Natural gas supplies basic raw material for ammonia, plastics, synthetic rubber, insecticides, detergents, dyes and synthetic fibres such as nylon, orlon and terylene. Important future uses may include gas fuel-cells and power-generator systems driven by gas turbines. Canada continues to be one of the world's largest producers of elemental sulphur, a byproduct recovered in the processing of sour gas (hydrogen sulphide bearing) from fields in western Canada.

Nepheline Syenite and Feldspar

G.H.K. PEARSE

Nepheline syenite is a white to whitish-grey, medium-grained igneous rock resembling granite in texture. It consists of nepheline, potash and soda feldspar, and accessory mafic minerals such as biotite, hornblende and magnetite. Although nepheline syenite is a rock type known to occur in many parts of Canada, its industrial application is limited to those deposits in which iron-bearing accessory minerals can readily be removed; its major uses are in the glass and ceramics industries.

Nepheline syenite as a raw material for glass, ceramic and filler industries was first developed in Canada, which was the world's sole producer for many years. Canada's only competitor in the field, Norway, began nepheline syenite mining and milling in 1961. Although the U.S.S.R. began mining nepheline syenite on the Kola Peninsula during the 1930s, the deposit was worked for its phosphate content. Byproduct nepheline from the Kola deposit became important as a source of aluminum and is still being used for this purpose. Nepheline syenite is also quarried in the United States for use as aggregate, railway ballast, jettystone and roofing granules.

Canada's nepheline syenite industry began in 1932 with the staking of five claims on Blue Mountain, 25 miles northeast of Peterborough. A long period of persistent efforts in technical and market research and development was necessary before this unique industry became established. Today there are two mills in operation on Blue Mountain processing rock from several quarries.

Over the years nepheline syenite has become preferred to feldspar as a source of essential alumina and the alkalis in glass manufacture. Its use has resulted in more rapid melting of the batch at lower temperatures than with feldspar, consequently reducing fuel consumption, lengthening the life of furnace refractories and improving the yield and quality.

Industrial uses for nepheline syenite other than for glass manufacture are many; and markets are expanding rapidly in ceramics, enamels, and as a filler in paints, papers, plastics and foam rubber.

Feldspar is the name of a group of minerals consisting of aluminum silicates of potassium, sodium and calcium. Feldspar is used in glassmaking as a source of alumina and the alkalis, ceramic bodies and glazes, in cleaning compounds as a moderate abrasive and as a flux coating on welding rods. High-calcium feldspars, such as labradorite, and feldspar-rich rocks such as anorthosite find limited use as building stones and for other decorative purposes. Dental spar, which is used in the manufacture of artificial teeth, is a pure white potash feldspar free of iron and mica.

Feldspar occurs in many rock types, but commercially viable deposits are mostly restricted to coarse-grained granite pegmatites from which the mineral is concentrated by flotation or less commonly, hand-cobbing. It is then ground to the desired size. Nearly all feldspar which has been produced in Canada has come from pegmatites in the Precambrian rocks of southern Ontario and southwestern Quebec.

Canadian production and developments

Nepheline syenite production originates from two operations on Blue Mountain in Methuen Township, Peterborough County, Ontario. The deposit is pear shaped, approximately five miles long and up to one and one-half miles wide. The iron content of the rock is distributed quite uniformly; but selective quarrying, blending of quarry material, and careful pit development are necessary to ensure a mill product capable of meeting consumer specifications. In general, the nepheline syenite zone is underlain by syenites and overlain by steeply dipping biotite schists. Nepheline syenite reserves are sufficient to satisfy demand for the foreseeable future.

Indusmin Limited, a subsidiary of Falconbridge Nickel Mines Limited, is the larger producer. The company's operation in Nephton, Ontario, was originally worked by its predecessor, American Nepheline Limited. Ore is currently being mined from five open pits. Rock is blasted from the pit face and loaded by electrically powered shovels into trucks for haulage to an adjacent mill at Nephton. The mill, which was built in 1956 and subsequently expanded to 1,000-tons-a-day capacity, operates three shifts a day, seven days a week and produces several grades of nepheline syenite to meet a wide variety of markets. The various grades produced are based on combinations of differing mesh sizes and iron content. Iron-bearing minerals are almost totally removed by electromagnetic methods. Finished products are transported by rail through

Table 1. Canada, nepheline syenite production, exports and consumption 1973-74

	1973		1974^p	
	(short tons)	($)	(short tons)	($)
Production (shipments)	569,403	7,860,300	607,000	8,510,000
Exports				
United States	437,438	5,821,000	469,241	7,216,000
United Kingdom	3,030	66,000	12,110	197,000
Australia	2,536	67,000	3,832	173,000
Spain	474	13,000	1,232	41,000
Italy	652	17,000	1,485	40,000
France	1,045	35,000	1,112	39,000
Israel	134	4,000	852	22,000
Greece	165	4,000	705	20,000
Thailand	330	9,000	454	16,000
Other countries	2,755	65,000	1,738	54,000
Total	448,559	6,101,000	492,761	7,818,000

Consumption[1] (available data)	1972	1973
	(short tons)	
Glass and glass fibre	57,071	66,148
Whiteware	12,450	14,529
Mineral wool	10,265	11,000^e
Paints	4,861	7,503
Porcelain enamel	250	260
Others[2]	11,780	3,569
Total	96,677	103,009

Source: Statistics Canada.
[1] Total and breakdown from Mineral Development Sector. [2] Includes miscellaneous chemicals, gypsum products, rubber products, cleansers and detergents and other minor uses.
^{p} Preliminary; ^{e} Estimated.

Havelock, Ontario, 18 miles south of the mill, to domestic and export markets. The United States accounts for about 76 per cent of total sales.

A major expansion of the secondary milling circuit was halted when sales dropped sharply in the last quarter of the year due to deteriorating economic conditions in the United States and Canada. However, installation can be completed within a few weeks when markets improve.

Ownership of International Minerals & Chemical Corporation (Canada) Limited's operation on Blue Mountain was transferred to Sobin Chemicals (Canada) Ltd., raising the former's interest in this company to 81 per cent from 37 per cent. The mill, located about four miles east of Indusmin's plant, was constructed in 1956 on a part of the deposit originally staked in 1932 by the Canadian Flint and Spar Company, Limited. Present capacity is 800 tons a day. The mill operates three shifts daily, seven days a week and produces a variety of products based on mesh sizes and iron content suitable for many industrial uses. Rock is mined from an open pit adjacent to the mill; a certain degree of blending from various parts of the pit is required to ensure an acceptable mill feed. Ore reserves are sufficient for many years.

Production is railed to Havelock, Ontario for distribution to various markets, approximately 90 per cent being exported to the United States. Sobin Chemicals (Canada) Ltd. produces three grades of nepheline syenite for glass, enamel, fibre and other applications.

In 1974, total nepheline syenite shipments amounted to 607,000 short tons valued at $8.51 million, a tonnage increase of 6.6 per cent from 1973. Revenue from sales in 1974 showed an increase of 8.3 per cent over 1974 reflecting, in part, price increases during the year.

From 1950 to 1962, annual shipments increased from 65,000 to 250,000 tons, an average growth rate of 17 per cent a year. Between 1963 and 1968 a growth rate of 9 per cent was realized. This dramatic growth was due largely to recognition by glassmakers of the superior properties, consistent quality, long-term reliable supply, and low cost of nepheline syenite compared with feldspar. Sales were especially buoyant in 1968 – 69 because of a tight supply situation for feldspar in the United States. Upon return to more normal feldspar supply conditions in 1970, a minor decrease in nepheline syenite shipments occurred. Since 1968, average annual growth has been 6 per cent.

International Minerals & Chemical Corporation (Canada) Limited, the sole Canadian producer of feldspar for several years, closed down operations at its mine at Buckingham, Quebec in mid-1972. As a result of substitution by nepheline syenite, output of feldspar has declined steadily from 55,000 tons in 1947 to 10,000 tons in 1961, a level that persisted throughout the 1960s and continues to be Canada's tonnage requirement. However, since closure, a shortage of potash feldspar, for which there is, as yet, no acceptable substitute in the manufacture of high-voltage electrical porcelain insulators, has developed in both the United States and Canada. Several local producers of high-value dental spar had delivered small tonnages to the mill at Buckingham until the recent closure.

Tantalum Mining Corporation of Canada Limited mines tantalum and lithium from a pegmatite containing abundant feldspar at Bernic Lake, Manitoba and the company is actively studying recovery and market potential of a clean quartz-feldspar product.

Other domestic occurrences

Nepheline syenite is known to occur in many localities in Canada but, to date, only the Blue Mountain deposit has proven to be amenable to economic mining and milling to produce material suitable for the glass and ceramic markets. Other occurrences are either too high in iron content or are too variable in chemical composition to allow large-scale, open-pit development.

An extensive body of nepheline syenite outcrops in the Bancroft area of Ontario. Small tonnages of this material were mined from 1937 to 1942, but the product proved unacceptable because of considerable variation in the nepheline content and an overabundance of iron-bearing accessory minerals. Tontine Mining Limited (now Coldstream Mines Limited) discontinued exploration work in 1971 on a large nepheline syenite intrusive located near Port Coldwell, Ontario, after obtaining discouraging results from petrologic and metallurgical studies.

Nepheline syenite occurs in several localities in southern British Columbia, notably in the Ice River area, near Field, and in the Big Bend area on the Columbia River.

Nepheline is a common mineral constituent in the alkaline complexes of northern Ontario and southern Quebec, but none of these deposits are, as yet, of economic significance.

Feldspar is the major mineral constituent of pegmatite dykes which are widely distributed in Canada. Any large deposit near potential markets warrants investigation.

Markets

In 1974, 81 per cent of Canada's nepheline syenite output was exported. Sales to the United States increased 7 per cent from 1973 and accounted for 95 per cent of total exports.

Canadian offshore sales were 23,520 short tons in 1974, about twice that of 1973, a return to the level of previous years. All significant importers of Canadian nepheline syenite increased their purchases. Britain and Australia together accounted for two thirds of Canada's offshore sales.

Domestic shipments decreased 6.5 per cent to an estimated 114,000 tons in 1974 or 19 per cent of producers' shipments. Of this, about 60 per cent was used in glass and glass fibre manufacture.

In the glass industry, 15 to 20 per cent by weight of the glass batch is nepheline syenite. Material with a size range of minus 30 mesh to plus 200 mesh and with an iron content of less than 0.1 per cent is required in the production of flintglass. An iron content as high as 0.6 per cent, expressed as Fe_2O_3, is allowable for the manufacture of coloured glass. A typical chemical analysis for high-quality nepheline syenite produced in Canada for glass manufacture is:

Silica SiO_2	–	60.00
Alumina Al_2O_3	–	23.60
Iron Fe_2O_3	–	0.07
Lime CaO	–	0.30
Magnesia MgO	–	0.10
Potash K_2O	–	5.30
Soda Na_2O	–	10.20
Loss-on-ignition	–	0.50

A growing market is developing for finely ground material in the whiteware industry. The finer grades used for ceramic applications are produced by reducing the basic minus 30 mesh material in pebble mills. In ceramics, nepheline syenite is used as both a body and glaze ingredient. High-purity material in the minus 200 – plus 375 mesh size and with an iron content of 0.07 per cent Fe_2O_3 or less is most frequently used. Products utilizing this material include bathroom fixtures, vitreous enamels for appliances, china, ovenware, electrical porcelain and ceramic artwares.

Very finely ground material is being increasingly used as a filler in plastics, foam rubber and paints. Fine-grinding down to 10 microns is accomplished in pebble and fluid-energy mills. The very fine grain size, high reflectance and low oil absorption are important physical characteristics which make nepheline syenite an excellent filler co-material in such finished products as paints, vinyl furniture upholstery, foam rubber cushions, foam rubber carpet backings, and floor and wall tile.

A low-grade nepheline syenite is sold in bulk for use in the manufacture of fibre glass and for glazing on brick and tile. Some material with iron content is used in the manufacture of mineral wool and as an aggregate.

Substitution of alternative materials for feldspar in ceramic manufacture has been less severe than in the manufacture of glass. The principal reason is that raw material costs are low in the ceramic industry in relation to total manufacturing costs and manufactures adopt a new raw material only after cautious trial use and extensive evaluation. Further, while the higher alumina content of nepheline syenite has been a decisive factor in the replacement of feldspar in glass manufacture, a high alumina content is less critical in ceramic manufacture. In ceramics, potash feldspar is used to bind the ceramic mix into what the industry terms a "body" and in the manufacture of electric porcelain for high voltage purposes this mineral is essential. The domestic market for feldspar appears to have bottomed at around 10,000 tons a year.

Table 2. Canada, nepheline syenite production and exports 1965-74

	Production[1]	Exports
	(short tons)	
1965	339,982	247,200
1966	366,696	263,624
1967	401,601	307,613
1968	426,595	323,182
1969	500,571	395,613
1970	486,667	387,947
1971	517,190	410,110[r]
1972	559,483	442,470[r]
1973	569,403	448,559[r]
1974[p]	607,000	492,761

Source: Statistics Canada.
[1] Producers' shipments.
[p] Preliminary; [r] Revised.

World review

The Norsk Nefelin Division of Christiania Spigerwerk is western Europe's only producer of nepheline syenite. Operations at the plant near Hammerfest in northern Norway began in 1961 and increased steadily from an output of 23,000 metric tons in 1963 to 200,000 metric tons in 1973. The latest expansion, completed in 1973, raised capacity from 175,000 to 225,000 metric tons a year. The lenticular deposit is over one mile long and at least 750 feet deep. Unlike Canadian producers, Norsk Nefelin mines underground, drilling and blasting by conventional techniques. Nepheline syenite is supplied to the glass, ceramic and enamel industries in two main grades; glass grade is about 28 Tyler mesh and ceramic grade 200 Tyler mesh. The finer-mesh ceramic grade material is usually shipped in bags, whereas the coarser glass grade is shipped in bulk to European markets. The company employs a modern fleet of coasters on long-term charter, and ships finished products to storage and distribution centres in major market areas.

Nepheline syenite is an important source of alumina for aluminum production in the U.S.S.R. Very large deposits occur near Kirovsk in the Kola Peninsula and also in the Lake Baikal region of Siberia. The Kola deposits were first mined in the 1930's for phosphate. Byproduct nepheline that contains 30 per cent Al_2O_3 is recovered for use in aluminum production. In the process used to extract alumina, limestone is added to the nepheline concentrates and the mix is sintered and treated with caustic soda to yield anhydrous alumina, soda, potash and cement. Aluminum producers elsewhere in the world, faced with rising bauxite prices and concern for raw material supply, are viewing with interest potential alternate domestic sources of alumina, such as nepheline syenite and anorthosite.

Feldspar still retains a major share of its traditional markets outside of North America, although Norwegian nepheline syenite is rapidly making headway in these markets. World production of feldspar is an estimated 2.8 million short tons.

Table 3. Canada, feldspar production 1973-74, consumption 1972-73

	1973		1974[p]	
	(short tons)	($)	(short tons)	($)
Production[1]	—	—	—	—
Consumption[2] (available data)			1972	1973[p]
			(short tons)	
Whiteware			8,530	6,099
Porcelain enamel			288	462
Soaps and cleaning compounds			73	—
Other[3]			833	417
Total			9,724	6,978

Source: Statistics Canada.
[1] Producers' shipment. [2] Breakdown by Mineral Development Sector. [3] Includes artificial abrasives, electrical apparatus, glass, paper and other minor uses.
[p] Preliminary; — Nil.

Table 4. Canada, feldspar production, trade and consumption, 1965-74

	Production[1]	Exports	Consumption
	(short tons)		
1965	10,904	3,746	8,338
1966	10,924	3,419	8,528
1967	10,394	..	8,571
1968	10,620	..	7,343
1969	12,385	..	7,635
1970	10,656	..	7,540
1971	10,774	..	8,854
1972	11,684	..	9,724
1973	—	..	6,978
1974^p	—	..	..

Source: Statistics Canada.
[1] Producers' shipments.
^{p} Preliminary; .. Not available; — Nil.

Outlook

The outlook for nepheline syenite continues to be good, although the current recession in the world economy undoubtedly will moderate growth in 1975 and, possibly, part of 1976. Housing starts were down 17 per cent in Canada in 1974, with no significant recovery expected until well into 1975. This industry, of course, is a major consumer of glass, sanitary-ware, paint, etc. Canadian shipments to Europe returned to former levels despite competition from Norwegian nepheline syenite. However, European sales account for less than 5 per cent of Canada's total sales and, therefore, will have little effect on overall developments in the industry.

Over the last several years, the market for micronized material used as a filler and extender in plastics, paint, rubber and paper has grown more rapidly than consumption for glassmaking and further diversification and growth of these markets is expected.

The phenomenal growth rate enjoyed by the nepheline syenite industry during the 1950s and early 1960s has moderated as markets formerly supplied by feldspar approach saturation. The near-term hiatus in growth is a temporary one, and, with the recovery of the glass industry and continued expansion of other uses, a growth rate of 7 per cent a year is anticipated for the medium-term.

With increasing electrical energy requirements, the demand for essential feldspar coupled with the decline in North American production, elevates this raw material to a position of prime importance. The present slackness in the economy has eased these pressures temporarily, but rising prices and growing markets could provide an opportunity to develop a suitable Canadian deposit in the near future.

Table 5. World production of feldspar, 1973-74

	1973	1974^e
	(short tons)	
United States	792,000	790,000
West Germany	338,000	350,000
U.S.S.R.	298,000	300,000
Norway	220,000	200,000
Italy	210,000	200,000
France	165,000	150,000
Japan	57,000	60,000
Sweden	38,000	50,000
Other countries	676,000	700,000
Total	2,794,000	2,800,000

Source: U.S. Bureau of Mines Commodity Data Summaries, January 1975.
^{e} Estimated.

Prices

Nepheline syenite prices vary from low-purity, crushed rock in bulk, at about $6.00 a ton, to over $30.00 a ton for high-purity products. The price of nepheline syenite used in the glass industry is around $15.00 a ton fob plant. The largest export market is the United States where entry is duty free.

United States feldspar prices in U.S. currency as quoted in *Engineering and Mining Journal*, December 1974.

(per short ton, fob mine or mill, carload lots, depending on grade)

	($)
North Carolina	
40 mesh, flotation	14.00 — 22.00
20 mesh, flotation	14.50 — 15.50
200 mesh, flotation	25.50 — 29.00
Georgia	
200 mesh	31.00
40 mesh, granular	26.00
Connecticut	
200 mesh	26.00
20 mesh, granular	19.00

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
29600-1	Feldspar, crude	free	free	free
29625-1	Feldspar, ground but not further manufactured	free	7½%	30%
29640-1	Ground feldspar for use in Canadian manufactures (July 2, 1974 to June 30, 1975)	free	free	30%

United States

Item No.		
522-31	Crude feldspar	free
522-41	Feldspar, crushed, ground or pulverized	3.5%

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Nickel

M.J. GAUVIN

Canadian mine production of nickel in 1974 increased to 299,661 tons* valued at $997.7 million from 268,908 tons valued at $785.2 million in 1973. The increased tonnage and value of 1974 production reflects the continued expansion of major world economies and price increases. World mine production is estimated at 757,000 tons in 1974 compared with 723,169 tons in 1973.

Canada maintained its position as the leader in world nickel production in 1974, accounting for about 39 per cent of the total. New Caledonia with about 17 per cent of production, and the U.S.S.R., with an estimated 16 per cent of world output, were the two next largest producers.

Nickel markets continued to improve in 1974 over 1973, and in mid-1974 producer inventories were at a low level. Demand slackened in the second half of the year, particularly in the last quarter, giving producers the opportunity to rebuild inventories. There were indications at the end of the year that an oversupply would develop in 1975 due to slackening economic activity and new production capacity being brought on stream in the Philippines, Australia and Botswana. Consumption of nickel in the noncommunist world in 1974 was about 625,000 tons. The comparable usage in 1973 was 590,000 tons.

There were three rounds of price increases during 1974, one in January, one in May and, one in October. The price for electrolytic nickel, a Class I type nickel product, increased from U.S. $1.53 at the beginning of the year to U.S. $2.01 at the end of the year; an unprecedented increase during one year. Other nickel products, such as nickel oxide sinter and ferronickel Class II type nickel products, underwent similar price increases. All Canadian prices are based on the U.S. price converted to Canadian funds at the official exchange rate.

Canadian operations and developments

Nine companies mined nickel ores in Canada during 1974. By far, the largest producer was The International Nickel Company of Canada, Limited (Inco) which operated mines in Ontario and Manitoba. Falconbridge Nickel Mines Limited, the second largest producer, treated ores from its mines located in the same provinces. A small amount of nickel ore was mined in Quebec and British Columbia. Inco, Falconbridge and Sherritt Gordon Mines, Limited each have integrated mine-concentrator-smelter and refinery complexes where they processed ore to the metal stage.

One new nickel mine started producing in 1974, that of Kanichee Mining Incorporated which began tune-up operations at Temagami, Ontario in January. Two mines ceased production during the year because of depletion of economically recoverable reserves, namely the Lac Edouard property of Société Minière d'Exploration Somex ltée, in January, and the Giant Nickel mine of Giant Mascot Mines Limited near Hope, British Columbia, in August.

The International Nickel Company of Canada, Limited is the world's largest producer of nickel. Record deliveries by Inco in 1974 of 274,535 tons of nickel accounted for almost 44 per cent of consumption in the noncommunist world. Inco's nickel production was at an all-time high of 255,000 tons in 1974 compared with 234,500 tons in 1973. The company operated twelve mines, five concentrators, two smelters and a nickel refinery in the Sudbury district, a mine and concentrator at Shebandowan, northwestern Ontario, and a nickel refinery and additive plants at Port Colborne, Ontario. In the Sudbury district, production from the Crean Hill mine was resumed on a regular basis while operations were completed at the Clarabelle open-pit mine. In Manitoba, Inco operated three mines, one concentrator, one smelter and one nickel refinery at Thompson. Three mines, the Totten and Murray in Ontario and the Soab in Manitoba were maintained on a standby basis. The proven ore reserves of the company in Canada are 414 million tons containing 6.7 million tons of nickel and 4.2 million tons of copper.

The new Copper Cliff nickel refinery, which uses Inco's top-blown rotary converter and pressure carbonyl process, operated throughout the year, but did not

*The short ton (2,000 pounds) is used throughout unless otherwise stated.

achieve its full capacity of 50,000 tons of nickel pellets and 12,500 tons of nickel powder in 1974. The refinery produces pellets of 99.97 per cent nickel and powder of 99.8 per cent purity. Inco phased out production of nickel oxide sinter 90 at the end of the year, its market being taken over by other products of the company. The 1,250-foot smelter stack built in 1972, together with technological improvements in the Sudbury operations, has significantly improved air quality in the region. Construction has begun on two waste water treatment plants to treat all effluents from the company's facilities in Sudbury as part of the company's continuing environmental program.

Falconbridge Nickel Mines Limited operated eight mines, four concentrators and one smelter in the Sudbury area. In Manitoba, the company operated the Manibridge mine and concentrator. Concentrates produced at Manibridge are smelted at Falconbridge. All nickel-copper matte produced at Falconbridge is shipped to the company's refinery at Kristiansand, Norway for treatment. Falconbridge has a program underway at Kristiansand to improve working conditions and the refining process.

At Sudbury, Falconbridge continued preparing the Lockerby mine for production. The sinking of the number 2 shaft was completed and lateral development was underway. Ore from the Lockerby mine will be trucked to the Strathcona mill which is being enlarged. Sinking of a new internal shaft at the Onaping mine was started in order to develop the mine at depth. The Hardy mine ceased underground operations in May, but open-pit mining of the crown pillar continued. Refrigeration units have been installed on an experimental basis to improve working conditions at depth at the Falconbridge mine. Falconbridge's ore reserves at the end of 1974 were 90,578,000 tons averaging 1.40 per cent nickel and 0.68 per cent copper. Work commenced on a major smelter environmental program at Falconbridge which will improve working conditions and the environment of the area. This program includes a new sulphuric acid plant, the replacement of the sinter plant by fluid bed roasters and of the blast furnaces by electric furnaces. This work is expected to be completed in 1977.

Table 1. Canada, nickel production, trade and consumption, 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Production[1]				
All forms				
Ontario	196,647	574,786,081	234,473	761,640,000
Manitoba	74,582	228,222,210	64,456	213,570,000
British Columbia	1,234	3,775,232	732	2,471,000
Yukon	1,702	5,209,621	—	—
Quebec	362	1,107,807	—	—
Total	274,527	813,100,951	299,661	977,681,000
Exports				
Nickel in ores, concentrates and matte[2]				
Norway	45,997	124,362,000	46,749	138,053,000
United Kingdom	37,545	112,691,000	37,517	124,481,000
Japan	16,615	41,402,000	9,580	25,828,000
United States	228	232,000	115	163,000
Total	100,385	278,687,000	93,961	288,525,000
Nickel in oxide				
United States	40,416	97,344,000	36,118	90,376,000
Belgium and Luxembourg	7,837	18,777,000	8,547	21,653,000
United Kingdom	5,010	12,253,000	4,881	12,477,000
Japan	1,727	4,237,000	1,742	5,447,000
Italy	4,186	10,018,000	1,459	3,648,000
Sweden	2,794	6,567,000	1,338	3,401,000
Australia	2,627	6,408,000	996	2,914,000
Other countries	1,222	3,151,000	1,267	3,375,000
Total	65,819	158,755,000	56,348	143,291,000

Table 1. (cont'd)

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Exports (cont'd)				
Nickel and nickel alloy scrap				
United States	1,626	2,396,000	2,568	5,277,000
Italy	313	941,000	186	574,000
West Germany	11	21,000	110	389,000
South Korea	222	590,000	38	116,000
Netherlands	—	—	23	60,000
Other countries	239	561,000	—	—
Total	2,411	4,509,000	2,925	6,416,000
Nickel anodes, cathodes, ingots, rods				
United States	82,595	211,619,000	83,046	256,874,000
People's Republic of China	19,819	58,855,000	22,051	65,446,000
United Kingdom	15,733	39,126,000	15,366	46,657,000
Japan	5,037	15,658,000	2,781	9,239,000
India	1,454	4,555,000	1,452	4,668,000
Australia	1,764	5,473,000	1,236	4,066,000
Brazil	1,046	3,281,000	1,098	3,705,000
South Korea	490	1,533,000	919	2,993,000
Argentina	333	1,050,000	554	1,949,000
Mexico	402	1,265,000	506	1,775,000
Taiwan	2,458	7,579,000	548	1,763,000
Other countries	1,818	5,739,000	1,420	4,493,000
Total	132,949	355,733,000	130,977	403,628,000
Nickel and nickel alloy fabricated material, nes				
United States	4,189	12,804,000	7,124	22,949,000
United Kingdom	1,732	4,337,000	1,330	3,950,000
Australia	240	718,000	204	636,000
Indonesia	—	—	239	553,000
Sweden	7	14,000	107	382,000
West Germany	67	200,000	92	366,000
France	3	17,000	205	338,000
Other countries	1,079	3,333,000	368	1,382,000
Total	7,317	21,423,000	9,669	30,556,000
Imports				
Nickel in ores, concentrates and scrap				
Australia	4,087	9,001,000	1,700	4,920,000
United States	3,908	4,241,000	3,384	4,493,000
United Kingdom	3,588	2,964,000	5,203	4,077,000
French Oceania	2,714	5,302,000	1,389	3,208,000
Belgium and Luxembourg	154	112,000	85	82,000
South Africa	14	30,000	9	22,000
Other countries	94	74,000	—	—
Total	14,559	21,724,000	11,770	16,802,000

Table 1. (concl'd)

	1973		1974p	
Imports (concl'd)	(short tons)	($)	(short tons)	($)
Nickel anodes, cathodes, ingots, rods				
Norway	13,567	43,714,000	16,615	58,789,000
United States	343	969,000	498	535,000
West Germany	10	44,000	32	162,000
Hong Kong	—	—	11	51,000
Other countries	2,221	6,374,000	—	—
Total	16,141	51,101,000	17,156	59,537,000
Nickel alloy ingots, blocks, rods and wire bars				
United States	1,163	2,473,000	933	2,734,000
Belgium and Luxembourg	1	6,000	—	—
West Germany	—	3,000	—	—
Total	1,164	2,482,000	933	2,734,000
Nickel and alloy plates, sheet and strip				
United States	2,075	7,501,000	3,702	17,489,000
United Kingdom	698	2,776,000	645	2,951,000
West Germany	33	76,000	86	382,000
Other countries	10	42,000	5	28,000
Total	2,816	10,395,000	4,438	20,850,000
Nickel and nickel alloy pipe and tubing				
United States	540	4,528,000	616	4,883,000
Sweden	5	19,000	85	1,064,000
Other countries	142	848,000	5	32,000
Total	687	5,395,000	706	5,979,000
Nickel and alloy fabricated material, nes				
United States	382	1,658,000	807	3,052,000
United Kingdom	115	555,000	135	464,000
West Germany	15	77,000	36	200,000
Other countries	2	9,000	15	69,000
Total	514	2,299,000	993	3,785,000
Consumption[3]	11,862	..	..	..

Source: Statistics Canada.
[1]Refined nickel and nickel in oxide and salts produced, plus recoverable nickel in matte and concentrates exported. [2]For refining and re-export. [3]Consumption of nickel, all forms (refined metal and in oxide and salts) as reported by consumers.
p Preliminary; — Nil; nes Not elsewhere specified; .. Not available.

The third largest Canadian nickel producer is Sherritt Gordon Mines, Limited. Sherritt Gordon continues to operate its Lynn Lake, Manitoba, nickel-copper mine and concentrator but at a reduced rate due to a shortage of miners and to some underground operational difficulties. Lynn Lake concentrates are shipped to the Sherritt Gordon hydrometallurgical refinery in Fort Saskatchewan, Alberta, which operated below capacity in 1974 because of a shortage of refinery feed from Lynn Lake and overseas. Production of refined nickel during 1974 amounted to 26,172,000 pounds which was 13 per cent below 1973 production and the lowest level of production since 1967. Increased deliveries of both nickel concentrates and matte from Western Australia are expected to improve the feed supply in 1975.

In the Timmins, Ontario area, the Langmuir mine, jointly owned by Noranda Mines Limited and Inco, completed its first full year of production and operated at somewhat below the rated capacity of the plant. Texmont Mines Limited maintained its mine on a standby basis and operated its hydrometallurgical plant to produce a nickel powder product from stockpiled concentrates.

Kanichee Mining Incorporated began production from an open-pit mine in January at its property near Temagami, Ontario. This orebody was mined in the 1920's by underground methods. The ore is concentrated to produce a bulk copper-nickel concentrate which is trucked to Falconbridge for smelting.

Renzy Mines Limited's property, leased to New Hosco Mines Limited, was brought back into production in January, but a fire in February destroyed the surface plant which has not been rebuilt.

Union Minière Explorations and Mining Corporation Limited (Umex) continued underground exploration work and commenced stripping operations for an open-pit copper-nickel mine at its Thierry deposit, near Pickle Crow, Ontario. The company has decided to construct a 4,000-ton-a-day concentrator in the first phase of the operation. Production is expected to start late in 1976. Current ore reserves are estimated at 13.8 million tons averaging 1.7 per cent copper and 0.2 per cent nickel.

Development work was suspended in October on the copper-nickel property of Great Lakes Nickel Limited located near Thunder Bay in northwestern Ontario. The work was being financed under an agreement with Boliden Aktiebolag and it had been planned to bring the property into production in 1975 at a rate of 1.8 million tons a year to be increased to 2.5 million tons at the end of 1976. At the time the project was put on a standby basis, a 3,417-foot adit had been driven and over 278,000 feet of diamond drilling completed. Ore reserves are estimated at 32.8 million tons grading 0.36 per cent copper and 0.20 per cent nickel.

Development and metallurgical test work on Dumont Nickel Corporation's large low-grade nickel deposit near Amos, Quebec, has been stopped.

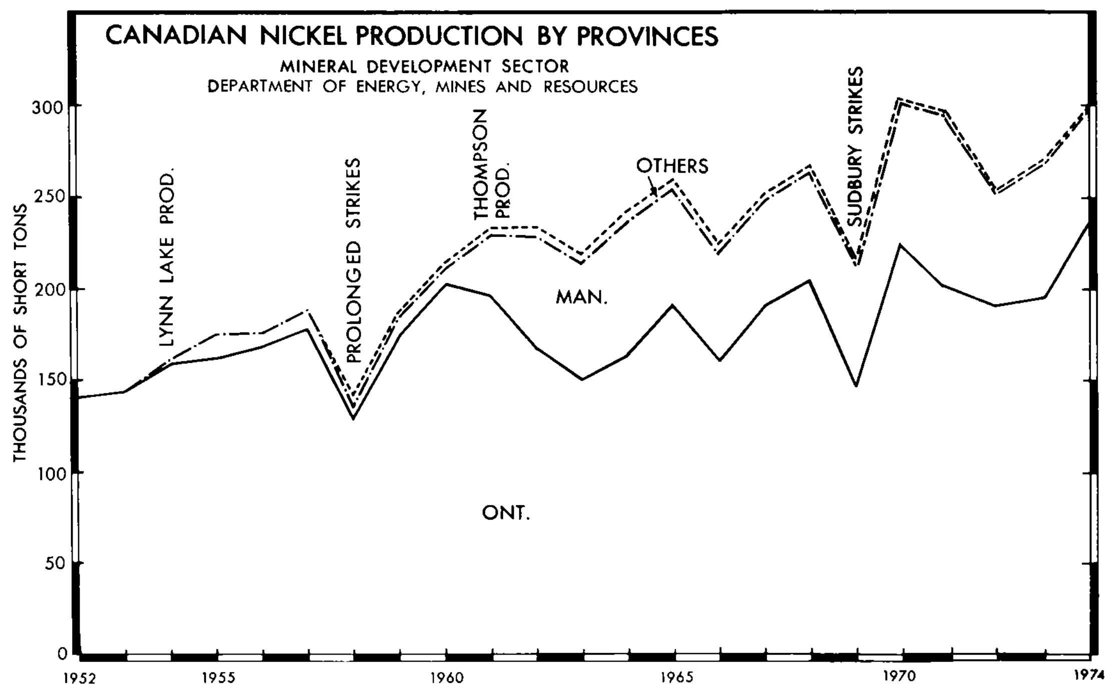


Table 2. Nickel production, trade and consumption, 1965-74

	Production[1]	Exports				Imports[2]	Con-sumption[3]
		In Matte etc.	In Oxide Sinter	Refined Metal	Total		
	(short tons)						
1965	259,182	82,327	40,956	135,197	258,480	12,172	8,924
1966	223,610	83,586	33,631	132,712	249,929	28,916	8,608
1967	248,647	83,662	34,204	128,659	246,525	9,557	8,767
1968	264,358	95,527	42,058	127,095	264,680	11,394	11,233
1969	213,612	76,976	29,009	104,243	210,228	12,601	12,094
1970	305,881	96,659	43,895	153,203	293,757	11,826	11,794
1971	294,342	116,496	42,755	125,479	284,730	14,066	8,585
1972	258,987	114,799	36,636	120,899	272,334	18,000	10,187
1973	274,527	100,385	65,819	132,949	299,153	16,141	11,862
1974[p]	299,661	93,961	56,348	130,977	281,286	17,156	. .

Source: Statistics Canada.
[1]Refined metal and nickel in oxide and salts produced, plus recoverable nickel in matte and concentrates exported. [2]Refined nickel, comprising anodes, cathodes, ingots, rods and shot. [3]Consumption of nickel, all forms (refined metal and in oxides and salts), as reported by consumers.
[p]Preliminary; . . Not available.

World developments

World mine production of nickel increased from 726,014 tons in 1973 to an estimated 757,000 tons in 1974. New projects coming on stream, drawing down of producers stocks, and increased production by established producers, were sufficient to meet the strong demand of 1974.

The Selebi-Pikwe project of Bamangwato Concessions Ltd. in Botswana started production as scheduled at the end of 1973. Ore is supplied to the plant from the Pikwe open-pit and underground mine, and a nickel-copper matte is produced in an Outokumpu Oy-type flash smelter. The Selebi mine is scheduled to start production in 1979. Major operating difficulties in the concentrator and smelter limited production to 6,663 tons of matte during the year. Plant modifications are expected to be completed by mid-1975 which will allow the complex to operate at its rated capacity of 40 millions pounds of nickel contained in matte a year. The matte is refined at the Port Nickel, Louisiana refinery of Amax Inc. The refinery, using an Amax-developed acid leach process to produce nickel briquettes, has a capacity of 80 million pounds of nickel a year.

Marinduque Mining and Industrial Corporation, in which Sherritt Gordon Mines, Limited has a 10 per cent interest, produced its first refined nickel in December at its new $270 million mine and refinery facilities in the Philippines. This is the first refined nickel to be produced directly from laterite ores. The refinery utilizes the Sherritt Gordon hydro-metallurgical process for refining nickel from laterite ores. Design capacity of the project is 68.4 million pounds of refined nickel in the form of briquettes and powder plus mixed sulphide concentrates containing 6.6 million pounds of nickel and 3.3 million pounds of cobalt. Marinduque expects the refinery to reach design capacity in the second half of 1975. Work began in preparation for production at Rio Tuba Nickel Mining Corporation's laterite orebody on Palawan Island, Philippines. Starting in 1976, the ore will be shipped to five Japanese smelters at a rate of 500,000 tons a year. Proven ore reserves are estimated at 28 million tons grading 2.2 per cent nickel.

The International Nickel Company of Canada, Limited is developing two laterite projects outside Canada. One of these is in Guatemala, where Inco, through Exploraciones y Explotaciones Mineras Izabal, S.A. (Exmibal) has started construction on the Lake Izabal laterite deposit. The plant will include a smelter with an annual capacity of 28 million pounds of nickel contained in a sulphide matte. Production is scheduled to start early in 1977. The project is owned 80 per cent by Inco and 20 per cent by The Hanna Mining Company, with provisions for the Guatemalan government and private Central American interests to eventually acquire up to 36 per cent of Exmibal. In Indonesia, P.T. International Nickel Indonesia continued construction on the first stage of the development of the Malii-Soroaka deposits on Sulawesi Island which is expected to begin production late in 1976. Annual capacity of the first stage of the project will be 35 million pounds of nickel contained in a 75 per cent nickel matte. Financing has been arranged for the second stage which will include a hydroelectric plant on the Larona River and will increase nickel production capacity to 90 million pounds a year in 1978. Total cost of the completed project is now estimated at over $600 million.

Table 3. Producing Canadian nickel mines, 1974 and (1973)

Company and Location	Mill or Mine Capacity	Grade of Ore: Nickel	Grade of Ore: Copper	Ore Produced	Contained Nickel Produced	Remarks
	(tons ore/day)	(%)	(%)	(tons)	(tons)	
Quebec						
Renzy Mines Limited Hainault Township	(1,000)	. .	. .	. .	. .	Surface plant destroyed by fire in February, 1974 after starting production in January.
Société Minière d'Exploration Somex ltée. Bickerdike Township, Lac Edouard	250 (250)	1.5 (1.5)	0.5 (0.5)	52 (90,000)	— (413)	Production ceased in January, 1974 due to a fire. Ore reserves were almost exhausted.
Ontario						
Falconbridge Nickel Mines Limited Falconbridge, East, Strathcona, Hardy Open Pit, Fecunis Lake, Onaping, North, Longvac South Falconbridge	12,100 3,000 6,600 2,500 1,500	. . (. .) (Falconbridge) (Strathcona) (Fecunis Lake) (Hardy – not operating)	. . (. .)	4,336,652 (4,292,900)	43,881[1] (48,704)[1]	Lockerby mine being prepared for production in 1975. Fraser No. 1 shaft being sunk to the 5,300 horizon.
The International Nickel Company of Canada, Limited Clarabelle, Coleman, Copper Cliff North, Copper Cliff South, Crean Hill, Creighton, Frood- Stobie, Garson, Kirkwood, Levack, Levack West, Little Stobie, and Victoria mines Sudbury	65,000 35,000 11,400 24,000 6,000	1.39[4] (. .) (Clarabelle) (Creighton-not operating) (Frood-Stobie) (Levack)	0.97[4] (. .)	18,021,305[3] (15,966,093)[3]	274,535[2] (258,515)[2]	Production was resumed from the Crean Hill mine on a regular basis. Scheduled operations were completed at the Clarabelle open-pit mine.
Shebandowan mine Shebandowan	2,500 (2,500)	. . (. .)	. . (. .)	see above[3] see above[3]	see above[2] see above[2]	
Kanichee Mining Incorporated Temagami	500 —	0.49 —	0.72 —	122,451 —	215 —	Mine commenced production in January 1974.

Table 3. (concl'd)

Company and Location	Mill or Mine Capacity	Grade of Ore		Ore Produced	Contained Nickel Produced	Remarks
		Nickel	Copper			
	(tons ore/day)	(%)	(%)	(tons)	(tons)	
Ontario (cont'd)						
Noranda Mines Limited	700	1.50	. .	212,699	2,606	Mine completed its first full
Langmuir Township	(700)	(. .)	(. .)	(67,020)	(730)	year of operations.
Manitoba						
Dumbarton Mines Limited,	—	0.72	0.30	326,378	1,700	Ore trucked to the 1,200-ton-a-day
Bird River	—	(0.76)	(0.30)	(331,851)	(2,053)	Consolidated Canadian Faraday Limited concentrator. Developing new ore reserves.
Falconbridge Nickel Mines Limited,	1,000	. .	. .	183,758	see above[1]	
Manibridge Mine	(1,000)	(. .)	(. .)	(135,716)	see above[1]	
Wabowden						
The International Nickel Company	18,400	see above[4]	see above[4]	3,767,202	see above[2]	Soab mine maintained on a
of Canada, Limited	(18,400)	(. .)	(. .)	(3,444,210)	see above[2]	standby basis. Pipe mine being
Birchtree, Pipe and Thompson mines						developed for underground
Thompson						operations.
Sherritt Gordon Mines, Limited	3,500	0.87	0.43	432,235	3,247	Four years ore reserves remain.
Lynn Lake	(3,500)	(0.84)	(0.39)	(675,907)	4,270	Mine put on salvage basis.
British Columbia						
Giant Mascot Mines Limited	1,800	0.68	0.21	157,181	770	Mine closed in August 1974
Hope	(1,800)	(0.58)	(0.24)	(352,758)	(1,306)	because of depletion of ore reserves.
Yukon Territory						
Hudson-Yukon Mining Co., Limited	600	—	—	—	—	Mine closed in July 1973 because
Wellgreen mine	(600)	(2.49)	(1.45)	(76,760)	(1,446)	of discontinuity and irregularity of
Kluane Lake						the orebody.

Sources: Company annual reports and data provided by companies.
[1]Includes Manibridge. [2]Total nickel deliveries. [3]Includes Shebandowan. [4]Includes Manitoba Division.
. . Not available; — Nil.

Table 4. Prospective[1] Canadian nickel mines

Company and Location	Mill Capacity[2] and Ore Grade	Year Production Expected	Destination of Nickel Concentrates	Remarks
	(%)			
Quebec				
Renzy Mines Limited, Hainault Township	1,000 Ni (0.69) Cu (0.72)	..	..	Surface buildings destroyed by fire in 1974 will have to be rebuilt.
Ontario				
Falconbridge Nickel Mines Limited, Falconbridge,	.. Ni (..) Cu (..)		Falconbridge	
Fraser mine		..		Shaft sinking in progress. Development continuing. One-third of maximum production rate expected by the end of 1975.
Lockerby mine		1975		
Thayer Lindsley mine		..		Deferred.
Onex mine		..		Deferred.
The International Nickel Company of Canada, Limited, Sudbury,	— Ni (..) Cu (..)		Sudbury	
Clarabelle mine		..		Open-pit mining completed in 1974. Mining will be resumed upon development of ore extension.
Murray mine		..		Suspended and placed on standby in 1971.
Totten mine		..		Development suspended and placed on standby in 1972.
Great Lakes Nickel Limited, Pardee Township	106,000,000 Ni (0.20) Cu (0.40)			The development work to bring the property into production at a rate of 1.8 million tpy has been suspended and the project put on standby.
Union Minière Explorations and Mining Corporation Limited, Pickle Lake, Thierry mine	4,000 Ni (0.20) Cu (1.70)	1976	..	Exploration shaft completed to a depth of 1780 feet. Stripping operations started for open-pit that will supply initial mill feed. Surface construction started.
Manitoba				
The International Nickel Company of Canada, Limited Thompson, Soab mine	— Ni (..) Cu (..)	..	Thompson	Production suspended and placed on standby in 1971.

Sources: Company annual reports and technical press.
[1]Mines with announced production plants. [2]Mill capacity in tons of ore a day.
.. Not available; — Nil.

Table 5. Nickel exploration projects

Company and Location	Indicated ore	Grade of ore	Remarks
	(tons)	(%)	
Quebec			
Dumont Nickel Corporation, Launey Township	15,500,000	0.646 (Ni)	Metallurgical test work and development work has been suspended.
Expo Ungava Mines Limited, Ungava	18,500,000	0.47 (Ni) 0.52 (Cu)	
New Quebec Raglan Mines Limited, Ungava	16,050,000	2.58 (Ni) 0.71 (Cu)	No work was carried out on the property in 1974. Studies continued on the feasibility of bringing the property into production.
Ontario			
The International Nickel Company of Canada, Limited, Sudbury Cryderman North Range and Whistle mines	..	.. (Ni) .. (Cu)	
Manitoba			
Bowden Lake Nickel Mines Limited, Waboden			
Bowden Lake mine	80,000,000	0.60 (Ni)	Development work has been suspended on these deposits.
Bucko Lake mine	30,000,000	0.78 (Ni)	
Saskatchewan			
National Nickel Ltd. and Cadillac Explorations Limited, Nemeiben Lake, La Ronge	5,476,000	0.34 (Ni) 0.18 (Cu)	Open-pit reserves.
	1,754,500	0.38 (Ni) 0.70 (Cu)	Underground reserves.

Sources: Company annual reports and technical press.
.. Not available.

Falconbridge Dominicana C. por A., 65.7 per cent owned by Falconbridge Nickel Mines Limited, produces ferronickel at its property in the Yuna River Valley in the Dominican Republic. Deliveries in 1974 were 68.7 million pounds of nickel contained in ferronickel compared with 66.3 million pounds in 1973. The ferronickel complex continued to operate in excess of its design capacity of 63 million pounds.

In Australia three new nickel producers started production in 1974. Production started at the Mt. Windarra orebody of Poseidon N.L. and Western Mining Corporation Limited in September aiming for a production rate of 28 million pounds of nickel a year. The concentrates are smelted at the Kalgoorlie smelter of Western Mining Corporation where capacity was recently increased to 140 million pounds of nickel in matte a year. Poseidon has contracted to sell 75 per cent of its share of the production to Sherritt Gordon for refining in Canada. Ore reserves of the Windarra deposits are estimated at 10 million tons averaging 1.92 per cent nickel. The Redross mine of The Anaconda Company and Conzinc Riotinto of Australia Limited began shipping its ore for toll-milling at Kalgoorlie. The concentrates are shipped to Sherritt Gordon's refinery at Fort Saskatchewan, Alberta. When the mine reaches full production it is expected to produce nickel in

Table 6. World production of nickel, 1973-74

	1973	1974[e]
	(short tons)	
Canada[1]	274,527	300,000
New Caledonia	127,758	136,000
U.S.S.R.	126,766	126,000
Australia	44,203	45,000
Cuba	35,274	35,000
Dominican Republic	33,180	33,000
Republic of South Africa	21,385	24,000
United States	16,976	18,000
Indonesia	15,432	18,000
Greece	15,322	18,000
Rhodesia	13,007	13,000
Finland	6,393	7,000
Brazil	3,858	4,000
Poland	1,654	2,000
Other	7,165	11,000
Total	742,900	790,000

Sources: World Bureau of Metal Statistics, May 1975. For Canada, Statistics Canada.
[1]Production all forms.
[e]Estimated.

concentrates at a rate of 10 million pounds a year. The Greenvale laterite nickel project in Queensland started operating near the end of the year. Owned by Freeport Minerals Company and Metals Exploration N.L., Greenvale has the capacity to produce 46 million pounds of nickel in the form of 90 per cent nickel oxide sinter plus 7.5 million pounds of nickel and 2.7 million pounds of cobalt in the form of mixed sulphides. Ore reserves are estimated at 44 million tons averaging 1.57 per cent nickel. British Selection Trust and MIM Holdings Limited will start construction in 1975 at their Agnew sulphide deposit. The $200 million mine and smelter project scheduled for completion in late 1977 is expected to have an initial capacity of 30 million pounds a year of nickel in matte. Ore reserves are estimated at 40 million tons averaging 2.2 per cent nickel.

Cuba has announced a modernization program for its Moa Bay and Nicaro refineries. Long-term plans to raise annual production from its current rate of about 80 million pounds to 280 million tons with the construction of three new plants, have also been announced. Development work has started on one of these to exploit the Punta Gorda orebody. U.S.S.R. and COMECON countries are to provide the $600 million financing for the Cuban expansion.

In New Caledonia, Société Le Nickel has changed its name to Société Imetal. A new company, Société Métallurgique Le Nickel (SLN), jointly owned by Société Imetal and Société Nationale des Pétroles d'Aquitaine, will take over Société Le Nickel's New Caledonia interests and its refining facilities in France. SLN has announced that the capacity of its Doniambo smelter in New Caledonia will be raised to 150 million pounds of contained nickel a year. On the north side of New Caledonia, Patino, N.V., through its subsidiary Compagnie Française d'Entreprises Minières, Métallurgique et d'Investissements (Cofremmi), has started development of the Poum deposit which it expects to bring into production in 1977 with a capacity of 40 million pounds a year of nickel in ferronickel. At the end of the year the French government suspended its authorization to Cofremmi which will cause a delay in the development of this deposit.

Uses

Nickel uses have not changed appreciably from the traditional pattern. Resistance to corrosion, high strength over a wide temperature range, pleasing appearance and suitability as an alloying agent are the chief advantages in almost all the uses of nickel.

Stainless steel is the largest single outlet for nickel, followed by nickel plating and high-nickel alloys. Stainless steel use has increased in the field of rapid transit and railway car manufacture, in fertilizer and food processing machinery, in petroleum refining and in architectural applications. High-nickel alloys are used in chemical, marine, electronic, nuclear and aerospace applications.

New end-use markets which will contribute to nickel's consumption growth are gas turbine engines for surface applications, cryogenic containers, nuclear generating plants, pollution abatement equipment and barnacle-resisting copper-nickel alloy hull plating for boats.

Outlook

The downturn in the economies of major world nations in the latter part of 1974 has carried over into 1975, and demand during 1975 will suffer accordingly. The amount by which consumption will drop from the record 1974 level will depend on the severity of the contraction in industrial activity. Coupled with the drop in demand is the additional productive capacity which has come on stream in the past year. Producers stocks are expected to rise and any price erosion or discounting will likely be traceable to producers lacking sufficient firm sales contracts to maintain their share of the market during this period of over-supply. Demand could quickly come back in line with supply when the economy recovers.

The medium- to long-term outlook is for nickel consumption to resume its long-term growth at a compound rate of 6 to 7 per cent a year. The widespread acceptance of the argon-oxygen furnace in the stainless steel making industry has accelerated the usage of the less pure forms of nickel, such as ferronickel and nickel oxide sinter at the expense of high-purity or Class I nickel. This trend is expected to continue.

Prices

Three major price changes occurred in 1974. At the beginning of the year, refined nickel was quoted at \$1.53 a pound and Class II (ferronickel and oxide sinter) was quoted in a price range of \$1.40 to \$1.47 a pound depending on the product and the producer. At the end of the year, a wide range of prices was quoted as some producers waited until the first week of 1975 to change or adjust their prices. The price differential between Class I and Class II narrowed or was eliminated by some producers indicating the strong demand for Class II products.

The second and third round of price increases were initiated by ferronickel producers in response to the higher cost of producing from laterite ores where huge amounts of hydrocarbons are required to dry and process the ore.

For most sales, the new price structure will not take effect until some time in 1975. Because of contract commitments, many sales throughout 1974 were made at the much lower 1973 prices.

Table 7. Prospective world nickel producers

Country Company Mine	Annual Capacity	Announced Date of Production	Destination of Concentrates	Remarks
	(tons of contained nickel)			
Australia				
Selcast Exploration Limited and Metals Exploration N.L., Mount Keith Western Australia	..	..	..	Metals Exploration is studying feasibility of this project.
Selection Trust Limited and MIM Holdings Limited Agnew deposit Western Australia	20,000	1978	own smelter	Construction of mine, smelter and town to start in 1975.
Brazil				
Cia Vale do Rio Doce Piaui State	6,000	..	own smelter	
Baminco Mineracao e Siderurgia, S.A. and The International Nickel Company of Canada, Limited and West German consortium Barro Alto deposit Goias State	..	..	..	Metallurgical test work in progress.
Colombia				
The Hanna Mining Company, Compania Niquel Chevron and Industrial Development Institute of Colombia Cerro Matoso deposit	25,000	..	..	Pilot plant tests and feasibility studies to be completed.
Cuba				
Cuban government Cuban deposits	33,000 66,000	1975-1980 1980-1985	own smelter own smelter	Three new plants each with a capacity of 33,000 tpy to be brought into production between 1975 and 1985.

Table 7 (cont'd)

Country Company Mine	Annual Capacity	Announced Date of Production	Destination of Concentrates	Remarks
	(tons of contained nickel)			
Greece				
Intercontinental Mining and Abrasives, Inc. and Southland Mining Company Lake Ionina	..	..	..	
Larco Larymna area	22,000	..	..	Expansion of current capacity of 16,000 tpy.
Guatemala				
Exploraciones y Explotaciones Mineras Izabal, S.A. (Exmibal) Lake Izabal	14,000	1977	own smelter	
India				
Hindustan Copper Ltd., Sukinda deposit Orissa State	4,800	1979	own smelter	
Indonesia				
P.N. Aneka Tambang Pomalea Sulawesi Island	4,000	1976	own smelter	Ferronickel plant.
P.T. International Nickel Indonesia Soroako deposit Sulawesi Island	14,000	1976	own smelter	Production to be expanded to 45,000 tpy in 1978.
P.T. Pacific Nikkel Indonesia Gag Island Irian Barat	50,000	1980	own smelter	
Indonesia Nickel Development Company Gebe and Halmahera Islands	5,000	1979	own smelter	
New Caledonia				
Patino, N.V., Poum deposit	18,000	1977	own smelter	Production may later be expanded to 36,000 tpy.
Amax Inc., and Société Minière et Metallurgique de Penarroya, S.A. (Penamax) Goro deposit	25,000	1980	Port Nickel, Louisiana, U.S.A.	

Table 7. (concl'd)

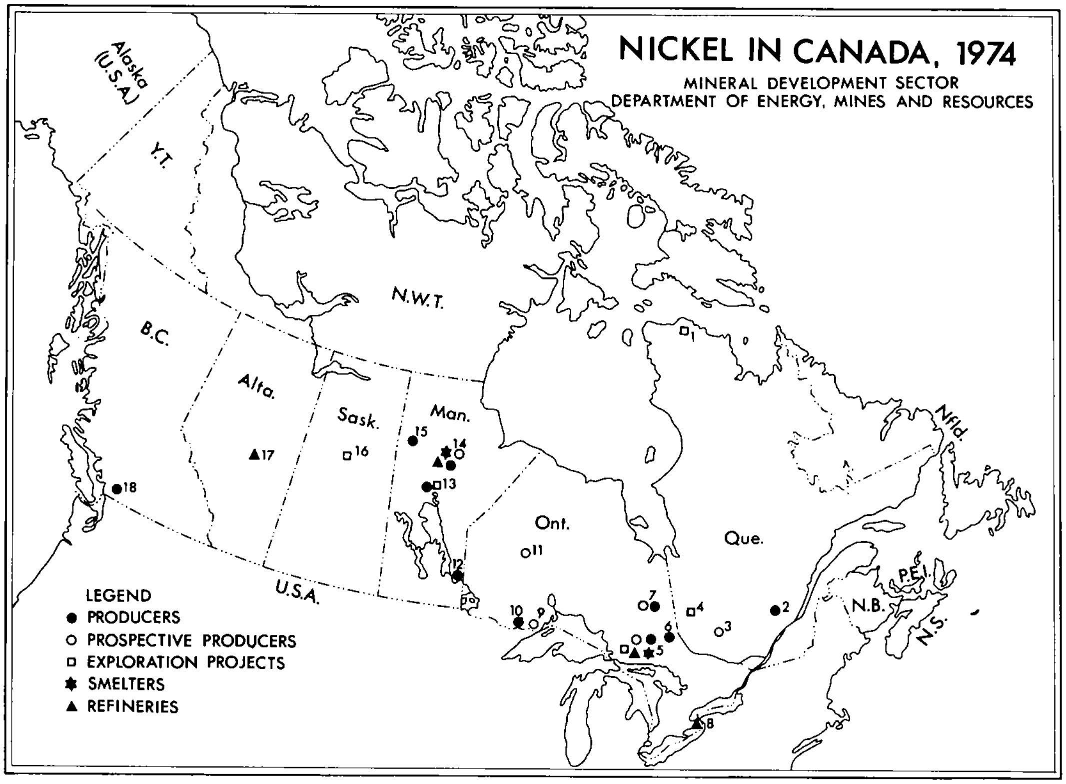
Country Company Mine	Annual Capacity	Announced Date of Production	Destination of Concentrates	Remarks
	(tons of contained nickel)			
Puerto Rico				
Universal Oil Products Co., Guanajibo deposit	15,000	..	..	In feasibility stage.
Republic of the Philippines				
Atlas Consolidated Mining and Development Palawan Island	17,500	..	own smelter	
Rio Tuba Nickel Mining Palawan Island	10,000	1976	Japan	Annual shipments of 500,000 tons of garnierite ore.
Rhodesia				
Johannesburg Consolidated Investment Company and Rhodesian Nickel Corporation Ltd. Shangani mine	7,000	1975	Bindura	Smelter owned by Rhodesian Nickel.
Venezuela				
Société Le Nickel and Venezuelan Government Loma de Hierro	20,000	..	own smelter	
Yugoslavia				
Government company				
Kavadarci deposit Macedonia	12,000	1979	own smelter	Ferronickel
Golos and Cikatovo deposits Kosovo	3,000	1977	own smelter	Ferronickel.

Sources: Company annual reports and technical press.
. . Not available.

Table 8. Producer prices for nickel quoted during 1974

	Price 1 January	Price after price changes in January	May-June	October-December
	(U.S. dollars per pound)			
Falconbridge Nickel				
Electrolytic, fob Thorold, Ont., 20,000 lb lots	$1.53	$1.62	$1.85	$2.05[2]
Ferronickel[1]	1.46	1.57	1.81	2.01
Inco				
Electrolytic, fob Port Colborne, Ont.	1.53	1.62	1.85	2.01
Nickel oxide sinter 75[1]	1.40	1.49	1.73	1.88
"F" shot	1.43	1.52	1.85	2.07
Pellets	1.53	1.62	1.85	2.01
Sherritt Gordon				
Briquettes or powder, fob Niagara Falls, Ont. and Fort Saskatchewan, Alta. 20,000 lb lots	1.53	1.62	1.85	1.85[3]
The Hanna Mining Company				
Ferronickel[1]	1.38	1.53	1.81	1.97
Société Le Nickel				
Rondelles	1.53	1.62	1.85	2.01
Ferronickel[1]				
FNC	1.45	1.56	1.80	2.00
FN3	1.47	1.58	1.82	2.02
FN4	1.43	1.54	1.78	1.98
Western Mining Corporation Limited				
Briquettes or powder				1.85

Sources: *The Northern Miner, Metals Week, American Metal Market* and *Metal Bulletin.*
[1] Price applies to nickel content. [2] Reduced to $2.01 January 6, 1975. [3] Increased to $2.01 January 2, 1975.



Producers

(numbers appear on accompanying map)

2. Société Minière d'Exploration Somex ltée (Lac Edouard)
5. Falconbridge Nickel Mines Limited (East, Falconbridge, Fecunis Lake open-pit, Longvack South, North, Onaping and Strathcona mines)
   The International Nickel Company of Canada, Limited (Clarabelle, Coleman, Copper Cliff North, Copper Cliff South, Crean Hill, Creighton, Frood-Stobie, Garson, Kirkwood, Levack, Levack West, Little Stobie, and Victoria mines)
6. Kanichee Mining Incorporated (Temagami)
7. Noranda Mines Limited (Timmins)
10. The International Nickel Company of Canada, Limited (Shebandowan mine)
12. Dumbarton Mines Limited (Bird River)
13. Falconbridge Nickel Mines Limited (Manibridge mine)
14. The International Nickel Company of Canada, Limited (Birchtree, Pipe and Thompson mines)
15. Sherritt Gordon Mines, Limited (Lynn Lake)
18. Giant Mascot Mines Limited (Hope)

Prospective Producers

3. Renzy Mines Limited (Hainault Township)
5. Falconbridge Nickel Mines Limited (Fraser, Lockerby, Onex and Thayer Lindsley mines)
   The International Nickel Company of Canada, Limited (Clarabelle mine, Murray and Totten mines)
7. Texmont Mines Limited (Timmins)
9. Great Lakes Nickel Limited (Pardee Township)
11. Union Minière Explorations and Mining Corporation Limited (Pickle Crow)
14. The International Nickel Company of Canada, Limited (Soab mine)

Nickel Exploration Projects

1. New Quebec Raglan Mines Limited (Ungava) and Expo Ungava Mines Limited (Ungava)
4. Dumont Nickel Corporation (Launay Township)

5. The International Nickel Company of Canada, Limited (Cryderman, North Range and Whistle mines)
13. Bowden Lake Nickel Mines Limited (Bowden Lake and Bucko Lake mines)
16. National Nickel Ltd. and Cadillac Explorations Limited (Nemeiben Lake)

Smelters

5. Falconbridge Nickel Mines Limited (Falconbridge)
The International Nickel Company of Canada, Limited (Sudbury)

14. The International Nickel Company of Canada, Limited (Thompson)

Refineries

5. The International Nickel Company of Canada, Limited (Sudbury)
8. The International Nickel Company of Canada, Limited (Port Colborne)
14. The International Nickel Company of Canada, Limited (Thompson)
17. Sherritt Gordon Mines, Limited (Fort Saskatchewan)

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
		%	%	%
32900-1	Nickel ores	free	free	free
33506-1	Nickelous oxide	10	15	25
35500-1	Nickel and alloys containing 60% or more nickel by weight, not otherwise provided for, viz: ingots, blocks, and shot; shapes or sections, billets, bars and rods, rolled, extruded or drawn (not including nickel processed for use as anodes); strip, sheet and plate (polished or not); seamless tube	free	free	free
35505-1	Rods containing 90% or more nickel, when imported by manufacturers of nickel electrode wire for spark plugs, for use exclusively in manufacture of such wire for spark plugs in their own factories	free	free	10
35510-1	Metal alloy strip or tubing, not being steel strip or tubing, containing not less than 30% by weight of nickel and 12% by weight of chromium, for use in Canadian manufactures	free	free	20
35515-1	Nickel and alloys containing 60% by weight or more of nickel, in powder form	free	free	free
35520-1	Nickel or nickel alloys, namely: matte, sludges, spent catalysts and scrap and concentrates other than ores	free	free	free
35800-1	Anodes of nickel	free	free	10
37506-1	Ferronickel	free	5	5
44643-1	Articles of nickel or of which nickel is the component material of chief value, of a class or kind not made in Canada, when imported by manufacturers of electric storage batteries for use exclusively in manufacture of such storage batteries in own factories	10	10	20
92934-2	Nickel carbonyl, in liquid form, for use in the manufacture of moulds of nickel (expires Oct. 31, 1975)	free	free	25

Tariffs (concl'd)

United States

Item No.		On and after January 1, 1974
419.72	Nickel oxide	free
601.36	Nickel ore	free
603.60	Nickel matte	free
607.25	Ferronickel	free
620.03	Unwrought nickel	free
620.04	Nickel waste and scrap	free
620.08	Nickel plates and sheets, clad	12%
620.10	Other wrought nickel, not cold worked	5%
620.12	Other wrought nickel, cold worked	7%
620.30	Nickel flakes	5¢ per lb
620.32	Nickel powders	free
620.46	Pipe and tube fittings	9%
620.47	If Canadian article and original motor vehicle equipment	free
620.50	Electroplating anodes, wrought or cast, of nickel	5%

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Petroleum

W.G. LUGG

Crude oil and natural gas liquids production declined for the first time since 1958, due, in part, to the imposition of mandatory export controls on crude oil shipments to the United States. The lack of oil discoveries in the established producing areas of western Canada was another contributing factor in the curtailment of overall industry activity during the year. Nevertheless, because of large increases in producer prices, the value of crude oil, natural gas and natural gas liquids reached an all-time high of $4.5 billion, 49 per cent higher than record 1973 levels. Expenditures by oil companies increased by more than $1,217 million over 1973 to $3,460 million. The increase is largely attributable to substantial increases in royalty payments to provincial governments.

With the cessation of the Arab-Israeli conflict in 1974, the international flow of petroleum and petroleum products returned to normal levels as producers of the Petroleum Exporting Countries (OPEC) gradually lifted the embargoes they had placed on many of the world's consuming nations, but high prices continued to prevail. The possibility that, in the future, the embargo might be reimposed and prices further increased, led most countries, including Canada, to reexamine their own oil and gas policies. The new direction of the policy change in Canada was towards an increasing involvement of the federal and provincial governments in the control of output and prices of crude oil and natural gas.

Although exploration in the frontier areas declined somewhat in 1974, several significant discoveries were made. Predicted discoveries of major oil and gas reserves in the areas offshore from the Mackenzie Delta apparently are being realized. The discovery of significant quantities of gas off the Labrador coast augurs well for that area. In southern areas, exploratory drilling activity decreased from the previous year and the success ratio also declined. This, combined with high production rates, was responsible for another major decrease in proven reserves of oil. Pipeline construction decreased in 1974, particularly in the large diameter category, as existing facilities were operating below capacity because of the regulated reduction of export volumes. Refinery capacity growth was substantial; due entirely to modifications to existing plants as no new units came on stream.

Outlook

The long-term outlook for Canada's oil and gas industry relates entirely to its ability to find and develop new sources in Canada. There is almost an insatiable demand, and supply is now the key. The unsettled conditions in the world oil industry have instilled in consuming countries the desire to become more self-sufficient in energy. Canada, where proven recoverable reserves have not been able to keep pace with production, is no exception, and is now attempting to ensure that domestic requirements will be met from indigenous supply before fully providing for export markets to the United States. The opportunities to enlarge oil and gas production in Canada are good, particularly in the frontier areas and in the heavy oil and bituminous sands regions of Alberta and Saskatchewan. However, development of these resources will require long lead times and large expenditures in effort, equipment and money. Therefore, if the declining trend in Canada's reserve position is to be reversed, the reversal will necessarily occur in the longer-term.

In detail, it is becoming apparent that Athabasca tar sands development may not proceed at the pace necessary to have a major impact on the domestic supply of the 1980s. The essential mix of capital, trained technical personnel and heavy equipment required to construct just one tar sands extraction plant is staggering. It would be optimistic to predict that enough technical and financial resources could be easily assembled to construct two 125,000 b/d (barrels a day) tar sands extraction plants by the early 1980s and even this would not be enough to meet presently forecasted requirements in the face of declining conventional crude oil output.

Exploration in the frontier areas has been encouraging, particularly in the Arctic areas, but most of the success obtained has been in the discovery of natural gas. Present estimates place the minimum reserve base required for economic development in the Mackenzie Delta at 1.5 to 3 billion barrels of oil. Even if these reserves are found, getting them to markets is a monumental task with long lead times and huge requirements for money, materials and manpower. Therefore, it is not likely that Arctic oil would have much of an impact on Canadian supply requirements before 1985, at the earliest.

In the short-term, there is no immediate danger of supply shortages of oil unless Arab producing states impose another embargo on oil supplies to eastern Canadian refineries. In this event, shortages could develop in eastern Canada, not because of inadequate productive capacity, but because of the inability of our existing transportation system to supply these markets. This inadequacy will be corrected, in part, by the extension of the Interprovincial pipeline system from Sarnia to Montreal, when it is completed. Production of crude oil will probably decline by about 150,000 b/d in 1975 as the increase in domestic consumption of about 40,000 b/d will be more than offset by regulated cutbacks in exports to United States markets.

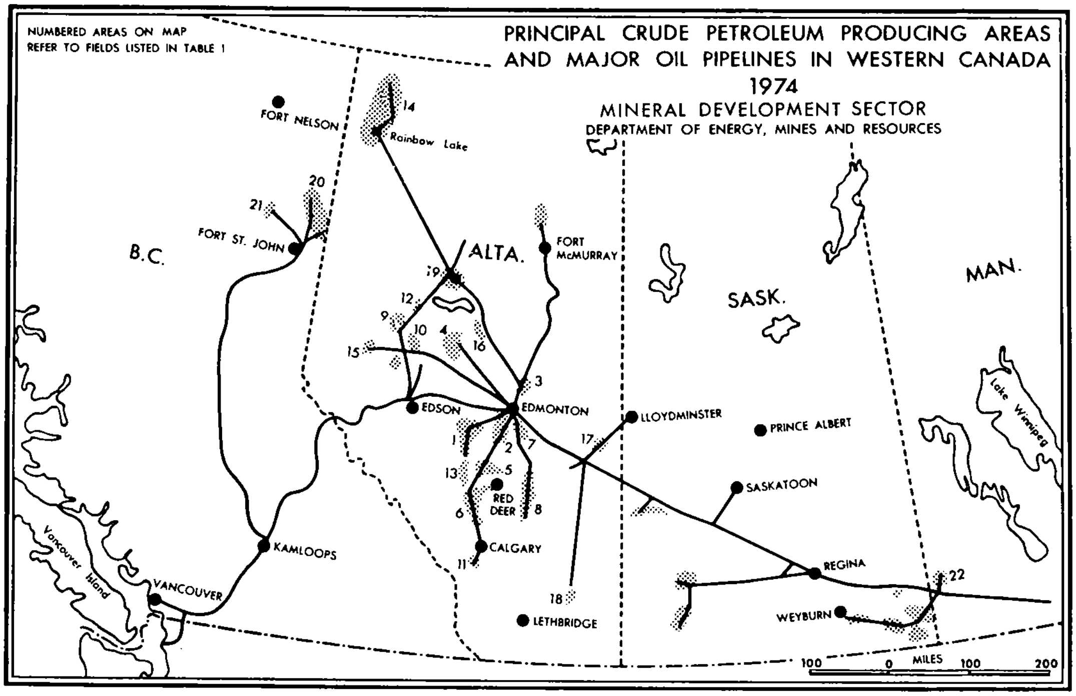


Table 1. Production of crude oil and condensates by province and field, 1973-74*p*

(Number in parentheses gives location of field on accompanying map)

	1973		1974*p*	
	(barrels)	(bbl/day)	(barrels)	(bbl/day)
Alberta				
Redwater (3)	45,250,954	123,975	44,252,099	121,239
Swan Hills (4)	47,058,089	128,926	44,072,243	120,746
Pembina (1)	46,688,219	127,913	41,380,516	113,371
Rainbow (14)	35,908,669	98,380	34,017,441	93,198
Judy Creek	33,700,842	92,331	31,586,883	86,539
Bonnie Glen (2)	27,034,322	74,067	30,619,597	83,889
Swan Hills South	18,127,579	49,665	20,011,920	54,827
Nipisi (19)	19,016,297	52,099	19,894,730	54,506
Wizard Lake (2)	22,931,225	62,825	18,884,351	51,738
Golden Spike (2)	17,647,408	48,349	18,826,469	51,579
Mitsue (16)	18,163,616	49,763	17,162,154	47,020
Fenn Big Valley (8)	11,266,238	30,866	10,356,674	28,374

Table 1. (cont'd)

	1973		1974p	
	(barrels)	(bbl/day)	(barrels)	(bbl/day)
Alberta (cont'd)				
Virginia Hills	9,864,672	27,026	8,817,429	24,157
Carson Creek North (4)	9,369,317	25,669	8,383,475	22,968
Leduc Woodbend (2)	8,981,388	24,607	7,906,614	21,662
Westerose (2)	7,462,662	20,446	6,534,892	17,904
Sturgeon Lake South	5,442,336	14,911	5,911,132	16,195
Zama (14)	6,062,504	16,610	5,508,981	15,093
Kaybob (10)	5,900,234	16,165	5,355,813	14,673
Willesden Green (13)	5,348,423	14,752	5,060,515	13,864
Harmattan East (6)	4,315,807	11,824	4,693,856	12,860
Kaybob South (10)	4,370,904	11,975	4,653,787	12,750
Acheson (2)	4,800,729	13,153	4,651,472	12,744
Countess	4,796,161	13,140	4,624,329	12,669
Innisfail (6)	3,427,349	9,390	3,929,612	10,766
Rainbow South (14)	3,813,472	10,448	3,854,129	10,559
Provost	2,668,566	7,311	3,386,825	9,279
Simonette (15)	2,351,353	6,442	3,095,067	8,480
Bellshill Lake	3,095,836	8,482	3,060,873	8,386
Joarcam (7)	3,370,962	9,236	3,043,363	8,338
Harmatton Elkton (6)	2,765,480	7,577	2,668,339	7,311
Snipe Lake	3,162,825	8,665	2,661,713	7,292
Medicine River (13)	2,988,744	8,188	2,592,741	7,103
Wainwright (17)	2,427,824	6,652	2,402,072	6,581
Red Earth	2,234,517	6,122	2,310,113	6,329
Virgo (14)	3,592,584	9,843	2,297,982	6,296
Bantry (18)	2,381,649	6,525	2,127,933	5,830
Goose River	2,242,803	6,145	1,986,494	5,443
Gilby (5)	2,100,898	5,756	1,696,564	4,648
Ferrier	1,447,091	3,965	1,573,265	4,310
Sturgeon Lake	1,964,732	5,383	1,568,147	4,296
Clive	2,105,714	5,769	1,554,761	4,260
Stettler	1,671,080	4,578	1,552,657	4,254
Utikuma Lake	1,678,768	4,599	1,536,044	4,208
Grand Forks	1,391,209	3,812	1,478,588	4,051
St. Albert – Big Lake	1,960,865	5,372	1,466,553	4,018
Joffre (5)	1,825,405	5,001	1,410,479	3,865
Sundre	1,525,398	4,179	1,306,441	3,579
West Drumheller	1,400,168	3,836	1,279,577	3,506
Boundry Lake South	1,639,314	4,491	1,261,095	3,455
Taber South	1,422,342	3,897	1,233,062	3,378
Glen Park	1,391,061	3,811	1,229,944	3,370
Cessford	1,130,934	3,098	1,163,855	3,188
Hussar	1,299,301	3,560	1,155,508	3,166
Cyn-Pem	1,059,139	2,902	1,139,518	3,122
Sylvan Lake	1,301,254	3,565	1,128,811	3,093
Turner Valley (11)	1,092,830	2,994	1,109,482	3,040
Drumheller	983,101	2,693	1,093,837	2,997
Meekwap	1,718,304	4,708	1,091,297	2,990
Lloydminster	920,890	2,522	1,089,947	2,986
Excelsior	1,445,713	3,961	1,061,087	2,908
Twining	762,624	2,089	1,030,712	2,824
Other fields and pools	46,465,445	127,302	43,978,141	120,488

Table 1. (concl'd)

	1973		1974[p]	
	(barrels)	(bbl/day)	(barrels)	(bbl/day)
Alberta (cont'd)				
Total	541,736,139	1,484,208	517,774,000	1,418,559
Total value ($)	1,894,723,619		3,004,334,000	
Saskatchewan[1]				
Total	85,935,503	235,440	73,000,000	200,000
Total value ($)	264,057,481		443,840,000	
British Columbia				
Boundary (20)	8,643,244	23,680	7,618,831	20,874
Peejay	3,118,148	8,543	2,787,828	7,638
Inga (21)	3,087,267	8,458	2,309,995	6,329
Milligan Creek (20)	2,115,934	5,797	1,753,706	4,805
Weasel	1,019,162	2,792	1,194,432	3,272
Other	3,332,512	9,130	3,155,208	8,644
Total	21,316,267	58,400	18,820,000	51,562
Total value ($)	65,643,444		103,500,000	
Manitoba				
North Virden Scallion (22)	2,442,489	6,692	2,322,519	6,363
Virden-Roselea (22)	1,289,758	3,534	1,201,891	3,293
Other	1,351,652	3,703	1,215,590	3,330
Total	5,083,899	13,929	4,740,000	12,986
Total value ($)	17,147,991		27,076,000	
Ontario				
Total	808,649	2,215	743,000	2,036
Total value ($)	2,865,853		4,715,000	
Northwest Territories				
Total	962,733	2,638	1,153,000	3,159
Total value ($)	2,239,606		1,614,000	
New Brunswick				
Total	9,920	27	8,000	21
Total value ($)	13,888		11,040	
Canada				
Total	655,853,110	1,796,857	616,238,000	1,688,323
Total value ($)	2,246,691,882		3,858,090,000	

Sources: Provincial government reports, and Statistics Canada.
[1] Saskatchewan lists production by formation rather than by field.
[p] Preliminary.

Consumers will again be faced with the prospect of paying more for petroleum products due to anticipated domestic producer price increases in 1975. Nevertheless, the price of domestic crude oil will still remain below the price of imported oil which could also be increased in 1975. One redeeming feature of increased prices is that it will tend to promote conservation, something that is needed in Canada where consumption of oil and gas per capita is the highest in the world.

Production

Production of all liquid hydrocarbons, crude oil and natural gas liquids averaged 1,998,000 barrels a day (b/d) during 1974, a decrease of 117,000 b/d or 5.5 per cent from 1974 production totals. Of this amount, crude oil output amounted to 1,685,000 b/d, 108,000 b/d less than in 1973. Natural gas liquid production decreased by 9,000 b/d to 313,000 b/d, consisting of 163,000 b/d of pentanes plus and condensate and 150,000 b/d of propane and butane. Alberta's crude oil production declined by 66,000 b/d and accounted for 84 per cent of total Canadian output. Of this amount, synthetic crude oil production from the Athabasca tar sands contributed 46,240 b/d, down 4,200 b/d from the previous year. Saskatchewan's crude oil production at 200,000 b/d was down 35,000 b/d from 1973 production levels and accounted for 12 per cent of the Canadian total. British Columbia's production declined by 7,000 b/d and represented 3 per cent of total national production. Manitoba accounted for 0.8 per cent, and Ontario and the Northwest Territories together 0.2 per cent. All provinces except the main producers, namely Alberta and Saskatchewan, were producing at capacity. With the cutback in exports, both Alberta and Saskatchewan fell well below their rated productive capacity, particularly Saskatchewan because of a lack of markets for its sour and heavy crude oils.

The scheduled expansion of Great Canadian Oil Sands Limited's tar sands plant near Fort McMurray from current rated capacity of 45,000 b/d to 65,000 b/d has been abandoned. Instead, the company now intends to expand in smaller stages by eliminating some bottlenecks in the existing operation.

Table 2. Production of natural gas liquids by province, 1973-74

	1973		1974p	
	(000's barrels)	(bbl/day)	(000's barrels)	(bbl/day)
Alberta				
Propane	32,551	89,181	31,890	87,370
Butane	21,145	57,932	20,868	57,173
Pentanes Plus	59,326	162,537	57,029	156,224
Condensate	1,049	2,874	891	2,441
Total	114,071	312,524	110,678	303,228
Saskatchewan				
Propane	731	2,003	576	1,578
Butane	314	860	243	666
Pentanes Plus	235	644	192	526
Condensate	190	521	149	408
Total	1,470	4,028	1,160	3,178
British Columbia				
Propane	624	1,710	569	1,559
Butane	686	1,880	664	1,819
Pentanes Plus	1,132	3,101	1,139	3,121
Condensate	127	348	104	285
Total	2,569	7,039	2,476	6,784
Canada				
Propane	33,906	92,894	33,035	90,507
Butane	22,145	60,672	21,775	59,658
Pentanes Plus	60,693	166,282	58,360	159,890
Condensate	1,366	3,743	1,144	3,134
Total	118,110	323,591	114,314	313,189
Returned to formation	492	1,348	114	312
Total net production	117,618	322,243	114,200	312,877

Source: Provincial government reports.
p Preliminary.

Early in 1975, agreement was reached between Syncrude Canada Ltd., the federal government and the governments of Alberta and Ontario on a revised format of participation in the Syncrude Athabasca tar sands project. The agreement was designed to ensure the continuation of the project which had been placed in jeopardy by the withdrawal of Atlantic Richfield Canada Ltd., from the Syncrude consortium. At the time of its withdrawal, Atlantic Richfield, had a 30% interest in the project of which estimated total costs recently had been revised upward from $800 million to $2 billion. The remaining original members of Syncrude include Imperial Oil Limited which had a 30% interest, Canada-Cities Service, Ltd., 30% and Gulf Oil Canada Limited, 10%. Under the terms of the new agreement, the federal government has agreed to take a 15% interest for $300 million in Syncrude; Alberta will take a 10% interest with an investment of $200 million; and Ontario 5% with an investment of $100 million. Alberta will also make a $200 million loan to the project and will invest between $500 million – $600 million in a power plant, a pipeline and housing and other related infrastructures required for the project. Together, the three new partners in the Syncrude project will assume the 30% equity formerly held by Atlantic Richfield. The three original partners will retain their 70% interest, but will contribute another $400 million into the project and a new percentage ownership will result. Under the new agreement, Imperial Oil's equity will climb to 31.25% with a total investment of $625 million, Canada-Cities Service will have 22% with a $440 million contribution and Gulf Oil Canada will increase its interest to 16.75% with a $335 million investment. The federal government provided an additional contribution to the projects overall viability by allowing Syncrude to sell its oil at world prices. In addition, production from the plant will not be prorated and the tax agreement made in 1973 will not be changed, i.e., royalties or profits paid to Alberta from the project will not incur federal income tax.

Because of the now near prohibitive capital costs of the construction phase of tar sands development, Shell Canada Limited has temporarily abandoned its plans to construct a bituminous sands plant on its lease in the Fort McMurray area. The only remaining tar sands project currently under consideration is that of Petrofina Canada Ltd.

Reserves

According to the Canadian Petroleum Association (CPA), Canada's proven reserves of conventional crude oil and natural gas liquids declined to 8.8 billion barrels. This is comprised of 7.2 billion barrels of crude oil and 1.6 billion barrels of natural gas liquids. These estimates do not include any oil in the Athabasca tar sands but, for the first time, includes estimates of natural gas liquids in the Mackenzie Delta. At the current rate of production of 712 million barrels per annum, the life index for conventional crude oil and natural gas liquids declined for the fifth consecutive year to 12 years, as production outstripped newly discovered oil by 480 million barrels. Reserves added in 1973 totalled 232 million barrels and of this amount, 201 million barrels were attributable to revisions, 24 million barrels to extensions of established fields and 7 million barrels to new discoveries.

Table 3. Value of natural gas liquids by province, 1973-74p

	1973	1974p
	($ thousands)	
Alberta	340,371,215	611,156,000
Saskatchewan	2,514,090	5,573,000
British Columbia	5,979,944	12,280,000
Total	348,865,249	629,009,000
Volume ('000 barrels)	116,250,569	113,055,000

Source: Statistics Canada.
p Preliminary.

The reserve position of all provinces declined; the most notable reduction occurring in Alberta where total reserves dropped by 432 million barrels. The CPA estimated Alberta's remaining recoverable reserves of crude oil at 6.35 billion barrels and natural gas liquids at 1.54 billion barrels. Together this accounted for about 90 per cent of Canada's proven reserves. Saskatchewan's reserves of liquid hydrocarbons declined from 596 million barrels to 573 million barrels in 1973. Oil discoveries in the frontier regions of the north and the Atlantic offshore regions are not included in these estimates because a lack of data precludes any meaningful estimate. However, at recent hearings held by the National Energy Board pertaining to Canada's present and future oil and gas supply and requirements, it was revealed that at least three significant oil discoveries had been made in the Mackenzie Delta area to date. It has been estimated that a pipeline from there to southern markets would cost over $5 billion which in turn would necessitate a reserve base of 1.5 to 3 billion barrels before construction of such a line would be considered to be economically viable.

Exploration and development

Alberta. A slight increase in development drilling in Alberta was more than offset by a decline in exploratory drilling and, as a result, overall drilling was slightly below 1973 levels. Drilling statistics show that development drilling increased by 1 per cent to 6.79 million feet and exploratory drilling decreased 15 per cent to 5.18 million feet.

There were several oil discoveries made in Alberta in 1974, but preliminary evaluation suggests that most of them are not of any substance. Amongst the most

Table 4. Canada, crude oil production, trade and refinery receipts, 1964-74

	Production	Imports[1]	Exports[1]	Refinery Receipts[2] Domestic	Imports	Totals
	(barrels)					
1964	274,626,385	143,530,957	101,258,926	199,456,597	143,946,481	343,403,078
1965	296,418,914	144,184,281	108,010,297	208,581,343	144,000,656	352,581,999
1966	320,542,794	146,076,898	123,691,342	220,196,625	158,546,823	378,743,448
1967	351,292,332	170,784,980	150,344,567	224,569,817	163,148,797	387,718,614
1968	379,396,276	177,738,586	167,487,968	236,178,376	177,293,134	413,471,510
1969	410,989,930	193,124,846	197,340,741	242,034,744	190,479,081	432,513,825
1970	461,180,059	207,633,062	240,893,633	258,966,344	208,339,853	467,306,197
1971	492,739,049	244,971,778	270,770,498	263,239,168	244,224,822	507,463,990
1972	561,976,934	281,664,159	341,252,881	273,238,175	288,754,232	561,992,367
1973	655,853,110	327,428,510	420,059,984	300,123,924	311,292,150	611,416,074
1974p	613,751,842	291,155,897	332,216,272	346,301,026	299,282,910	645,583,936

Source: Statistics Canada.
[1] Trade of Canada (SC) data. [2] Includes condensate and pentanes plus.
p Preliminary.

Table 5. Canada, year-end reserves of crude oil, 1973-74

Province or Region	1974	% of Total 1973	% of Total 1974	Net change 1974 over 1973
	('000 bbls)			
Alberta	6,351,437	88.4	88.6	-432,831
Saskatchewan	566,265	7.7	7.9	-22,474
British Columbia	160,637	2.7	2.2	-44,469
Northwest Territories	40,795	0.5	0.6	-1,100
Manitoba	40,782	0.6	0.6	-2,864
Eastern Canada	11,313	0.1	0.1	817
Total	7,171,229	100.0	100.0	-502,921

Source: Canadian Petroleum Association.

significant of these was a Granite Wash Formation oil discovery in the Otter River region of northwestern Alberta, situated approximately 20 miles northwest of the Red Earth oil field. Although the discovery well yielded substantial quantities of oil during evaluation tests, it is still too early to predict the significance of the find in terms of recoverable reserves. A follow-up well is being drilled about one and one-half miles northwest of the initial test, the result of which will provide additional information on which to evaluate the find. This discovery is important in that it may provide a regional extension to the Granite Wash producing trend from the Red Earth oil field.

In west-central Alberta, two discoveries were made in mid-1974, one in the Medicine River area and the other near Crossfield, just north of Calgary. The Medicine River well is a dual zone oil discovery reported to be in the Blairmore formation of Cretaceous age. The Crossfield venture was drilled near the northwest corner of the Crossfield east gas field and the producing zone is believed to be the Cardium formation. Further drilling is planned to evaluate both these discoveries. Immediately east of this area, an indicated oil success was made in the Gough Lake area by Bow Valley Exploration Ltd. Details as to the significance of this find have not yet been released as the well is still on the confidential list. In the Thorsby area of central Alberta, Ashland Oil Canada Limited made an oil discovery eight miles northeast of the Pembina oilfield and a follow-up is now being drilled. In

Table 6. Canada, reserves of liquid hydrocarbons at the end of 1974

	Natural Gas Liquids	Crude Oil Plus Natural Gas Liquids	% of Total
	('000 bbls)	('000 bbls)	
Alberta	1,543,342	7,894,779	90.1
Saskatchewan	7,320	573,585	6.5
British Columbia	37,508	198,145	2.3
Other areas	—	92,890	1.1
Total	1,588,170	8,759,399	100.0

Source: Canadian Petroleum Association.
— Nil.

the same general area, Pacific Petroleums, Ltd. encountered commercial production in the Cardium formation of Cretaceous age. The new oil success was drilled approximately two and one-half miles southwest of the nearest oil producer in the Ferrier Cardium oilfield. Further drilling is planned to determine the extent of the discovery.

Although most of the development drilling was confined to within the boundaries of established producing fields, a major extension to the Sylvan Lake Viking A field was established by the drilling of an offset well on the northeast flank of the field. A second offset well is scheduled to be drilled on the same side of the field as the first. The remainder of the development drilling was done to improve the productivity and recovery in known fields. The largest development projects occurred at the Bellshill Lake, Grandforks, Bantry, Pembina, Keg River and Zama fields. Development drilling in the heavy oilfields of the Wainwright-Lloydminster trend declined substantially from the previous year due mainly to the lack of export markets for heavy crude oil.

At the present time, enhanced recovery schemes in western Canada account for almost one half of the remaining oil estimated to be recoverable from Alberta's 1400 pools. Approximately 350 enhanced recovery schemes are now in operation in Alberta. The cheapest and most effective of these are waterflood projects where increase in recoverable oil per unit cost is excellent. The other methods of secondary recovery utilize a miscible solvent flood system or heat, in the form of steam or fire flood as the mechanisms for recovery. Although technological advance has been steadily improving in these methods, they are still high cost and in the case of thermal methods, energy intensive. It would seem that a new concept in secondary recovery techniques will be required if large new producible reserves can be obtained from presently non-recoverable oil in place. Improved cost-price economics, largely a result of recent crude oil price increases should provide some incentive to develop these new techniques in enhanced recovery.

Saskatchewan and Manitoba. Both the number of wells and footage drilled declined substantially in Saskatchewan in 1974. Total footage amounted to only 706,133 feet compared to 1,752,056 feet in 1973. Only 288 wells were drilled and many of these were drilled by either the Saskatchewan Oil and Gas Corporation (Saskoil), the provincial Crown Corporation or Saskatchewan Power Corporation. Most of the exploratory wells drilled in Saskatchewan were in search of shallow gas in the southwestern corner of the province. The limited amount of drilling for oil was unsuccessful. Development drilling at 154 completions and 349,000 feet was less than 50 per cent of what it was in 1973. This reflects to some degree, the lack of incentive to develop the heavy oil of the Lloydminster area because of the declining demand for heavy crude oil.

In Manitoba, drilling completions and footages increased this year as 20 wells were drilled for a total footage of 72,060 feet. Fourteen exploratory wells were drilled, 9 of which were drilled by Asamera Oil Corporation Ltd. in partnership with the Manitoba government, completing a two-year 25 well exploratory program. None of the wells were successful.

Table 7. Canada, wells completed and footage drilled

	1955		1960		1973		1974	
	(no.)	(ft)	(no.)	(ft)	(no.)	(ft)	(no.)	(ft)
Western Canada								
Westcoast offshore	—	—	—	—	—	—	—	—
New field wildcats	—	—	—	—	—	—	—	—
British Columbia								
New field wildcats	34	194,014	60	365,818	13	115,204	8	82,679
Other exploratory	2	13,020	11	55,749	87	451,296	78	366,888
Development	—	—	72	331,740	65	301,421	60	310,797
	36	207,034	143	753,307	165	867,921	146	760,364
Alberta								
New field wildcats	307	1,773,980	338	2,078,876	424	1,937,315	457	1,901,299
Other exploratory	105	436,941	223	1,171,077	1,253	4,036	933	3,285,526
Development	1,208	6,219,810	1,131	7,125,856	2,099	6,730,499	2,250	6,798,017
	1,620	8,430,731	1,692	10,375,811	3,776	12,704,112	3,640	11,994,842
Saskatchewan								
New field wildcats	312	1,182,727	113	468,507	130	346,848	78	210,484
Other exploratory	50	179,511	28	99,203	156	405,833	56	145,734

Table 7. (cont'd)

	1955		1960		1973		1974	
Saskatchewan (cont'd)	(no.)	(ft)	(no.)	(ft)	(no.)	(ft)	(no.)	(ft)
Development	550	1,873,040	461	1,795,968	380	999,375	154	349,915
	912	3,235,278	602	2,363,678	666	1,752,056	288	706,133
Manitoba								
New field wildcats	59	174,313	10	30,505	16	44,780	13	51,734
Other exploratory	10	23,743	3	6,370	—		1	3,519
Development	292	647,379	54	110,073	—		6	16,817
	361	845,435	67	146,948	16	44,780	20	72,060
Territories and Arctic Islands								
New field wildcats	9	12,666	32	105,969	78	633,779	47	389,197
Other exploratory	—	—	—	—	17	49,205	9	83,703
Development	—	—	—	—	6	58,233	4	30,327
	9	12,666	32	105,969	101	741,217	60	503,227
Total western Canada								
New field wildcats	718	3,337,300	553	3,049,675	661	3,077,926	603	2,635,393
Other exploratory	167	653,215	265	1,332,401	1,513	4,942,632	1,077	3,885,370
Development	2,050	8,740,229	1,718	9,363,637	2,550	8,089,899	2,474	7,515,863
	2,935	12,730,744	2,536	13,745,713	4,724	16,110,086	4,154	14,036,626
Eastern Canada								
Eastcoast offshore								
New field wildcats	—	—	—	—	27	300,764	19	185,352
Other exploratory	—	—	—	—	3	30,684	—	—
					30	331,448	19	185,352
Hudson's Bay offshore								
New field wildcats	—	—	—	—	—	—	2	9,511
Other exploratory	—	—	—	—	—	—	—	—
							2	9,511
Ontario								
New field wildcats	64	112,246	39	68,393	39	73,854	51	103,435
Other exploratory	57	92,536	55	109,839	19	27,563	42	50,223
Development	266	271,191	213	228,190	69	118,391	61	88,187
	387	475,973	307	406,422	127	219,808	154	241,845
Quebec								
New field wildcats	9	10,226	5	4,287	3	26,560	6	27,705
Other exploratory	—	—	—	—	—	—	—	—
Development	—	—	1	240	—	—	—	—
	9	10,226	6	4,527	3	26,560	6	27,705
Prince Edward Island								
New field wildcats	—	—	—	—	—	—	—	—
Other exploratory	—	—	—	—	—	—	—	—
Development	—	—	—	—	—	—	—	—
Total eastern Canada								
New field wildcats	75	127,267	47	95,543	71	423,647	78	326,003
Other exploratory	57	92,536	55	109,839	22	58,247	42	50,223
Development	273	272,234	214	228,430	69	118,391	61	88,187
	405	512,137	316	433,812	162	600,285	136	464,413

Table 7. (concl'd)

	1955		1960		1973		1974	
	(no.)	(ft)	(no.)	(ft)	(no.)	(ft)	(no.)	(ft)
Total Canada								
New field wildcats	793	3,464,567	600	3,145,218	732	3,501,573	681	2,961,396
Other exploratory	224	745,751	320	1,442,240	1,535	5,000,879	1,119	3,935,593
Development	2,323	9,032,563	1,932	9,592,067	2,619	8,208,290	2,535	7,604,050
	3,340	13,242,881	2,852	14,179,525	4,886	16,710,371	4,335	14,501,039

Source: Canadian Petroleum Association.
— Nil.

Table 8. Wells drilled by province, 1973-74

	Oil		Gas		Dry[1]		Total	
	1973	1974	1973	1974	1973	1974	1973	1974
Western Canada								
Alberta	600	651	1,518	1,719	1,586	1,225	3,704	3,595
Saskatchewan	392	71	73	126	192	88	657	285
British Columbia	8	6	54	47	99	89	161	142
Manitoba	—	5	—	—	16	15	16	20
Yukon and Northwest Territories								
Arctic Islands	—	2	10	10	91	48	101	60
Westcoast offshore	—	—	—	—	—	—	—	—
Hudson's Bay offshore	—	—	—	—	—	—	—	—
Subtotal	1,000	735	1,655	1,902	1,984	1,465	4,639	4,102
Eastern Canada								
Ontario	11	4	34	60	25	90	120	154
Quebec	—	—	—	—	3	6	3	6
Atlantic provinces	—	—	—	—	2	—	2	—
Eastcoast offshore	—	—	1	—	29	19	30	19
Hudson's Bay offshore	—	—	—	—	—	2	—	2
Subtotal	11	4	35	60	109	117	155	181
Total Canada	1,011	739	1,690	1,962	2,093	1,582	4,794	4,283

Source: Canadian Petroleum Association.
[1]Includes suspended and abandoned wells.
— Nil.

British Columbia. Aggregate drilling in British Columbia declined in 1974 by 12 per cent to 760,364 feet as a slight increase in development drilling was more than offset by the decline in exploratory drilling. Exploratory drilling amounted to 449,567 feet, 116,933 feet less than in 1973. Development drilling increased by 9,376 feet to 310,797 feet. Almost all of the development drilling was confined to natural gas fields as there has not been a significant oil discovery made in British Columbia for several years. The only discovery of any substance in 1974 was made by Brascan Resources Limited in the Mike region of northeastern British Columbia. Producing formations and other pertinent data have not been released as the well is still on the confidential list.

Yukon Territory, Northwest Territories and Arctic Islands. Exploration in Canada's north continued to progress but at a reduced pace. There were 60 wells drilled in 1974 for a total footage of 503,227 feet

Table 9. Oil wells in western Canada at the end of 1973-74

	Producing Wells		Wells capable of Production	
	1973	1974	1973	1974
Alberta	10,028	10,395	14,368	14,819
Saskatchewan	6,521	6,228^e	7,653	7,779^e
Manitoba	659	673	882	854
British Columbia	542	519	867	785
Northwest Territories and Arctic Islands	43	35	65	64
Total	18,802	17,850	23,835	24,301

Source: Provincial and federal government reports.
^{e} Estimated.

compared with 101 wells and 741,217 feet in 1973. All but four of the 60 wells were classed as exploratory and, of these, two were classed as new natural gas finds, three as oil discoveries and two as successful step-out wells to existing fields.

Despite the decline in drilling, exploration continued to progress satisfactorily, particularly in the offshore areas. New technologic advances in the construction of man-made islands composed either of gravel or ice have permitted northern operating companies to extend the search for oil and gas seaward and these ventures have met with considerable success. Research is now well advanced on a more portable type of drilling platform which will be capable of operating in deeper waters farther from shore and research is progressing on subsea gathering systems that would move the oil or gas ashore either from a series of permanent gravel production platforms or sophisticated underwater installations.

Since large-scale exploratory drilling began in the Mackenzie Delta in 1965, there have been several significant oil and gas discoveries. At least three gas discoveries and one oil discovery are in the major field category. One of these, the Taglu field on Richards Island was discovered in 1971 and subsequent step-out drilling has verified that the field contains at least 3 trillion cubic feet of gas. The Ivik J-26 oil and gas discovery, drilled in 1972, also appears to be in the major oilfield category. Early in 1975 Shell Canada Limited drilled a one mile step-out to its original Niglintgak H-30 gas discovery well drilled in January 1973. When tested, the well yielded large flows of oil and gas from a different sandstone formation to that in the J-26 well. Although further drilling will be required to fully evaluate the discovery, early indications are that it is a major one. Shell was again successful when their well J-06 Kumak, located 7 miles south of Imperial's Taglu gas field and eight miles northwest of the Gulf-Mobil P-53 Ya Ya gas discovery, encountered several hydrocarbon-bearing zones at intermediate depths. Shell reported that more than 215 feet of sandstone is oil bearing and 70 feet is gas bearing and, when tested, yielded significant flows of both oil and gas from several different zones. Further drilling is contemplated to delineate the size and extent of the find.

These discoveries are land based, but industry enthusiasm is derived chiefly from successes in the past year in the shallow coastal waters of the Beaufort Sea. The geology there is considered to be even more favourable for hydrocarbon accumulation than onshore, and increasing confidence in the ability to operate successfully in this hostile environment has contributed to industry optimism.

Early in 1974, Imperial completed drilling its well Adgo F 28, in the Beaufort Sea, 10 miles offshore from Richards Island, on an artificial island specifically constructed for use as a temporary drilling platform. According to initial reports, the well yielded substantial flows of both oil and gas from several different sandstone formations. Later in 1974, Imperial drilled a successful follow-up well from another artificial island located three miles south of the Adgo F 28 well. The offset well, Adgo P 25, encountered oil and gas in all the same formations as the discovery well, but confirmed the presence of both oil and gas in reservoirs at elevations substantially above those in the original discovery. The thick pay sections and excellent porosities of the reservoir rocks in these two wells is strongly indicative that this may be Canada's first major offshore oil discovery and would tend to vindicate industry faith in the potential of the Beaufort Sea to be a future oil producing province. At year-end, plans were being made to extend the search to deeper waters in the Beaufort Sea where it is impossible to construct artificial islands by existing methods. Two specially constructed drillships are now being built for Dome Petroleum Limited. The drillships are designed to drill offshore during the summer season in from 90 to 2,000 feet of water. They are expected to be operational by the summer of 1976 and it is anticipated that the first well drilled will be on Dome's permit acreage approximately 70 miles north of the Adgo artificial island.

Current unofficial estimates place proved recoverable oil reserves of the Mackenzie Delta at 1 billion barrels, about one half of that is needed to justify the construction of a large-diameter pipeline to southern Canadian markets.

In the Arctic Islands, the pace of exploration declined from previous years. Since 1969, when large scale exploration began there, Panarctic Oils Ltd. has discovered and partly delineated five substantial gas fields — Drake Point, King Christian, Kristoffer Bay, Thor and Hecla. Dome Petroleum has also discovered sizeable gas reserves in two locations on King Christian Island. In respect to oil and prior to 1974, Panarctic had only made one non-commercial oil discovery — the Fosheim Peninsula discovery on Ellesmere Island.

In 1974, exploration was highlighted by two events, the first being the discovery of oil by Panarctic on Cameron Island and the second being the successful drilling of a step-out well from a floating ice island in deep water off the east coast of Melville Island. Panarctic confirmed that their Bent Horn N-72 well had yielded oil at a rate of 500 b/d on test from an undisclosed Devonian formation. Although the discovery is not considered to merit commercial development, it is very significant in that it is the first exploratory test in the Arctic Islands that recovered 'live' crude oil from lower Paleozoic rocks. Farther west, a successful step-out well to the Hecla gas discovery on the west coast of Melville Island was drilled 8 miles from shore in 400 feet of water from a floating ice platform. The well is not only important from a commercial standpoint in that it substantially enlarged previous estimates of the size of the Hecla field but, from a technologic point of view, it ushered in another major breakthrough in Arctic exploratory drilling technology.

Table 10. Mileage in Canada of pipelines for crude oil, natural gas liquids and products

Year-end	Miles	Year-end	Miles[1]
1959	7,808	1967	14,155
1960	8,436	1968	14,832
1961	9,554	1969	17,075
1962	10,037	1970	17,062
1963	10,607	1971	17,837
1964	11,744	1972	18,310
1965	12,315	1973	18,732
1966	12,995	1974[e]	19,050

Source: Statistics Canada.
[1] Includes producer gathering lines for 1969 to 1974.
[e] Estimated.

Table 11. Deliveries of crude oil and propane by company and destination, 1973-74

Company and Destination	1973	1974
	(millions of barrels)	
Interprovincial Pipe Line		
Western Canada	53.7	56.9
United States	278.3	228.7
Ontario	170.8	191.6
Total	502.8	477.2
Trans Mountain Pipe Line		
British Columbia	44.2	44.6
State of Washington	93.9	73.7
Westridge terminal	6.3	19.2
Total	144.4	137.5

Source: Company annual reports.

Eastern Canada. In southwestern Ontario, 93 exploratory tests and 61 development wells were drilled during 1974 for an aggregate footage of 241,845 feet compared to 58 exploratory tests and 69 development wells with a total footage of 219,808 in 1973.

Exploration for Silurian reefs both onshore and offshore from Lake Erie increased substantially reflecting an overall increase in exploratory drilling footage. The most significant discoveries in 1974 were gas, three gas-bearing Silurian pinnacle reefs in Lambton County and one Ordovician gas discovery in Elgin County. In oil exploration and development, only one exploratory well and two development wells were successful during the year. The oil discovery was Silurian in age while the development wells were completed in Cambrian producing fields.

In Quebec, most of the exploratory activity was carried out by the Quebec crown corporation, Quebec Petroleum Operations Company (SOQUIP) in joint ventures with other oil companies. Soquip earned a 50 per cent interest in 2.8 million acres in the St. Lawrence Lowlands southwest of Quebec City, by drilling three exploratory wells. Although the wells encountered indications of natural gas, the showings proved to be non-commercial and the wells were abandoned. In another joint venture, Soquip drilled an exploratory well on Anticosti Island in the Gulf of St. Lawrence. This well also encountered minor showings of natural gas but was, subsequently, abandoned.

Offshore from the east coast, both the number of wells and footage drilled declined. In 1974, nineteen wells were drilled for a total footage of 185,352 feet compared to 30 wells and 331,448 feet in 1973. All wells were in the exploratory category. The results of exploratory drilling on the Scotian Banks have been disappointing and as a consequence the oil companies operating in this area are beginning to surrender large blocks of their permit acreage. In the last 2 years, total acreage under permit has declined by over 50 million acres to a current 245 million acres.

By the end of 1974, 120 wells had been drilled offshore from the east coast and almost all of these were exploratory. Of these, four listed significant quantities of hydrocarbons but currently are considered to be non-commercial. All of these discoveries were made in the vicinity of Sable Island, the first and best being discovered on the southwestern tip of the island in 1971. Since the initial discovery, seven step-out wells were drilled on the same structure and six of these were successful but with considerably reduced pay sections. Results of this drilling indicated that geological setting of the discovery is too complex to permit commercial development.

A bright spot on the exploration horizon in the eastern offshore is the Labrador Shelf. Two significant discoveries were made here in 1974, both by a group of companies lead by Eastcan Exploration Ltd. The first of these discoveries was made by the Gudrid H-55 well located about 500 miles north of St. John's, Newfoundland. The second discovery was made by the Bjarni H. 81 well, started and suspended in 1973, and then re-entered and completed in 1974. Both of these discoveries are on large structures with excellent reservoir potential. When tested they yielded large flows of gas with condensate. Current plans are to drill four more wells with two self-positioning drillships during the 1975 season. One other company also intends drilling two wells on the Labrador Shelf during the summer of 1975 and also with a self-positioning drillship. This is an extremely difficult area in which to work because of inclement weather, hazards of drifting icebergs and a very short drilling season. Because of this, it will probably take several years before the full potential of the region is evaluated.

In the Gulf of St. Lawrence, 17 miles northeast of Prince Edward Island, Hudson's Bay Oil and Gas Company Limited commenced drilling a well in 1973 but had to abandon it before completion because of inclement weather. Last year they re-entered the well and drilled it to total depth. Subsequently, they announced the well had encountered encouraging shows of natural gas, but further testing and drilling would be required to fully evaluate the find.

The potential of a new offshore east basin will be tested early in 1975 when the team of Gulf Oil Canada Limited and Mobil Oil Canada, Ltd. will drill an 8,000-foot exploratory well in the Bay of Fundy, 35 miles southwest of Saint John, New Brunswick.

Transportation

Because of the cutback in oil production and prospects for a continuation of this trend in the future, crude oil and product pipeline construction was negligible this year; only 318 miles of new pipeline were put into operation. All of the construction was confined to medium- and small-diameter line. Both of the two major trunkline systems in Canada, Trans Mountain Pipe Line Company Ltd. and Interprovincial Pipe Line Limited are now operating below capacity. Because of this, they confined their construction to modifying their installations.

Trans Mountain does not plan on any new construction for 1975 but Interprovincial is now committed to construct the Sarnia-Montreal extension of its mainline system. Earlier, Interprovincial had shown reluctance to construct the line because predicted shortfalls in domestic crude supply in the early 1980s could have made the line unprofitable. However, early in 1975 the federal government and Interprovincial reached agreement on the conditions of construction of the line. According to the terms of this agreement, the federal government will provide financial backing to Interprovincial in the event of an interruption in supply. Construction of the 520-mile, 30-inch diameter pipeline is expected to commence in 1975 with completion date tentatively scheduled for 1976. The line will have an initial design capacity of 350,000 b/d with an initial throughput of 250,000 b/d and is expected to cost $185 million. Fully powered with 16 pumping stations, the capacity of the line would approach 690,000 b/d. Flow in the line will be reversible. By the end of 1974, Interprovincial had a total 2,747 miles of right of way, 1,007 miles in Canada and 1,740 in United States. Other than the Montreal extension, Interprovincial has no plans for major expansions in the immediate future.

Other pipeline construction of significance carried out in 1974 was confined to product pipeline. These included construction of the remaining 30 miles of 12-inch parallel line of Sun-Canadian Pipe Line Company Limited's product pipeline between Sarnia and Toronto, thus twinning the line. Late in December, Dome Petroleum Limited completed a 19 mile, three-inch lateral LPG (liquid petroleum gas) line from the Cox-Sylvan Lake gas processing plant to its Calgary-Edmonton line. Amoco Canada Petroleum Company Ltd. commenced construction of its 11 mile, 4 inch LPG pipeline from the Carson Creek gas processing plant to a point on the Peace River pipeline near Whitecourt, Alberta.

Having completed its research program on an oil pipeline from the North Slope of Alaska to Edmonton, Mackenzie Valley Pipe Line Research Limited is in the process of being disbanded. This organization has been involved in research on northern oil pipeline construction with the principal subject of investigation being the response of permafrost to a warm oil pipeline. Their findings were set out in a report which concluded that it was technically feasible to construct and operate the line without major or irreparable damage to the Arctic environment.

Very recently, five members of this research group, namely Gulf Oil Canada Limited, Imperial Oil Limited, Shell Canada Limited, Interprovincial Pipe Line Limited and Trans Mountain Pipe Line Company formulated the Beaufort-Delta Oil Project Limited. The company will carry out joint studies preparatory to the construction of a crude oil pipeline from the Mackenzie Delta — Beaufort Sea area to tie in with existing crude oil pipeline systems in Alberta. Some of the participating companies are heavily involved in exploration in the Delta and their decision to form the pipeline company is indicative of their confidence that an oil reserve base sufficient to justify the project will be proved.

This year, Interprovincial's American subsidiary Lakehead Pipe Line Company, Inc. substantially increased its pipeline tariffs and will do so again April

1, 1975. On September 1, 1974 Lakehead's rates were increased up to 4 cents a barrel with another 4 cents a barrel increase to be effective April 1, 1975. In addition, on April 1, 1975 Interprovincial has proposed to increase its portion of joint tariffs to Toronto by 2 cents a barrel and to Buffalo by 3 cents a barrel. Then, effective April 1, 1975 the tariff from Edmonton to Sarnia will be 55 cents a barrel, an increase of 8 cents a barrel from the previous rate and the tariff from Edmonton to Toronto will be 60 cents a barrel, 10 cents more than in April 1974.

Petroleum refining

Crude oil refining capacity of all plants in Canada at the end of 1974 totalled 2,023,300 b/d, an increase of 166,000 b/d. This was a gain of about 9 per cent in the industry's ability to refine crude oil, and about 134,000 b/d more than the demand increase for petroleum products in 1974. All of the increase was due to expansion of existing plants as no new refineries were built during the year.

Refinery expansion in the Maritimes was confined to minor increases in crude oil capacity at Texaco Canada Limited's and Imperial Oil Enterprises Ltd.'s Halifax refineries. Other refinery developments in this area included the addition of platforming, hydrocracking and hydrofining units at Newfoundland Refining Company Limited's Come-By-Chance refinery thereby increasing its flexibility in meeting demand for a wider range of petroleum products. This all-hydrogen plant commenced operating in 1973 and features the production of fuel oils, jet fuel and gasoline. Irving Refining Limited is well advanced on the expansion of its Saint John, New Brunswick refinery. When completed it will be the largest in Canada with a capacity of 250,000 b/d compared to current capacity of 120,000 b/d.

Table 12. Crude oil refining capacity by regions

	1973		1974	
	(bbl/day)	(%)	(bbl/day)	(%)
Atlantic provinces	414,000	22.3	414,500	20.5
Quebec	608,000	32.7	646,600	32.0
Ontario	413,700	22.3	522,700	25.8
Prairies and Northwest Territories	290,800	15.7	296,100	14.6
British Columbia	130,300	7.0	143,400	7.1
Total	1,857,300	100.0	2,023,300	100.0

Source: Department of Energy, Mines and Resources, *Petroleum Refineries in Canada* (Operators List 5), January 1975.

Because of excellent potential deepwater harbour sites, several major refinery proposals for the Maritimes are still pending despite current unfavourable economic conditions for refinery construction. Amongst the most important of these are two large refineries to be constructed by Shaheen Natural Resources Company Inc., New York, the company that built the Come-By-Chance refinery. One of these new refineries is a 200,000 b/d facility to be located across the Canso Strait from Gulf Oil Canada's Point Tupper refinery. The other would be built at Come-By-Chance close to the present plant and would have a capacity of 300,000 b/d, the largest ever built in Canada.

Substantial expansion of existing facilities in Quebec raised that province's overall refinery capacity by over 50,000 b/d. Petrofina Canada Ltd. increased the capacity of their Pointe-aux-Trembles refinery by 20,000 b/d to 95,000 b/d. Other refinery developments in Montreal East consisted of a 15,000 b/d expansion of Shell Canada Limited's refinery, a 12,100 b/d capacity increase in Gulf Oil Canada Limited's facility and a 5,000 b/d increase in the capacity of Texaco Canada Limited's plant.

In Ontario, BP Refinery Canada Limited completed the major expansion of its Oakville refinery, increasing capacity by 38,000 b/d to 76,000 b/d. Sun Oil Company Limited more than doubled the capacity of its Sarnia refinery to 84,000 b/d and at the same time added a 15,000 b/d powerforming unit. Gulf increased the capacity of its Clarkson refinery to 62,400 b/d and Shell Canada Limited, raised the capacity of its Port Credit refinery by 12,000 b/d to 80,000 b/d. Construction has commenced on Texaco's 95,000 b/d refinery at Nanticoke on Lake Erie with completion tentatively scheduled for 1976.

On the Prairies, Imperial Oil Limited's Strathcona refinery, located on the site of their existing plant at Edmonton, is nearing completion and is expected to come on stream early in 1975. When this refinery is completed, Imperial's smaller refineries in Regina, Calgary and Winnipeg will be converted to petroleum product distribution terminals. Expansions of other refineries in the Prairie Provinces were relatively minor, the largest being a 3,500 b/d increase in rated capacity of Consumers' Co-operative Refineries Limited's Saskatoon plant.

There were several small additions to British Columbia's seven refineries, but the only noteworthy increase was a 7,700 addition to Gulf's Port Moody refinery. In respect to future refinery expansion, the British Columbia government is considering the feasibility of building a 100,000 b/d refinery in the Vancouver area.

Imperial Oil Enterprises Ltd. remained the largest refiner in Canada. The company's nine refineries comprise 23 per cent of Canadian refinery capacity. Gulf Oil Canada Limited's eight plants constitute 18 per cent of Canadian refinery capacity and Shell

Table 13. Canada, crude oil received at refineries, 1973 and 1974p

Location of Refineries		Country of Origin							
		Canada	Middle East	Trinidad	Venezuela	Africa	Colombia	Other	Total Received
Atlantic provinces	1973	230,825	56,879,934	—	39,069,549	—	—	16,850,054	113,030,362
	1974	3,836,785	83,183,797	—	36,407,091	—	106,949	7,398,767	130,933,389
Quebec	1973	5,315,499	70,009,491	—	105,362,587	18,835,661	3,839,175	2,719,334	206,081,747
	1974	23,417,074	73,898,172	—	91,552,160	4,572,833	231,007	1,864,532	195,535,758
Ontario	1973	148,886,750	—	—	490,453	—	—	—	149,377,203
	1974	165,494,791	—	—	67,622	—	—	—	165,562,413
Prairies	1973	93,325,241	—	—	—	—	—	—	93,325,241
	1974	100,357,178	—	—	—	—	—	—	100,357,178
British Columbia	1973	51,420,427	—	—	—	—	—	—	51,420,427
	1974	52,218,908	—	—	—	—	—	—	52,218,908
Northwest Territories and Yukon	1973	945,182	—	—	—	—	—	—	945,182
	1974	976,290	—	—	—	—	—	—	976,290
Total	1973	300,123,924	126,889,425	—	144,922,589	18,835,661	3,839,175	19,569,388	614,180,162
	1974	346,301,026	157,081,969	—	128,026,873	4,572,833	337,956	9,263,299	645,583,936

Source: Statistics Canada.
p Preliminary; — Nil.

Canada Limited, third largest refiner, operates six refineries which account for 15 per cent of the total.

Marketing and trade

Crude oil deliveries to Canadian refineries during 1974 averaged 1.77 million barrels a day, approximately 5 per cent more than in 1973. Refineries served by domestic crude oil increased their consumption by 15.4 per cent to 949,000 b/d. Of this amount 74,680 b/d went to refineries in Quebec and the Maritime Provinces. The remainder to refineries in Ontario and western Canada. On the other hand, use of imported crude oil by Canadian refineries in Quebec and the Maritime Provinces declined to 820,000 b/d, 77,000 b/d less than in 1973. The decline in the rate of use of imported crude oil was attributable to the increasing use of western Canadian crude oil in refineries east of the Ottawa Valley Line, in line with federal government policy to lessen the dependency of the major refining area on imported crude oil for refinery feedstock. When the Sarnia to Montreal pipeline is completed in 1977, then this dependency will decline by at least 250,000 b/d. Most of the crude oil shipped to Quebec and the Maritimes in 1974 was shipped either by tanker via the Great Lakes and St. Lawrence Seaway or by tanker from west coast ports via the Panama Canal. This cumbersome and relatively costly method of transporting crude oil to eastern markets was set up on a contingency basis to partially offset the Arab embargo on crude oil shipments to Canada in 1973.

The Middle East replaced Venezuela as the largest supplier of crude oil to Canada. The volume of imports from the Persian Gulf states increased by 24 per cent to 430,361 b/d, more than 50 per cent of Canada's imports in 1974. Forty-one per cent of imports from this area came from Iran, the country which did not participate in the 1973–74 oil embargo. Venezuela, long the principal source of Canada's crude oil imports, slipped by 12 per cent to 351,000 b/d. Imports of African oil, mainly from Nigeria, declined by 75 per cent to 12,500 b/d in 1974. In 1974, Middle East sources of imported oil were Iran, Saudi Arabia, Iraq, Kuwait, Qatar, Bahrain and the Trucial States. It is anticipated that the Middle East's share of Canada's import requirements will continue to increase if only because Venezuela's productive capacity is beginning to decline.

Imported oil accounted for 46 per cent of Canadian refinery requirements in 1974, 5 per cent less than the previous year. Canada's self-sufficiency index (consumption of refined petroleum products versus output of crude oil and equivalent) declined to 105 per cent in 1974 from the previous year's all-time high of 113 per cent. The decline was due to restrictions in the flow of exported oil to the United States and the lessening in the demand for refined petroleum products from the export orientated eastern Canada based refineries to traditional northeastern United States markets.

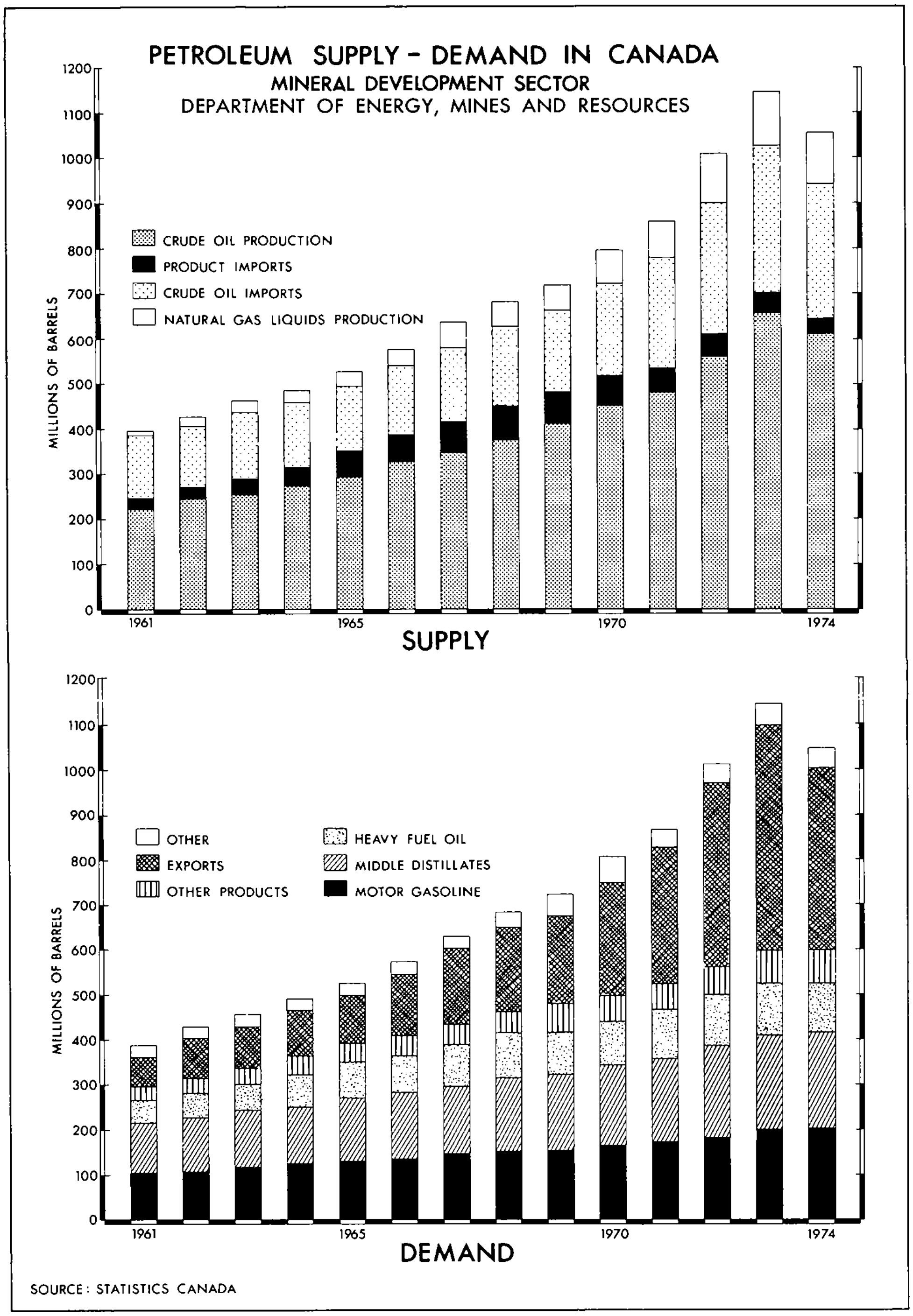
Exports to the United States of crude oil and equivalent decreased by 21 per cent to 910, 180 b/d in 1974. Canadian exports to the United States west coast region (District 5) via Trans Mountain Pipe Line Company Ltd. averaged 202,000 b/d, a decrease of 55,342 b/d from the 1973 average. Exports to markets in the northern states east of the Rocky Mountains (Districts 1-4), primarily via Interprovincial's main line decreased by 136,000 b/d.

Exports of petroleum products in 1974, including gas plant propane and butane, amounted to 201,000 b/d about 12,000 b/d less than last year. Most of this went to United States northeastern states which have

Table 14. Consumption of petroleum products by province, 1974^p

	Motor Gasoline	Kerosene, Stove Oil, Tractor Fuel	Diesel Fuel Oil	Light Fuel Oils No. 2 and 3	Heavy Fuel Oils No. 4, 5 and 6
	(thousands of barrels)				
Newfoundland	3,573,774	1,310,046	2,927,530	3,503,517	5,720,942
Maritimes	14,311,260	2,815,396	5,683,236	13,937,975	22,371,941
Quebec	48,726,392	5,081,738	12,955,297	38,078,755	42,776,438
Ontario	75,194,157	2,490,636	15,644,603	37,339,002	26,678,494
Manitoba	9,718,946	1,158,975	4,358,672	1,657,291	1,311,690
Saskatchewan	11,574,644	1,247,646	4,950,997	1,449,849	269,714
Alberta	21,192,245	489,141	8,496,930	836,187	698,180
British Columbia	22,424,937	1,612,427	11,263,960	6,252,223	10,164,634
Northwest Territories and Yukon	563,319	375,581	1,443,211	745,781	150,290
Total	207,279,674	16,581,586	67,724,436	103,800,580	110,142,323

Source: Statistics Canada.
^{p} Preliminary.


PETROLEUM SUPPLY - DEMAND IN CANADA
MINERAL DEVELOPMENT SECTOR
DEPARTMENT OF ENERGY, MINES AND RESOURCES
CRUDE OIL PRODUCTION
PRODUCT IMPORTS
CRUDE OIL IMPORTS
NATURAL GAS LIQUIDS PRODUCTION
MILLIONS OF BARRELS
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1961
1965
1970
1974
SUPPLY
OTHER
EXPORTS
OTHER PRODUCTS
HEAVY FUEL OIL
MIDDLE DISTILLATES
MOTOR GASOLINE
MILLIONS OF BARRELS
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1961
1965
1970
1974
DEMAND
SOURCE: STATISTICS CANADA

virtually no refining capacity and have to bring in most of their petroleum product requirements from other areas both inside and outside of the continental United States.

Imports of petroleum products declined substantially in 1974 to 83,000 b/d; 38,000 b/d less than in 1973. The trend to reduced product imports began when refinery capacity in eastern Canada was substantially increased by the addition of the St. Romuald and Point Tupper refineries in 1971 and again in 1973 when Newfoundland Refining Company Limited's 100,000 b/d refinery at Come-By-Chance, Newfoundland came on stream. These refineries were designed essentially for the export market for refined products but with the recent slump in this market, their productive capacity has been diverted to serve the domestic market, particularly for heavy fuel oil. With the exception of a few specialty products, imports of refined petroleum into Canada should virtually be eliminated in the near future.

To summarize, Canada remained a net exporter of crude oil and products in 1974, although at a somewhat reduced level from the previous year, as exports exceeded imports by 76 million barrels or 208,000 b/d.

To safeguard Canada's interest, the Canadian government introduced a new oil export control system. The government took this action on recommendations set out in a report prepared by the National Energy Board. The report provides a comprehensive review of Canadian crude oil supply and demand and was published after a series of public hearings which terminated on May 2, 1974. Appraisal of the evidence produced at the hearing coupled with existing supply and demand trends indicated a deficiency in supply to the domestic market served by Canadian oil would develop in 1982 and grow to 200,000 b/d by 1983. Later in the 1980s, production from the oil sands and frontier areas is expected to more than meet all Canadian requirements. It was to minimize or eliminate entirely the forecasted supply gap of the early 1980s that the federal government introduced the new oil export control system. Under the terms of this system, exports to the United States will be reduced to 800,000 b/d in January 1975, and further reduced to 650,000 barrels a day July 1, 1975. The last reduction will follow consultation with the western Canadian producing provinces and is designed to ensure a long-term supply of 250,000 b/d for the proposed interprovincial pipeline extension from Sarnia to Montreal scheduled for completion in 1976. Beyond 1975, export levels will be adjusted to account for immediate supply and demand factors.

In addition to control over export volumes, 1974 witnessed the extension of both provincial and federal government control over the pricing mechanisms for crude oil and petroleum products, an area formerly controlled solely by the oil producing and refining companies. In order to ensure that exported Canadian

Table 15. Canada, exports and imports of refined petroleum products, 1973-74

	Exports		Imports	
	1973	1974ᵖ	1973	1974ᵖ
	(millions of barrels)			
Propane and butane	36.35	34.13	0.27	0.07
Aviation gasoline	—	—	0.11	0.03
Motor gasoline	3.31	0.99	0.22	0.03
Aviation turbo fuel	1.67	1.21	2.46	1.84
Kerosene, stove oil and tractor fuel	0.08	0.07	0.98	0.18
Diesel fuel oil	0.52	0.70	1.13	1.34
Light fuel oil #2 and 3	1.28	2.36	4.87	1.89
Heavy fuel oil #4, 5 and 6	31.65	28.02	28.48	18.74
Asphalt	0.01	0.19	0.10	0.06
Petroleum coke	—	—	3.37	3.89
Lubricating oils	0.02	0.01	1.58	1.64
Other products	2.85	5.64	0.62	0.57
Total, all products	77.74	73.32	44.19	30.28

Source: Statistics Canada.
ᵖ Preliminary; — Nil.

crude oil was priced at market values comparable to other imported and domestically produced crude oils in the United States, the federal government levied a tax on exported crude oil and equivalent late in 1973. Initially the tax was set at 40 cents a barrel, but was progressively raised to higher levels to a maximum of $6.40 a barrel early in 1974 as the foreign reference prices escalated upwards. By the end of 1974 the tax had declined to $5.20 a barrel. At about the same time as it introduced the oil export tax, the federal government froze all domestic product prices both east and west of the Ottawa Valley Line and decided to compensate companies from federal funds for losses incurred in importing foreign crude oil and petroleum products.

In respect to the wellhead price of crude oil, both federal and provincial governments agreed on a price of $6.50 a barrel for domestically produced crude oil effective April 1, 1974. The price of crude oil had been frozen at $4.00 a barrel since September 1973 when the federal government had requested that oil companies not raise their prices until January 30, 1974. The $4.00 price was subsequently extended to March 31, 1974 by general agreement between the provinces and the federal government at a meeting of the First Ministers on energy prices in January 1974. The effects of these government actions were twofold — consumers in Canada did not have to pay the large increase in petroleum product prices they would have if the price of domestic crude oil had been allowed to rise with

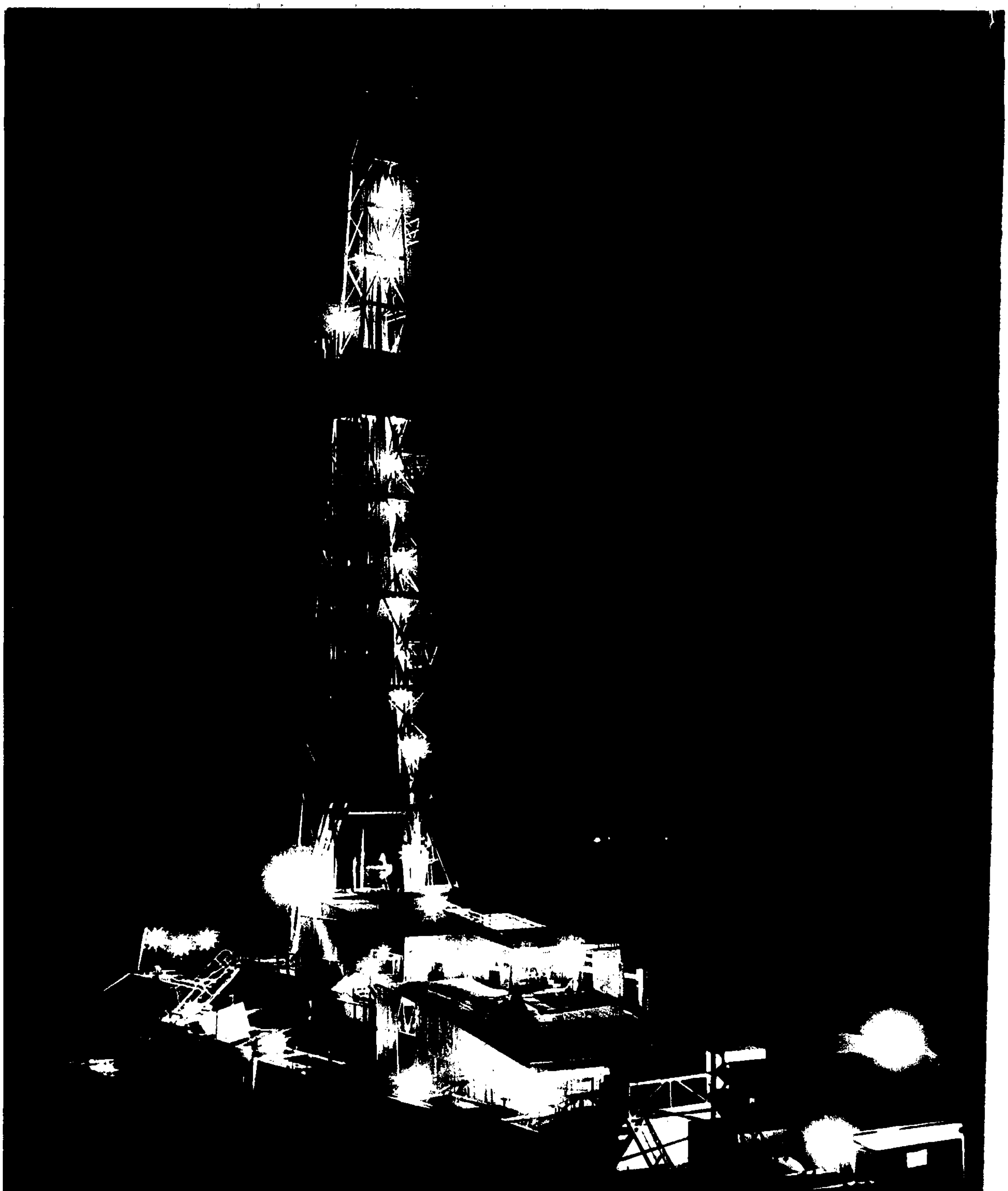
Table 16. Canada, supply and demand of oils, 1973-74

	1973	1974p
	('000 barrels)	
Supply		
Production		
Crude oil and condensates	655,853	616,238
Other natural gas liquids	116,252	113,056
Net production	772,105	729,294
Imports		
Crude oil	327,429	299,283
Products	44,194	30,275
Total imports	371,623	329,558
Changes in stocks		
Crude and natural gas liquids	−5,538	−1,164
Refined petroleum products	−7,754	−13,664
Total changes	−13,292	−14,828
Oils not accounted for	−263	+5,756
Total supply	1,130,173	
Demand		
Exports		
Crude oil	420,060	332,216
Products	77,741	73,319
Total	497,801	405,535
Domestic sales		
Motor gasoline	202,101	207,280
Middle distillates	203,033	211,031
Heavy fuel oil	111,721	110,142
Other products	71,151	71,279
Total sales	588,006	599,732
Uses and losses		
Refining	42,975	43,102
Field plant and pipeline	1,391	1,411
Total	44,366	44,513
Total demand	1,130,173	1,049,780

Source: Statistics Canada and provincial government reports.
p Preliminary.

world prices, and the prices of petroleum products nationally were essentially equalized regardless of the source of refinery feedstocks discounting differences in transportation charges.

Since the agreement on the $6.50-a-barrel domestic price for crude oil is due to expire June 30, 1975, the federal government scheduled a meeting of First Ministers for April 1, 1975 to seek a new agreement on both oil and gas prices. In respect to oil, there is some consensus amongst industry and governments, particularly those of the producing provinces, that the price gap between domestically produced oil at $6.50 a barrel and that of imported oil of $11.50 is too large. Their argument is that the price of domestic crude oil should be raised substantially in the best interests of conservation and exploration incentives. To further justify crude oil price increases, it has been pointed out that, at the current domestic price of $6.50 a barrel, economic large-scale development of the Athabasca tar sands is not possible, a circumstance that is not acceptable in view of predicted shortages of crude oil in the early 1980s.



Conventional oil-drilling rig operating in western Canada.

Phosphate

A.F. KILLIN

Phosphate is a term applied to a rock, mineral, or salt containing one or more phosphorous compounds. About four fifths of the world's phosphate consumption is for agriculture, largely fertilizers. World demand for phosphate rock expanded at unprecendented rates from 1963 to 1967 to meet the needs of a rapidly developing phosphate fertilizer industry. The demand eased considerably between 1968 and 1971 because of overcapacity in the phosphate fertilizer industry resulting in decreased prices and a lessening demand for fertilizer arising from lower farm product prices. A world-wide food shortage that assumed serious proportions in 1970–71, has carried through 1974. This shortage has been accompanied by higher food prices and a sharp increase in the demand for fertilizers, including phosphates. There have also been actual and projected increases in phosphate rock mine capacity and phosphate fertilizer plant capacity in many parts of the world in response to this most recent surge in demand.

Phosphate rock

Phosphate rock, or phosphorite, contains one or more suitable phosphate minerals, usually calcium phosphate, in sufficient quantity for use, either directly or after beneficiation, in the manufacture of phosphate products. Sedimentary phosphate rock is the most widely used phosphate raw material; apatite, which occurs in many igneous and metamorphic rocks and can be represented by the formula $Ca_5(PO_4)_3(F, Cl, OH)$, is second in importance. Other sources of phosphate include guano and a basic slag byproduct of some steel mills. Phosphate rock can be decomposed by three methods: acid treatment; thermal reduction; or thermal treatment without reduction. Canadian phosphate producers use the first two methods.

Phosphate rock is graded either on the basis of its P_2O_5 equivalent (phosphorus pentoxide) or $Ca_3P_2O_5$ content (tricalcium phosphate or bone phosphate of lime–BPL). For comparative purposes, 0.458 P_2O_5 equals 1.0 BPL, and one unit of P_2O_5 contains 43.6 per cent phosphorus.

Occurrences in Canada

Although there are numerous occurrences of low-grade phosphate rock in Canada, there is no commercial production in this country. Large quantities of rock are imported, mostly from the United States, for use in the manufacture of agricultural and industrial products sold in domestic and export markets.

Known Canadian deposits are of limited extent and fall into three main categories: apatite deposits within Precambrian metamorphic rocks in eastern Ontario and southwestern Quebec; apatite deposits in some carbonate-alkaline complexes in Ontario and Quebec; and Late Paleozoic—Early Mesozoic sedimentary phosphate rock deposits in the southern Rocky Mountains.

The Precambrian metamorphic apatite deposits of Ontario and Quebec occur in pyroxenites as small, irregular, scattered pockets and veins with phlogopite mica and pink calcite. Most of the outcrops are in the Rideau Lakes region of eastern Ontario and the Lievre River area of southwestern Quebec, where many deposits were worked extensively between 1869 and 1900, before low-cost Florida rock entered world markets. Among the more important alkaline-complex apatite occurrences are: the Nemegos deposits, some 150 miles northwest of Sudbury; the Oka deposit, 20 miles west of Montreal; and some deposits north of Arvida.

Sedimentary phosphate beds are fairly common in the Rocky Mountains. Most of the exposures occur along the Alberta–British Columbia border between the International Boundary and Banff. Beds at the base of the Fernie shale have received considerable attention during recent years.

Canadian phosphate industry

Elemental phosphorus. Elemental phosphorus is produced in Canada by the thermal reduction method which involves the smelting of phosphate rock with carbon (coke) and a siliceous flux. Coproducts of the process are ferrophosphorus, carbon monoxide and calcium silicate slag. About nine tons of phosphate rock grading 66–68 per cent BPL are required to manufacture one ton of phosphorus. Although elemental

Table 1. Canada, phosphate rock imports and consumption, 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Imports				
United States	3,671,229	23,704,000	3,685,183	40,139,000
Netherlands Antilles	6,327	204,000	3,982	280,000
Romania	1,061	5,000	—	—
Total	3,678,617	23,913,000	3,689,165	40,419,000
	1972		1973	
Consumption[1] (available data)				
Fertilizer, stock and poultry feed	2,102,529		2,166,282	
Chemicals	244,656		254,934	
Other[2]	14,825		9,148	
Total	2,362,010		2,430,364	

Source: Statistics Canada.
[1] Breakdown by Mineral Development Sector. [2] Includes amounts for refractories, food processing, medicinals and pharmaceuticals.
p Preliminary; — Nil.

phosphorus can be used for making fertilizers, it is generally used in the manufacture of chemicals, insecticides, detergents and other industrial compounds.

Phosphate fertilizers. Phosphate fertilizers are normally produced by decomposing phosphate rock with a strong mineral acid. In Canada, only the two most common acidulents, sulphuric acid and phosphoric acid, are used in commercial practice; the former is by far the most common.

When phosphate rock is treated with sulphuric acid, either single superphosphate or phosphoric acid (correctly named orthophosphoric acid, H_3PO_4) is produced. For the former, the rock is treated with sufficient acid to convert the tricalcium phosphate into water-soluble monocalcium phosphate; the coproduct of the reaction, calcium sulphate, remains in the mixture. Normal raw material requirements to produce one ton of superphosphate, grading 20 per cent P_2O_5 equivalent, are 0.64 ton of phosphate rock (70–72 per cent BPL) and 0.47 ton of sulphuric acid (100 per cent basis).

Table 2. Canada, phosphate rock imports and consumption, 1965-74

	Imports	Consumption
	(short tons)	
1965	1,695,296	1,606,915
1966	2,181,341	1,735,488
1967	2,279,767	2,275,095
1968	2,349,980	2,234,259
1969	2,201,331	1,822,069
1970	2,470,050	1,896,684
1971	2,844,453	2,031,289
1972	2,985,102	2,362,010
1973	3,678,617	2,430,364
1974p	3,689,165	..

Source: Statistics Canada.
p Preliminary; .. Not available.

Table 3. World Production of phosphate rock, 1972-74

	1972	1973	1974
	('000 metric tons)		
United States	37,040	38,226	41,500
U.S.S.R.	19,750	21,080	22,540
Morocco	14,468	16,564	19,326
Tunisia	3,387	3,473	3,903
People's Republic of China	2,600	2,750	3,000
Nauru	1,340	2,323	2,288
Togo	1,928	2,272	2,553
Senegal	1,425	1,752	1,878
Christmas Island	1,074	1,493	1,809
South Africa	1,450	1,365	1,550
Jordan	694	1,086	1,600
Israel	800	750	1,000
Ocean Island	512	742	549
Spanish Sahara (Rio de Oro)	25	696	2,386
Algeria	527	608	802
Arab Republic of Egypt	500	540	550
Other countries	1,602	1,772	3,960
Total	89,122	97,492	111,194

Source: The British Sulphur Corporation Ltd., Statistical Supplement May/June 1975 for 1973-74.

To produce phosphoric acid, larger quantities of sulphuric acid are added to maintain a fluid slurry that facilitates removal of calcium sulphate by filtering. Filtered acid, containing 30 to 32 per cent P_2O_5 equivalent, may be used either directly in the manufacture of phosphate fertilizers or concentrated by evaporation to as high as 54 per cent P_2O_5 equivalent prior to further use or sale as merchant acid. Typical raw material requirements for one ton of P_2O_5 equivalent produced are 3.1 tons of phosphate rock (74–75 per cent BPL) and 2.6 tons of sulphuric acid (100 per cent basis). Also, for every ton of P_2O_5 equivalent produced, about 4.5 tons of waste calcium sulphate are generated.

Most of the acid is then neitralized with ammonia to form ammonium phosphate fertilizers. Common grades are 16–20–0 (16 per cent N, 20 per cent P_2O_5 equivalent, and 0 per cent K_2O equivalent), 11–40–0 and 18–46–0. At some plants, phosphoric acid is used to acidulate phosphate rock, in which case the end product is triple superphosphate, normally grading 46 per cent P_2O_5 equivalent.

There are ten phosphoric acid plants in Canada with a combined annual productive capacity of 1,133,000 tons of P_2O_5 equivalent. The balance of Canada's P_2O_5 productive capacity, amounting to 21,000 tons annually, consists of plants that are capable of producing single and/or triple superphosphate.

Production, trade and consumption. Nearly all Canada's trade in te fertilizers is with the United States, mostly in areas where plants are close to farming communities in the neighbouring country. Under foreign aid programs, shipments are occasionally made to southeast Asian countries. Preliminary figures indicate that imports of phosphate rock in 1974, at 3,689,165 tons, were only 10,548 tons higher than in 1973; phosphate fertilizer production decreased by 46,406 tons to 767,566 tons (P_2O_5 equivalent); and consumption of phosphate fertilizer (P_2O_5 equivalent) rose 19 per cent to 544,795 tons. Exports of fertilizer decreased 17.7 per cent to 272,932 tons (P_2O_5 equivalent) during the 1973–74 fertilizer year.

Outlook

Despite a continuing world food shortage, fertilizer sales have been affected by the world-wide decline in industrial activity and by inflationary factors associated with the universal energy crisis. Fertilizer plants in Canada operated near capacity throughout the year but inventories increased. The outlook is for increased sales in 1976 and for some capacity increases in order to meet the projected rise in demand.

Table 4. Canada, phosphate fertilizer production, years ended June 30, 1965-74

	short tons P_2O_5 equivalent
1965	374,159
1966	461,608
1967	533,460
1968	538,796
1969	523,934
1970	496,380
1971	619,669
1972	745,667
1973	813,972
1974p	767,566

Source: Statistics Canada.
p Preliminary.

Table 5. Canada, phosphorus and phosphate fertilizer plants, 1974

Company	Plant Location	Annual Capacity	Principal End Products	Basis for H_2SO_4 Supply for Fertilizer Plants
		(short tons)		
Elemental phosphorus				
Erco Industries Limited[1]	Varennes, Que.	20,000	el ph	
	Long Harbour, Nfld.	80,000	el ph	
Total elemental phosphorus		100,000		
Phosphate fertilizer		(P_2O_5 eq.)		
Canada Wire and Cable Limited[2]	Belledune, N.B.	147,000	am ph	SO_2 smelter gas
Canadian Industries Limited	Beloeil, Que.	20,000	ss	sulphur
	Courtright, Ont.	93,000	am ph	SO_2 pyrrhotite, Copper Cliff
Cominco Ltd.	Kimberley, B.C.	129,000	am ph	SO_2 smelter gas
	Trail, B.C.	84,000	am ph	SO_2 smelter gas
International Minerals & Chemical Corporation (Canada) Limited	Port Maitland, Ont.[3]	168,000	H_3PO_4, ss ts, ca ph	sulphur
Green Valley Fertilizer & Chemical Co. Ltd.	North Surrey, B.C.	1,000	ss	SO_2 smelter gas, Trail
Imperial Oil Limited	Redwater, Alta.	210,000	am ph	sulphur
Northwest Nitro-Chemicals Ltd.	Medicine Hat, Alta.	70,000	am ph	sulphur
St. Lawrence Fertilizers Ltd.	Valleyfield, Que.	50,000	ts, am ph	SO_2 smelter gas
Sherritt Gordon Mines, Limited	Fort Saskatchewan, Alta.	65,000	am ph	sulphur
Simplot Chemical Company Ltd.	Brandon, Man.	..	am ph	
Western Co-operative Fertilizers Limited	Calgary, Alta.	120,000	am ph	sulphur
Total, phosphate fertilizer		1,157,000		

el ph Elemental phosphorus; P_2O_5 eq. Phosphorus pentoxide equivalent; am ph Ammonium phosphates; ss Single superphosphate; ts Triple superphosphate; ca ph Food supplement calcium phosphate; .. Not applicable, H_3PO_4 is made elsewhere

[1] Electric Reduction Company of Canada, Ltd. changed its name to Erco Industries Limited, effective January 1, 1973. [2] Noranda Mines Limited acquired full ownership of Belledune Fertilizer, effective April 1, 1972, name changed to Canada Wire and Cable Limited, June 5, 1972. [3] Operates at less than annual capacity because of environmental restrictions.

Table 6. Canada, trade in selected phosphate products, 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Imports				
Calcium phosphate				
United States	24,782	2,898,000	19,598	3,197,000
Israel	—	—	20	11,000
Italy	—	—	22	8,000
France	—	—	40	6,000
Total	24,782	2,898,000	19,680	3,222,000
Fertilizers				
Normal superphosphate, 22% P_2O_5 or less				
United States	4,949	155,000	11,999	566,000
Triple superphosphate, over 22% P_2O_5				
United States	19,689	1,063,000	23,140	1,856,000
France	6	7,000	—	—
Total	19,695	1,070,000	23,140	1,856,000
Phosphate fertilizers, nes				
United States	40,075	3,451,000	65,257	9,540,000
Belgium and Luxembourg	515	96,000	1,507	482,000
United Kingdom	554	159,000	319	141,000
France	—	—	241	30,000
Netherlands	40	6,000	59	30,000
Sweden	—	—	20	9,000
West Germany	—	—	2	4,000
Total	41,184	3,712,000	67,405	10,236,000
Chemicals				
Potassium phosphates				
United States	2,465	695,000	3,801	1,435,000
Sodium phosphate tribasic				
United States	1,118	187,000	3,119	543,000
France	97	15,000	18	7,000
Belgium and Luxembourg	60	8,000	—	—
West Germany	3	3,000	—	—
Total	1,278	213,000	3,137	550,000
Sodium phosphate, nes				
United States	3,300	899,000	4,009	1,335,000
West Germany	63	25,000	98	38,000
United Kingdom	—	—	1	2,000
Total	3,363	924,000	4,108	1,375,000
Exports				
Nitrogen-phosphate fertilizers, nes				
United States	495,363	33,760,000	460,159	51,010,000
Indonesia	—	—	16,763	5,403,000
Ireland	3,090	252,000	36,619	3,393,000
Chile	—	—	28,749	3,211,000
Belgium and Luxembourg	—	—	42,622	2,367,000

Table 6 (concl'd)

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Exports (concl'd)				
Viet Nam	—	—	11,066	1,660,000
Japan	2,611	225,000	11,417	1,320,000
India	45,569	3,054,000	16,645	863,000
Lebanon	79,653	4,626,000	9,665	596,000
Mauritius and Dependencies	—	—	5,508	441,000
Pakistan	40,649	4,071,000	—	—
Other countries	12,294	765,000	—	—
Total	679,229	46,753,000	639,213	70,264,000

Sources: Statistics Canada.
— Nil; nes Not elsewhere specified; p Preliminary.

Prices

Prices of the three basic raw materials, namely phosphate rock, sulphur and natural gas, used in the manufacture of phosphate fertilizer have been rising since 1972. Farm prices have also risen and the increased cost of fertilizer is being passed directly to the farmer and indirectly to the consumer of farm products.

For some years prior to January 1, 1974 the United States phosphate rock producers had been the world price leaders. In October, 1973, the Office Cherifien des Phosphates, the Moroccan, state controlled, agency announced large price increases for exported phosphate rock and other world producers followed suit.

Listed Export Prices for Florida Phosphate Rock

Grade	March 1973	January 1974	July 1974	October* 1974
	(Basis: U.S. $/metric ton fob Tampa or Jacksonville)			
77/76% TPL	14.50	29.53	46.75	62.00
75/74% TPL	13.10	27.07	41.34	55.00
72/70% TPL	11.50	23.62	35.43	48.00
70/68% TPL	10.80	21.65	32.48	43.00
68/66% TPL	9.90	19.68	29.53	39.00
66/64% TPL	9.40	17.72	27.07	36.00

Source: British Sulphur Corporation Limited.
*Florida producers have not announced price changes for 1975.

Listed Prices for Moroccan Phosphate Rock

Grade	March* 1973	January 1974	July 1974	January 1975
	(Basis: U.S. $/metric ton fas Casablanca or Safi)			
Khouribga				
77/79% TPL (calcined)		47.25	71.00	76.50
75/77% TPL		42.00	63.00	68.00
70/72% TPL		40.00	60.00	65.00
Youssoufia				
70/72% TPL		37.50	56.25	60.75

Source: British Sulphur Corporation Limited.
* Prices in 1973 were equivalent to Florida prices.

Phosphate rock prices are based upon the TPL content. Maximum limits of moisture, iron and alumina are specified and bonuses are paid and penalties assessed for variations above and below the base grade. Although much phosphate rock is supplied on a contract basis, price quotations serve as a reliable guide. Prices for phosphate fertilizers are usually based on the unit content or minimum analysis of the P_2O_5 equivalent, commonly expressed as an available phosphoric acid (apa).

The December 31, 1974 issue of Chemical Marketing Reporter listed the following prices:

	($)
Phosphate rock, Florida land pebble, run-of-mine, underground, bulk, carlots, fob mines, per short ton (% BPL)	
66-68	25.00
68-70	26.75
70-72	28.55
74-75	31.65
76-77	33.90
Defluorinated phosphate, feed grade, 100-lb bags, carlots, fob Coronet, Fla., freight equalized, 18 per cent P, per short ton	72.25
Phosphoric acid, agricultural grade, fob works, per unit-ton[1], 52-54 per cent apa	1.95
Superphosphate, run-of-pile, pulverized, bulk, carlots, fob works, per unit-ton, under 22 per cent apa	not quoted

[1] A unit-ton is 2,000 pounds of 1 per cent of the basic constituent or other standard of the material. The percentage figure of the basic constituent multiplied by the price shown gives the price of 2,000 pounds of the material.

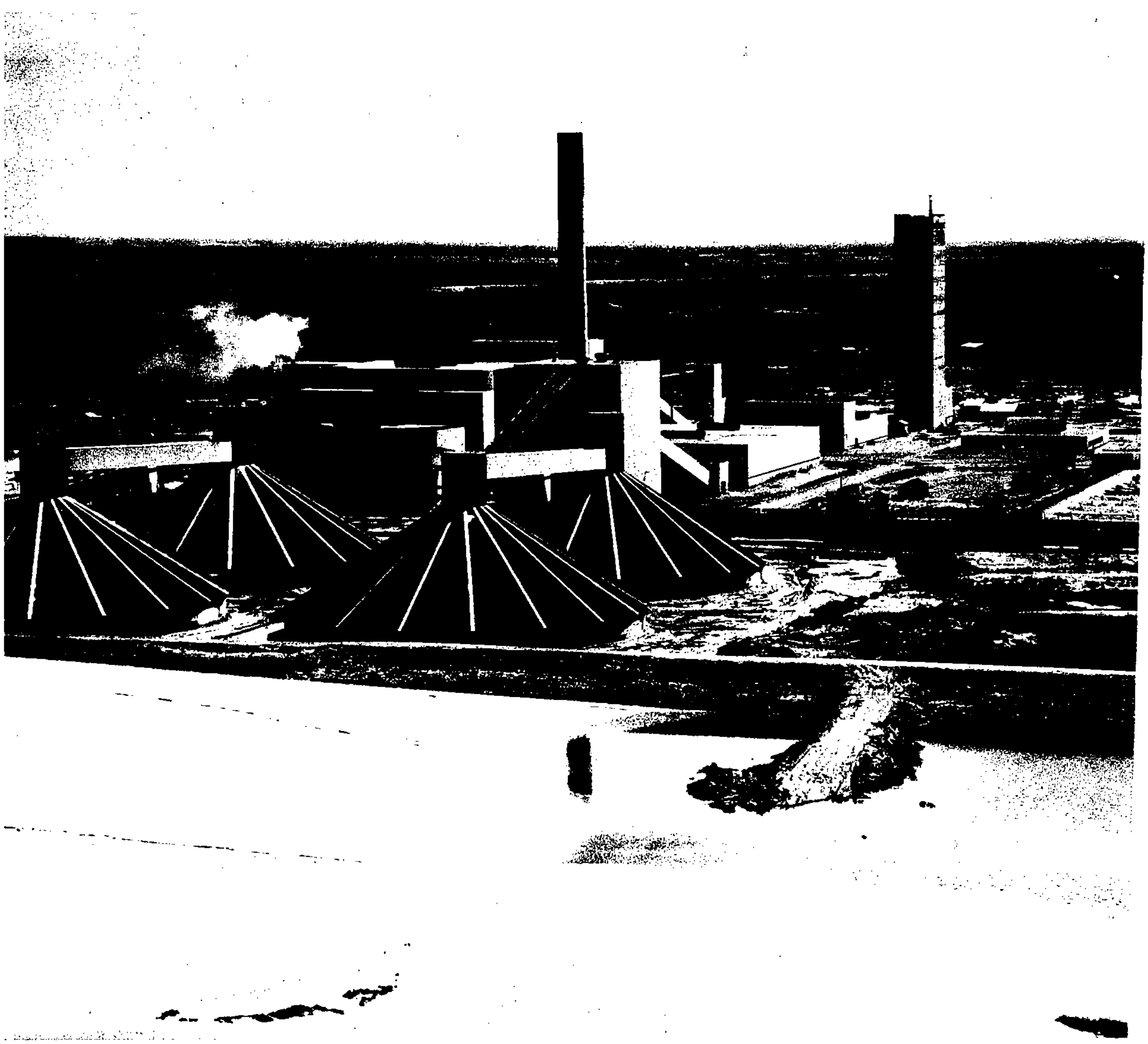
Table 7. Canada, phosphate fertilizer consumption and trade, years ended June 30, 1965-74

	Consumption	Imports[1]	Exports
	(short tons P_2O_5 equivalent)		
1965	293,758	66,604	97,207
1966	367,591	65,498	126,524
1967	412,214	73,936	138,133
1968	440,093	43,726	165,048
1969	347,813	24,054	161,051
1970	309,400	11,293	218,501
1971	359,781	11,421	338,779
1972	375,682	21,863	300,705
1973	457,784	8,463	331,522
1974^p	544,795	10,953	272,932

Source: Statistics Canada.
[1] Excludes nutrient content of mixtures and of orthophosphoric acid.
^{p} Preliminary.

Tariffs

Phosphate rock and phosphate fertilizer materials enter Canada and the United States duty free.



K-2 mine and refinery of International Minerals and Chemical Corporation (Canada) Limited, near Esterhazy, Saskatchewan.
(George Hunter photo)

Platinum Metals

J.J. HOGAN

The platinum group metals consist of platinum, palladium, rhodium, iridium, ruthenium and osmium. The metals are found in nature associated with basic and ultrabasic rocks and in placer deposits, although production from placers is now of minor importance. A large quantity of platinum metals comes from mines worked principally for platinum metals, mainly in the Republic of South Africa; a substantial amount is also recovered as a byproduct from the treatment of nickel–copper ores.

The major producers, ranked in decreasing order of production volume are the Republic of South Africa, U.S.S.R., and Canada. Minor producers are Colombia, the United States, Japan and the Philippines.

Canadian production of platinum group metals in 1974 was estimated at 360,000 ounces* valued at $65,776,000 compared with 354,223 ounces in 1973 valued at $41,993,743. Although there was only a small increase in volume, the dollar value was up significantly because of substantial increases in the prices of platinum and palladium, the metals which account for the largest quantity of the platinum group metals recovered in Canada. Platinum metals output in Canada is derived as a byproduct of nickel–copper refining operations. A change in the base-metal recovery process at one of the nickel producers resulted in a build up of platinum metals in its circuit and was responsible for production being below what might have been expected in 1974.

World mine production of the platinum group metals in 1974 was estimated at 6,031,000 ounces, an increase of 15.1 per cent over the 5,239,781 ounces recovered in 1973. Expansion of plant capacity by the producers in the Republic of South Africa was mainly responsible for the significant increase in production. South Africa was the leading world producer of platinum metals followed closely by the U.S.S.R. These two countries were responsible for about 93 per cent of total world output in 1974 and Canada, the third largest producer, accounted for some 6 per cent.

Japan and the United States were the leading consumers of platinum group metals in 1974, with Japan being the larger consumer mainly because of the demand for platinum jewellery by the Japanese people. The U.S. Bureau of Mines (USBM) estimated the platinum group metals sold to industry in the United States in 1974, excluding sales of platinum and palladium for automotive emission catalysts, at 1,481,010 ounces. The percentages of platinum group metals sold to the U.S. consuming industries were platinum 40.1, palladium 49.7, ruthenium 4.4, rhodium 4.2, iridium 1.5 and osmium 0.1. The major consumers in the U.S. were the chemical and electrical industries which accounted for about 66 per cent of the total. Preliminary estimates show that consumption of platinum and palladium (71 per cent platinum and 29 per cent palladium) in 1974 in catalytic converters manufactured in the U.S. was 300,000 ounces. The USBM reports the stocks of platinum group metals held by refiners, importers and dealers in the United States at the end of 1974 at 1,137,377 ounces.

Canadian operations and developments

The platinum group metals produced in Canada were recovered as a byproduct from the treatment of the nickel–copper sulphide ores, principally those in the Sudbury district of Ontario and the Thompson–Wabowden region of Manitoba. In processing these ores for recovery of nickel and copper, the platinum metals concentrate in the sludge formed during the electrolytic refining of the nickel–copper anodes. The sludge produced by The International Nickel Company of Canada, Limited (Inco) is shipped to its refinery at Acton, England for the extraction and refining of the platinum metals. Falconbridge Nickel Mines Limited ships nickel–copper matte from its Falconbridge, Ontario plant to its refinery in Kristiansand, Norway. The sludge collected from this operation is shipped to Engelhard Minerals & Chemicals Corporation at Newark, New Jersey for recovery of the contained platinum metals. In Canada, the metal ratios of the platinum group metals are approximately 46 per cent platinum, 40 per cent palladium and 14 per cent other platinum metals.

Inco, the largest producer of platinum metals in Canada, operated twelve nickel–copper mines, five concentrators and a nickel-copper smelter in the Sudbury area, Ontario. Elsewhere in Ontario, Inco operated a nickel refinery at Port Colborne and a mine-concentrator complex at Shebandowan, near Thunder Bay. Falconbridge Nickel operated eight nickel–copper mines, three concentrators, and one smelter in the

*The term "ounce" refers to "troy ounce".

Table 1. Canada, platinum group metals, production and trade, 1973-74

	1973		1974p	
	(troy ounces)	$	(troy ounces)	$
Production[1]				
Platinum, palladium, rhodium, ruthenium, iridium	354,223	41,993,743	360,000	65,776,000
Exports				
Platinum metals in ores and concentrates				
United Kingdom	432,312	31,267,000	487,289	53,904,000
Norway	14,623	1,864,000	33,014	4,224,000
United States	203	18,000	614	87,000
Total	447,138	33,149,000	520,917	58,215,000
Platinum metals				
United States	8,668	659,000	21,469	2,985,000
United Kingdom	4,667	758,000	4,638	467,000
Switzerland	—	—	193	41,000
Other countries	124	13,000	54	11,000
Total	13,459	1,430,000	26,354	3,504,000
Platinum metals in scrap				
United States	26,130	2,731,000	27,846	4,279,000
United Kingdom	5,516	838,000	3,026	522,000
Total	31,646	3,569,000	30,872	4,801,000
Re-export[2]				
Platinum metals, refined and semiprocessed	49,762	5,248,000	37,873	3,680,000
Imports				
Platinum lumps, ingots, powder and sponge				
United Kingdom	8,119	1,339,000	1,914	311,000
United States	2	...	97	26,000
Switzerland	50	8,000	—	—
Total	8,171	1,347,000	2,011	337,000
Other platinum group metals in lumps; ingots, powder and sponge				
United States	13,357	816,000	25,048	3,567,000
United Kingdom	26,500	2,259,000	16,380	2,454,000
South Africa	11,101	895,000	5,685	489,000
Japan	4,823	338,000	—	—
Total	55,781	4,308,000	47,113	6,510,000
Total platinum and platinum group metals				
United States	13,359	816,000	25,145	3,593,000
United Kingdom	34,619	3,598,000	18,294	2,765,000
South Africa	11,101	895,000	5,685	489,000
Japan	4,823	338,000	—	—
Switzerland	50	8,000	—	—
Total	63,952	5,655,000	49,124	6,847,000

Table 1. (concl'd)

	1973		1974p	
	(troy ounces)	$	(troy ounces)	$
Imports (concl'd)				
Platinum crucibles[3]				
United States	25,517	4,118,000	18,750	3,480,000
Platinum metals, fabricated materials, not elsewhere specified				
United Kingdom	25,575	3,532,000	30,119	4,744,000
United States	5,227	422,000	26,877	1,576,000
Total	30,802	3,954,000	56,996	6,320,000

Source: Statistics Canada.
[1] Platinum metal, content of concentrates, residues and matte shipped for export. [2] Platinum metals, refined and semiprocessed, imported and re-exported after undergoing no change or alteration. [3] Includes spinnerets and bushings.
p Preliminary; — Nil; ... Less than one thousand dollars.

Sudbury district. In the Timmins area, the Langmuir mine, owned 51 per cent by Noranda Mines Limited and 49 per cent by Inco shipped its concentrate to the Inco smelter at Copper Cliff and Kanichee Mining Incorporated, near Temagami, shipped its concentrate to Falconbridge Nickel's smelter.

Three companies in Manitoba mined nickel–copper sulphide ores containing platinum metals. Inco operated three mines and a concentrator–smelter–refining complex in the Thompson region. At Wabowden, Falconbridge Nickel operated a mine and concentrator and shipped the concentrates to its smelter in Ontario. Ore from Dumbarton Mines Limited in the Bird River area, was custom treated at the Werner Lake concentrator of Consolidated Canadian Faraday Limited in Ontario. The nickel–copper concentrate produced was shipped to the Falconbridge smelter. The hydrometallurgical process used by Sherritt Gordon Mines Limited to recover nickel from its Lynn Lake mine does not lend itself to the economic recovery of platinum metals.

A palladium–platinum discovery was made in 1974 in the Lac des Iles area about 55 miles north of Thunder Bay, Ontario. An exploration program was carried out by Boston Bay Mines Limited. Diamond drill results have indicated two zones containing significant values in palladium with lesser amounts of platinum, the ratio of palladium to platinum being about 8 to 1. Further work will be required to determine the economic merits of the deposit.

Foreign developments

Republic of South Africa. Producers of platinum metals in the Republic of South Africa, the largest suppliers in the noncommunist world, continued their expansion programs initiated in 1972 and 1973 to increase the output of platinum metals to meet anticipated increases in general industrial and jewellery usages, and to satisfy the needs of the automotive industry in the United States for catalytic converters containing platinum metals.

The Republic of South Africa is the only country that mines platinum-bearing ores primarily for the recovery of platinum metals. The deposits, which occur in the Merensky Reef horizon near Rustenberg also contain some gold, copper and nickel. Platinum group metals recovered from the ores contain approximately 70 per cent platinum, 25 per cent palladium and 5 per cent other platinum group metals. Small amounts of osmium and iridium were recovered as byproducts from the treatment of gold ores.

Rustenberg Platinum Mines Limited, the largest platinum metals producer in the noncommunist world, announced in 1972 that its production capacity was to be increased to 1,525,000 ounces a year by 1976. The company operated three mines, a smelter and a refinery in the Transvaal district; two mines being in the Union section and one in the Rustenberg section of the Transvaal. Production at these mines will be increased to 1,300,000 ounces. A new mine, Amadelbult, was being developed in the Transvaal for an initial annual output of 225,000 ounces of platinum metals. This new operation will give the company flexibility to adjust to possible fluctuations in future demands for platinum. The refinery of Matthey Rustenberg Refineries (Proprietary) Limited in South Africa, jointly owned by Johnson Matthey & Co., Limited and Rustenberg was being expanded to recover approximately 1.2 million ounces of precious metals annually, including about one million ounces of platinum with

Table 2. Canada, platinum group metals, production and trade, 1965-74

	Production[1]		Exports				Imports[4]	
			Domestic[2]		Re-export[3]			
	(ounces)	($)	(ounces)	($)	(ounces)	($)	(ounces)	($)
1965	463,127	36,109,799	551,022	30,103,254	321,950	11,389,395	233,603	13,461,546
1966	396,059	32,370,064	441,625	25,800,000	199,152	11,779,822	197,853	14,930,000
1967	401,263	34,668,915	475,855	29,829,000	164,033	9,087,955	212,889	13,161,000
1968	485,891	46,199,718	584,942	38,068,000	83,228	8,254,753	207,961	17,077,000
1969	310,404	30,881,016	463,500	35,306,000	52,694	5,247,240	118,946	9,300,000
1970	482,428	43,556,597	650,066	43,174,000	20,399	2,365,735	60,745	3,123,000
1971	475,169	39,821,616	224,796	23,917,000	35,523	3,185,000	53,608	3,298,000
1972	406,048	34,656,545	614,848	35,150,000	33,376	4,542,000	47,719	2,858,000
1973	354,223	41,993,743	447,138	33,149,000	49,762	5,248,000	63,952	5,655,000
1974p	360,000	65,776,000	520,917	58,215,000	37,873	3,680,000	49,124	6,847,000

Source: Statistics Canada.
[1] Platinum metals, content of concentrates, residues and matte shipped for export. [2] Platinum metals in ores and concentrates and platinum metals, refined. [3] Platinum metals, refined and semiprocessed, imported and re-exported after undergoing no change or alteration. [4] Imports of refined and semiprocessed platinum metals, derived from Canadian concentrates and residues, a large part of which is re-exported.
p Preliminary.

the remainder being comprised of gold and other platinum group metals. Refining operations are also carried out in the United Kingdom by Matthey Refiners Limited, a subsidiary of Matthey Rustenberg Refiners.

Impala Platinum Limited operated a mine–concentrator–refinery complex near Rustenberg. The capacity of its refinery was increased in 1974 to an annual capacity of 850,000 ounces of platinum a year, thereby completing the major part of an expansion program planned to produce 950,000 ounces a year. Problems were encountered in bringing production up to capacity and, towards the end of 1974, the plant operated at an equivalent rate of 600,000 ounces of platinum a year. Labour was in short supply because some workmen recruited by the Chamber of Mines of South Africa for the platinum mines were diverted to gold mines which experienced unexpected labour shortages. Also, recruitment of mine labour from Malawi was suspended in April 1974 by the government of that country.

The Middlekraal mine–concentrator–smelter–refinery complex of Western Platinum Limited, jointly owned by Lonrho Limited, Falconbridge Nickel Mines Limited and Superior Oil Company, operated a plant at a rated capacity of 150,000 ounces of platinum metals a year. Production for the fiscal year ending September 30, 1974 was 139,000 ounces of platinum group metals compared with 109,000 ounces in 1973. A refinery, with an annual rated capacity of 150,000 ounces of platinum metals a year, designed to recover platinum, palladium and gold, was officially opened about the middle of 1974. Residues containing other platinum metals will be stockpiled for recovery at a later date.

Atok Platinum Mines (Propietary) Limited, near Pieterburg, Transvaal, plans to increase its plant capacity to an annual rate of 40,000 ounces of platinum metals.

U.S.S.R. In the U.S.S.R. platinum metals were derived mainly as a byproduct from mining nickel–copper ores in the Norilsk region of Siberia and the Kola Peninsula of northwest Russia. Small amounts of platinum metals were recovered from placer deposits in the Southern Urals. Output in 1974 was estimated at 2.60 million ounces compared with 2.45 million ounces in 1973. The U.S.S.R. was carrying out a major expansion program in the Norilsk region to increase nickel production. The first phase of this program, the preparation of a new mine to feed a new smelter complex was expected to be completed in 1975. The second phase, which involves bringing a second mine into production, was expected to be completed by 1980. This expansion program should contribute substantially to the quantity of platinum metals produced in the U.S.S.R., especially palladium, as the ratio of the palladium to platinum content of the ores is high.

United States. Mine production of platinum metals in the United States was derived from placer deposits in the Goodnews Bay area of Alaska and as a byproduct of gold and copper refining. The United States also recovered a substantial quantity of platinum metals from secondary sources. In 1974 the United States

Bureau of Mines estimated new and secondary platinum metals recovered by refiners in the United States at 338,450 ounces. New production was estimated at 18,000 ounces.

Johns-Manville Corporation carried out an extensive exploration program on its platinum holdings in Sweetgrass County, Montana. Significant values in palladium and platinum have been obtained, the ratio being approximately one part platinum to three parts palladium. The company plans to carry out an underground exploration program.

Colombia. Production of platinum metals in Colombia was estimated at 26,000 ounces in 1974, about the same as in the previous year, and was recovered from placer operations in the Choco district.

Uses

The industrial uses of platinum group metals are based on special properties; the principal ones being catalytic activity, resistance to corrosion and to oxidation at elevated temperatures, good electrical properties, high melting point, high strength, good ductility and aesthetic qualities. Platinum and palladium are the major platinum metals. The others, namely iridium, osmium, rhodium and ruthenium, are mainly used as alloying elements with platinum and palladium, but small amounts are also used in special applications.

Platinum metal catalysts find wide application in the petrochemical, chemical and pharmaceutical industries. A major new use for platinum and palladium resulted from the development of catalytic converters for installation on automotive vehicles for sale in the United States to meet the exhaust emission standards established by the Environmental Protection Agency (EPA) to reduce air pollution. Platinum and palladium catalysts are currently used on a limited scale in emission control systems where clean exhausts are required, and in catalytic incineration systems for fume abatement.

Platinum catalysts are used in the petroleum industry for the production of high-octaine gasoline. The platinum catalytic exhaust control system in automobiles requires lead-free gasoline because lead fouls the catalyst and destroys its effectiveness. To obtain a satisfactory octane rating in unleaded or low-lead gasoline requires further reforming and thereby increases the demand for platinum alloy catalysts used in the process. A platinum–rhenium catalyst has been found to be effective in this application, but a drawback to its use is the small potential supply of rhenium metal.

A major use of platinum, especially in Japan, is in jewellery. A platinum–rhodium alloy is used in bushings in the manufacturing of fibre glass, in spinnerets in the production of synthetic fibres, in electrical furnaces and in thermocouples.

Platinum metals have many other applications, e.g., in the computer field, in electrical and laboratory equipment and in the dental and glass-making industries. Another application is in the cathodic protection of ships' hulls. A major use of palladium is in electrical contacts for telephone equipment, but the relatively high price of the metal has led to the use of substitutes in this application. Because of its resistance to corrosion at high temperatures, iridium crucibles are used for the growing of laser crystals and synthetic gems.

Prices

The quoted producer and dealer prices for platinum, palladium, iridium, and rhodium increased sharply during 1974, while the prices of osmium and ruthenium remained unchanged. The producer price of platinum was quoted in *Metals Week* at $158–163 (U.S.) an ounce at the beginning of 1974 and increased

Table 3. World mine production of platinum group metals 1972-74

	1972	1973	1974[e]
		(troy ounces)	
Republic of South Africa	1,453,000	2,362,800	3,000,000
U.S.S.R.	2,350,000	2,450,000	2,600,000
Canada	406,048	354,223	360,000
Colombia	24,111	26,358	26,000
United States	17,112	19,980	18,000
Other countries	18,319	26,420	27,000
Total	4,268,590	5,239,781	6,031,000

Sources: U.S. Bureau of Mines *Minerals Yearbook Preprint 1973* for 1972 and 1973. Bureau of Mines, Commodity Data Summaries, January 1975 for 1974; Statistics Canada for Canadian production.
[e] Estimated.

in stages until a price of $190–200 was established on June 30 and which remained unchanged for the balance of the year. Rapidly rising inflation and problems related to the unsettled world monetary situation, led to considerable speculative buying of precious metals and the dealer price for platinum in the first part of the year was about $30–70 an ounce above the producer price. In the latter part of 1974 the demand for platinum by industry weakened because of reduced business activity and speculative interest in the metal declined forcing the dealer price to fall $20–25 an ounce below the producer price.

Palladium followed a similar pattern to that of platinum. The producers' price at the beginning of 1974 was $84–86 (U.S.) an ounce and increased in stages until a price of $150–155 was established on May 1, at which level it remainded for the balance of the year. This price increase brought the producer and dealer prices into line. However, the dealer price gradually declined and at the end of the year was $30–35 an ounce below the producer price. The U.S.S.R. is the world's major producer of palladium metal and, as a result, has a strong influence on determining the selling price of the metal. Despite the substantial difference between the producer and dealer prices in the latter part of the year the U.S.S.R. maintained its price at $150 (U.S.) an ounce. A tight supply situation for both iridium and rhodium in 1974 forced sharp price increases in both the producer and dealer prices. At the beginning of January the iridium producer price was quoted at $285–290 (U.S.) an ounce and increased in price to $500–510 on October 14, at which level it remained for the rest of the year. The dealer price opened the year at $525–570 an ounce and then increased in price until it reached a high of $800–850 on May 16; thereafter the price declined and at the end of 1974 was quoted at $575–650 an ounce. On January 1 the producer price for rhodium was quoted at $270–275 (U.S.) an ounce and increased to $350–360 on June 3, at which level it remained for the balance of the year. The rhodium dealer price at the beginning of the year was $425–450 an ounce and at year-end it was $500–550. A high of $715–740 an ounce was recorded on May 23. Throughout 1974 the producer and dealer prices of osmium remained at $200–250 (U.S.) an ounce and $140–165 an ounce respectively. Corresponding prices for ruthenium were $60–65 (U.S.) an ounce and $48–60 an ounce, respectively.

Outlook

The short-term outlook for platinum and palladium is for supply to be more than adequate to meet demand. When it appeared that there would be a strong demand for platinum in catalytic converters to be installed on all automobiles manufactured for sale in the United States, to comply with the established exhaust emission standards, the producers of platinum in the Republic of South Africa initiated an expansion program to increase the capacity of its plants to about 2.66 million ounces of platinum metals a year. As a result of smaller amounts of platinum and palladium required for catalytic converters than originally estimated and a decrease in automobiles sales in the United States, a surplus developed.

In South Africa, unlike Canada and the U.S.S.R., where the platinum metals output depends on nickel production, the mine producers can lower their platinum metal output to meet world requirements because their ores are mined primarily for platinum metals content. Early in 1974 the major producers in South Africa announced that steps were being taken to curtail production to correct the situation of oversupply.

Near the end of the second quarter of 1974, the President of the United States signed into law a bill which retained the interim automobile exhaust emission standards through the model-year 1976 and also gave the Environmental Protection Agency the authority to extend the interim standards through the model-year 1977. Some consideration was also given to extending the emission standards for a further five years because of problems related to energy shortage. Considerable research is being done to develop a catalytic converter for the automotive industry that does not require any precious metal. Further research is in progress to develop an automotive engine that does not require a catalytic converter in order to meet the United States exhaust emission standards. These factors indicate that the consumption of platinum by the automotive industry faces an uncertain future both in the short- and long-term. General Motors Corporation was strongly committed to platinum catalytic converters and will install them on most of their 1975 model automobiles sold in the United States and Canada. Most of the 1975 model automobiles manufactured by Ford Motor Company and Chrysler Corporation for the United States market will have catalytic converters, but those manufactured for the Canadian market will not have converters because they are not required to meet Canadian emission standards. Platinum catalytic converters will be required on all automobiles sold in the Japanese market, beginning in April 1975. This will improve the demand for platinum.

Although the market for platinum metals is weak at the present time it is expected that in the long-term the demand for these metals in the chemical, petroleum, jewellery, glass and electrical industries will have an upward trend. The uncertainty in the economic field has resulted in the purchase of platinum by speculators and investors, and a continuation of inflationary pressures could lead to increased purchases by these groups.

United States' prices of platinum group metals, 1974 as reported in Metals Week.

	Producers	Dealers
	(U.S. $ per troy ounce)	
Iridium		
January 1 – January 27	285–290	525–600
January 28 – February 25	300–305	560–610
February 26 – April 22	310–315	600–725
April 23 – May 8	400–405	700–725
May 9 – August 1	400–405	775–850
August 2 – October 13	400–410	650–780
October 14 – December 18	500–510	650–775
December 19 – December 31	500–510	575–650
Osmium		
January 1 – December 31	200–225	140–165
Palladium		
January 1 – January 27	84–86	83–93
January 28 – February 16	90–92	93–100
February 17 – February 25	90–99	98–104
February 26 – March 27	97–99	101–125
March 28 – April 1	97–122	126–131
April 2 – April 30	125–127	126–152
May 1 – November 25	150–155	129–152
November 26 – December 31	150–155	118–131

	Producers	Dealers
	(U.S. $ per troy ounce)	
Rhodium		
January 1 – January 27	270–275	425–520
January 28 – February 25	285–290	475–540
February 26 – March 27	310–315	530–600
March 28 – May 29	310–315	650–740
May 30 – June 2	310–360	715–740
June 3 – December 11	350–360	575–725
December 12 – December 31	350–360	500–550
Ruthenium		
January 1 – December 18	60–65	55–60
December 19 – December 31	60–65	48–53
Platinum		
January 1 – January 27	158–163	163–184
January 28 – May 29	170–175	185–250
May 30 – June 2	170–210	201–207
June 3 – August 28	190–200	171–212
August 29 – December 31	190–200	165–195

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General	General Preferential*
36300 – 1	Platinum wire and platinum bars, strips, sheets or plates; platinum, palladium, iridium, osmium, ruthenium and rhodium, in lumps, ingots, powder, sponge or scrap	free	free	free	free
48900 – 1	Crucibles of platinum, rhodium and iridium and covers therefore	free	free	15%	free

*General Preferential Tariff rate from July 1, 1974 to June 30, 1984

United States

Item No.		Rate of Duty
601.39	Precious metals ores	free
605.02	Platinum metals, unwrought, not less than 90% platinum	free

Tariffs (concl'd)

United States (concl'd)

		On and After Jan. 1, 1972
605.03	Other platinum metals, unwrought	20%
605.05	Alloys of platinum, semimanufactured, gold-plated	25%
605.06	Alloys of platinum, semimanufactured, silver-plated	12%
605.08	Other platinum metals, semimanufactured, including alloys of platinum	20%
605.60	Platinum leaf	20%

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Potash

B.W. BOYD

In 1974 world production of potash reached 26,000,000 tons*, an increase of 12 per cent over 1973 production of 23,000,000 tons. Canada and the U.S.S.R. were the largest contributors to the increase and together accounted for over half the world total supply. For the second consecutive year consumption exceeded production, with the results that potash prices increased during the year and producer inventories were depleted.

The bulk of world potassium production is in the form of potassium chloride (KC1) known in the industry as muriate of potash, used in the production of fertilizer. All Canadian potash production is marketed as potassium chloride, with a potassium content of about 50 per cent (60–62 per cent K_2O equivalent). This product is marketed in the United States, in offshore countries and domestically; in the ratio of 66.8 per cent to 28.6 per cent to 4.6 per cent. The high percentage of exports led to Canada's near 40 per cent share of international potash trade. Canpotex Limited, the industry's offshore marketing unit, penetrated several new markets in 1974 including; Costa Rica, Guatemala, El Salvador, Colombia, Ecuador, Peru, South Viet Nam and southwest Africa.

Production and developments in Canada

Saskatchewan. Canadian production of 6,058,048 tons of potash in 1974 increased 28.9 per cent over 1973 production, but remained below rated capacity. There are ten potash mines in Canada (all in the province of Saskatchewan) with an installed productive capacity of 13,680,000 tons of potassium chloride (8,324,200 tons K_2O equivalent). During the year, production allowables were raised five times as world demand increased so that on August 21 the allowables equalled the capacity at each mine. Unfortunately, shortages of manpower and mining equipment, as well as bottlenecks which limited mine-hoisting capacities prevented the industry from producing at rated capacity.

The value of potash sales totalled $303,490,000, according to the Saskatchewan Department of Mineral Resources. This revenue represents an average price of 49 cents a short ton unit K_2O equivalent (1 short ton unit = 20 pounds). The average price a short ton unit K_2O equivalent paid for shipments within Canada was 50 cents, to the United States 51 cents and for offshore exports was 45 cents, fob mine. These prices were somewhat lower than realized average price fob New Mexico for potash produced in the United States. During the year, posted prices were raised four times and realized prices rose by 40 to 50 per cent. On August 21 the Saskatchewan Department of Mineral Resources announced that producing licenses for 1974–75 were no longer subject to the minimum price of 33.75 cents a unit K_2O equivalent. The minimum price which had been established in 1970 as part of the province's prorationing regulations to stabilize the industry is no longer relevant.

According to the Saskatchewan Department of Mineral Resources, producer stocks at the end of 1974 stood at 267,996 tons which is about half the level recorded at the end of 1973 and one-fifth the amount in inventory at the end of 1972 when stocks were at an all-time high. It is reported that consumer stocks of fertilizer were fairly high at the end of 1974 so that demand early in 1975 may not cause reductions in producers' stockpiles.

On October 23, 1974 the Minister of Mineral Resources for Saskatchewan announced a new potash policy with the following three major elements:

the provincial government would have majority control or full ownership of any new potash mines in Saskatchewan;

the Saskatchewan government has offered to participate in the cost of financing expansion of the existing mines in return for equity in the mine; and

a reserve tax calculated on a formula involving the following factors: productive capacity; grade of ore; capital cost; and selling price of potash in arm's-length transactions.

The reserve tax was imposed retroactive to July 1, 1974 and will effectively represent part of the province's share of profits arising from increased potash prices. At a price of $60 a ton K_2O equivalent the new tax would yield to the provincial government about $10 for each ton sold. The new tax is expected to produce about $87 million in revenue for the province in 1975.

By year-end 1974 a decision was still pending in the legal case of Central Canada Potash Co. Limited and

(text continued on page 405)

*Unless otherwise noted, potash tonnages are in short tons of K_2O equivalent.

Table 1. Canada, potash production, shipments and trade, 1973-74

	1973		1974p	
	(short tons)	$	(short tons)	$
Production, potassium chloride				
Gross weight[1]	7,682,452	. .	9,910,876	. .
K_2O equivalent	4,698,046	. .	6,058,048	. .
Shipments				
K_2O equivalent	4,909,438	176,875,825	6,072,000	303,490,000
Imports, fertilizer potash				
Potassium chloride				
United States	5	2,000	330	48,000
West Germany	103	38,000	11	5,000
United Kingdom	—	—	3	—
Total	108	40,000	344	53,000
Potassium sulphate				
United States	24,190	1,107,000	24,396	1,396,000
Potash fertilizer, nes				
United States	49,342	1,130,000	56,920	1,670,000
Mexico	74	1,000	—	—
Total	49,416	1,131,000	56,920	1,670,000
Potash chemicals				
Potassium carbonate	1,165	212,000	1,632	369,000
Potassium hydroxide	1,918	349,000	2,153	468,000
Potassium nitrate	3,077	487,000	3,656	782,000
Potassium phosphate	2,465	695,000	3,801	1,435,000
Potassium bitartrate	120	88,000	76	152,000
Potassium silicates	1,041	167,000	937	184,000
Total potash chemicals	9,786	1,998,000	12,255	3,390,000
Exports, fertilizer potash				
Potassium chloride				
United States	5,751,958	133,542,000	6,977,287	216,084,000
Japan	663,808	16,028,000	864,055	17,454,000
India	237,763	6,509,000	469,433	9,204,000
Brazil	149,208	3,035,000	462,423	9,002,000
South Korea	218,366	5,600,000	259,561	5,503,000
People's Republic of China	58,652	1,368,000	216,320	4,239,000
Taiwan	35,882	903,000	117,445	2,570,000
Singapore	87,641	1,929,000	162,379	2,520,000
Belgium and Luxembourg	390,708	8,096,000	94,725	1,918,000
Australia	75,942	1,697,000	55,252	1,103,000
France	33,918	687,000	47,387	920,000
Other countries	154,846	4,512,000	243,205	5,156,000
Total	7,858,692	183,906,000	9,969,472	275,673,000

Sources: Statistics Canada; Saskatchewan Department of Mineral Resources for K_2O production figures.
[1] Based on a conversion factor of K_2O x 1.64 for standard, special standard, granular and coarse grades, and K_2O x 1.60 for soluble and chemical grades.
p Preliminary; — Nil; . . Not available.

Table 2. Canada, summary of potash mines and production allowables

Company and location	Initial Production	Production Capacity		Production Allowables (short tons K_2O equivalent)				
		KCl	K_2O equiv.	Jan/18/74	Mar/04/74	April/04/74	June/25/74	Aug/21/74
		(short tons)						
Saskatchewan								
International Minerals & Chemical Corporation (Canada) Limited, Esterhazy	1962	2,100,000	1,280,000	1,741,700	1,741,700	1,825,573	2,096,803	2,330,000
	1967	1,720,000	1,050,000					
Kalium Chemicals Limited, Belle Plaine	1964	1,500,000	937,500	633,299	651,291	645,732	741,842	937,500
Potash Company of America, Saskatoon	1965	760,000	460,000	300,428	319,083	388,059	363,997	460,000
APM Operators Ltd., Allan	1968	1,500,000	912,000	614,807	614,807	729,376	776,217	912,700
Alwinsal Potash of Canada Limited, Lanigan	1968	1,000,000	600,000	401,863	409,110	439,637	474,779	600,000
Duval Corporation of Canada, Saskatoon	1968	1,200,000	732,000	517,270	546,955	578,645	579,230	732,000
Cominco Ltd., Vanscoy	1969	1,200,000	720,000	384,127	344,364	412,240	569,734	720,000
Central Canada Potash Co. Limited, Colonsay	1969	1,500,000	900,000	638,499	674,998	743,145	712,168	900,000
Hudson Bay Mining and Smelting Co. Limited, Rocanville	1970	1,200,000	732,000	543,238	572,923	691,166	579,230	732,000
Total		13,680,000	8,324,200	5,775,231	5,875,231	6,453,573	6,894,000	8,324,200

Source: Department of Mineral Resources, Saskatchewan.

Table 3. Canada, potash production and sales by grade[1] and destination, 1973-74

	1974							
	Standard	Special Standard	Coarse	Granular	Soluble	Chemical	Total	1973
	(short tons K_2O equivalent)							
Production	1,808,007	336,536	2,083,559	1,221,865	512,810	95,271	6,058,048	4,684,179
Sales								
Domestic	33,886	327	233,752	18,858	7,089	216	294,128	212,235
United States	832,567	38,306	1,632,771	1,201,633	424,924	98,447	4,228,648	3,683,169
Offshore								
Anguilla	—	—	61	—	—	—	61	—
Australia	8,623	—	17,411	10,339	—	—	36,373	54,533
Bangladesh	—	—	45	4,264	—	—	4,309	10,482
Belgium	—	—	—	—	—	—	—	250,022
Brazil	86,712	—	212,490	7,896	—	—	307,098	75,692
Chile	10,451	—	—	—	—	—	10,451	17,571
Colombia	10,482	6,119	—	4,079	—	—	20,680	—
Costa Rica	8,491	—	2,605	—	—	—	11,096	—
Cuba	19,624	—	—	—	—	—	19,624	2,751
Ecuador	7,074	—	—	8,350	—	—	15,424	—
England	1,953	6,987	16,965	2,925	—	1,338	30,168	998
France	5,670	8,054	5,714	—	—	—	19,438	23,853
Guatemala	1,984	—	—	—	—	—	1,984	—
Guyana	—	—	—	710	—	—	710	—
Holland	—	—	—	—	—	—	—	3,255
Hong Kong	268,803	—	—	—	—	—	—	27,432
India	—	—	—	—	—	—	268,803	197,537
Indonesia	21,397	—	—	—	—	—	21,397	16,731
Italy	10,085	—	—	—	—	—	10,085	21,667
Japan	77,764	249,397	51,711	4,720	117,056	—	500,648	406,195
North Korea	—	—	—	—	9,664	—	9,664	88,850
South Korea	148,198	17,192	—	—	—	—	165,390	48,864
Malaysia	57,844	—	—	1,846	—	—	59,690	31,447
New Zealand	10,838	—	—	—	—	—	10,838	47,195
Pakistan	—	—	—	—	—	—	—	2,010
Peru	7,748	—	—	—	—	—	7,748	—
Philippines	22,998	—	—	—	—	—	22,998	24,984
People's Republic of China	137,935	—	—	—	—	—	137,935	—
Salvador	6,584	—	—	—	—	—	6,584	—
Singapore	3,151	—	—	581	—	—	3,732	6,525
South Africa	—	—	—	—	—	—	—	3,060
Southwest Africa	—	—	3,420	—	—	—	3,420	—
South Viet Nam	23,250	—	—	2,718	—	—	25,968	—
Taiwan	77,242	—	—	—	—	—	77,242	20,077
Turkey	—	—	—	—	—	50	50	—
Offshore Total	1,034,901	287,749	310,422	48,428	126,720	1,388	1,809,608	1,381,731
Total Sales	1,901,354	326,382	2,176,945	1,268,919	558,733	100,051	6,332,384	5,277,135

Source: Saskatchewan Department of Mineral Resources, Monthly Potash Report.
[1] Common specifications are: standard −28 to +65 mesh, special standard −35 to +200 mesh, coarse −8 to +28 mesh, granular −6 to +20 mesh, each grading a minimum of 60 per cent K_2O equivalent; soluble and chemical grade a minimum of 62 per cent K_2O equivalent.
— Nil.

the Attorney-General of Canada *versus* the Government of Saskatchewan and others, concerning the prorationing regulations instituted in 1969. The plaintiffs want the regulations declared *ultra vires* of the provincial government, and Central Canada Potash Co. Limited is seeking damages in excess of $2,000,000. The prorationing regulations were suspended in August 1974, but the settlement of the case may affect future provincial legislation.

Table 4. Posted prices for muriate of potash

Grade and % K_2O min.	Feb.-June/74	July-Aug./74	Sept. 74	Oct./74 Jan./75
	(cents/short ton unit, fob Saskatchewan)			
Standard 60-62	52	52	54	57
Coarse 60-62	55	55	58	61
Granular 60-62	57	57	60	63
Soluble 62	55	57	59	63

Source: Price schedules of various potash companies.

Table 5. Realized prices for potash

Grade	Jan. 74	Feb.-June/74	July-Sept./74	Oct.-Dec./74
	(cents/short ton unit, fob Saskatchewan)			
Standard	38	42	46	53
Coarse	41	47	54	59
Granular	42	49	56	62
Soluble	38	44	57	60

Source: Saskatchewan Department of Mineral Resources, *Monthly Potash Report*.

New Brunswick. The Potash Company of America (a subsidiary of Ideal Basic Industries) continued its drilling program near Sussex. Although results indicate some continuation of the potash horizon drilled in 1973 assessment is difficult because of structural complexity within the deposit. Evaluation will continue in 1975.

A joint drilling program of the federal department of Regional Economic Expansion and the New Brunswick government led to discovery of evaporite beds at Salt Springs, 12 miles southwest of Sussex. A single drill hole intersected 50 feet of sylvinite averaging 31.6 per cent K_2O and a percentage of NaCl. In 1975 the New Brunswick government will evaluate proposals by private corporations for the exploration and development of potash and salt (NaCl) in a 77 square mile area around the drill hole.

Nova Scotia. Amax Exploration, Inc., International Minerals & Chemical Corporation (Canada) Limited and St. Joseph Explorations Limited have taken out exploration licenses with the Nova Scotia government. All three companies will be searching for potash in the Antigonish and Stewiacke regions of the province.

Ontario. Because of pollution control problems, the potassium sulphate plant of Shamrock Chemicals Limited, which opened in 1972, was inoperative for the second year in a row.

Markets

About 95 per cent of the world's potash output is used as fertilizer; the balance for industrial purposes including the manufacture of soaps, glass, ceramics, textiles, dyes, explosives and numerous chemicals. In Canada, potash consumption totalled some 360,000 tons in 1974, and all but 11,000 tons was used as fertilizer. Deliveries of Canadian potash to consumers in Canada totalled 294,128 tons, distributed mainly to farm communities in Southern Ontario, Quebec and the Maritime Provinces.

The United States imported 67 per cent of Canadian potash shipments and final deliveries reached nearly every state in the union. The 4,228,648 tons imported represented a 15 per cent increase over shipments in 1973 and amounted to over 70 per cent of the potash distributed in the United States market. The six states consuming the most potash, Illinois, Iowa, Indiana, Ohio, Minnesota and Georgia are supplied chiefly from Canada as are eight of the twelve other major potash consuming states (over 100,000 tons K_2O equivalent each, annually). The portion of the market not served by Canada is supplied from potash mines in New Mexico, Utah and California and imports from Israel.

Overseas sales of potash increased by 31 per cent to 1,809,608 tons in 1974, as Canpotex Limited increased Canadian shipments to Japan, Brazil, India, South Korea and Republic of China each of which received more than 100,000 tons K_2O equivalent from Canada in 1974. The only large market lost was Belgium, which imported 250,000 tons in 1973 and none in 1974.

In July a new ocean freight and shipping brokerage company "Canpotex Shipping Services Limited" was formed by Canpotex to handle ocean shipments of Canadian potash and a full range of other exports and imports through ports in British Columbia.

Imports of potassium chloride to eastern Canada remained very low at 344 tons KCl, well below the peak reached in 1972 when 69,120 tons were shipped from the United States. Imports of potassium sulphate were stable at around 24,000 tons K_2SO_4 although imports of potash fertilizers other than KCl or K_2SO_4 rose to 56,920 tons in 1974, up 7,504 tons over imports in 1973 and 28,087 tons over imports in 1972. Imports of potassium chemicals totalled 12,255 tons and have varied little over the past four years.

World review

In 1974, and for the fifth consecutive year, the U.S.S.R. ranked as the world's largest potash producer. New mines have been opened in the main producing areas in the Urals and Belorussiya, and more new mines and refineries are under construction. Problems in delivery of potash to domestic consumers have arisen from shortages of covered railway cars and storage space.

In June 1974, the U.S.S.R. and Occidental Petroleum Corporation (a U.S. company) signed contracts involving the manufacture and trade of fertilizers. The U.S.S.R. will supply potash, ammonia and urea as payment for phosphoric acid produced in the United States. As a new entrant into the United States market, the U.S.S.R. could affect fertilizer prices and market distribution after deliveries begin in 1978.

In the United States, Mississippi Chemicals Corporation has acquired what is reportedly the nation's largest known potash reserves at Carlsbad, N.M., through the purchase of the outstanding stock of Teledyne Potash Inc. The Company plans to construct new processing facilities at the site; the new plant will be completed in 1977. Mississippi Chemical currently uses 300,000 tons of potash annually at its Pascagoula fertilizer complex. At present, the company receives most of its potash from Saskatchewan and has also acquired two shipments of potash from the U.S.S.R.

Noranda Exploration Company, Limited, a U.S. subsidiary of Noranda Mines Limited, has acquired about 7,200 acres of potash property in New Mexico, from 32,000 acres on which it has an option, and plans to acquire another 3,800 acres next year.

International Minerals & Chemical Corporation began work on a $35 million expansion program to nearly double production of langbeinite ($K_2Mg_2(SO_4)_3$) at its Carlsbad mine. Additional langbeinite capacity is the primary objective of the expansion although some additional muriate of potash will result as a coproduct.

In Israel, production was adversely affected by the Arab-Israeli war. Capacity has been expanded by 30 per cent to a designed output of 790,000 tons a year. In 1974 production was below 670,000 tons and exports totalled 580,000 tons.

In France, potash production is expanding as a result of the rationalization program started in 1972. In the long-term, mine productivity should be increased by making greater use of cutting machines.

The World Food Conference held in Rome in November made vague promises of aid for the hungry, but commitments to provide food or fertilizers fell short of projected needs. One resolution asked international institutions to give high priority to financial assistance to developing countries for imports of fertilizers and fertilizer raw materials and recommended that the Food and Agriculture organization and other international groups organize a fertilizer plant assistance program. Other recommendations were for the formation of cooperatives, promotion of effective use of fertilizers and increased transfer of fertilizer technology into the less-developed countries. Potash was not specifically mentioned because this fertilizer ingredient is not as well established in the Third World as nitrogen and phosphorus.

Table 6. Canada, potash production and trade, years ended June 30, 1965-74

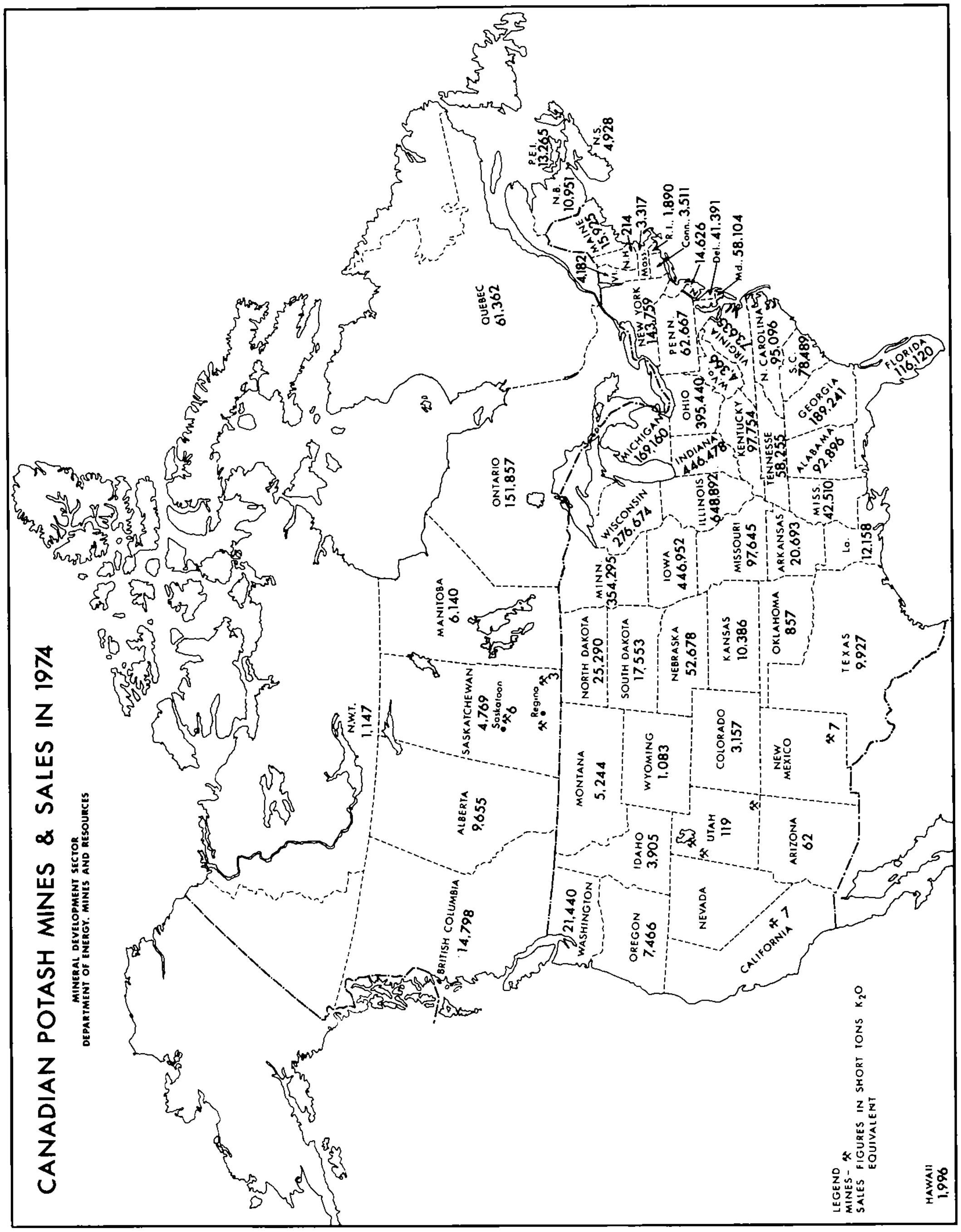
	Production	Imports[1]	Exports
	(short tons K_2O equivalent)		
1965	1,176,408	49,780	983,556
1966	1,927,843	34,522	1,676,174
1967	2,204,231	38,090	2,004,504
1968	2,971,206	32,900	2,723,471
1969	3,085,995	24,600	2,620,672
1970	3,930,662	27,020	3,648,384
1971[r]	3,422,430	28,010	3,319,284
1972	4,151,105	52,052	3,974,278
1973	3,994,685	69,009	3,889,330
1974	5,376,851	94,450	5,233,648

Source: Statistics Canada.
[1] Includes potassium chloride, potassium sulphate and sulphate of potash magnesia, except that contained in mixed fertilizers.
[r] Revised.

Table 7. Canada, consumption of potash fertilizers, years ended June 30, 1965-74

	In Materials	In Mixtures	Total
	(short tons K_2O equivalent)		
1965	18,264	117,142	135,405
1966	20,644	135,695	156,339
1967	27,806	150,336	178,142
1968	34,771	148,329	183,100
1969	40,967	144,560	185,527
1970	40,475	152,004	192,479
1971	46,831	156,362	203,193
1972[r]	48,340	226,057	274,397
1973	45,974	164,246	210,220
1974	48,870	173,840	222,710

Source: Statistics Canada.
[r] Revised.


CANADIAN POTASH MINES & SALES IN 1974
MINERAL DEVELOPMENT SECTOR
DEPARTMENT OF ENERGY, MINES AND RESOURCES
N.W.T. 1,147
BRITISH COLUMBIA 14,798
ALBERTA 9,655
SASKATCHEWAN 4,769
Saskatoon
Regina
MANITOBA 6,140
ONTARIO 151,857
QUEBEC 61,362
N.B. 10,951
P.E.I. 13,265
N.S. 4,928
MAINE 15,925
N.H. 214
Vt. 4,182
Mass. 3,317
R.I. 1,890
Conn. 3,511
N.J. 14,626
Del. 41,391
Md. 58,104
NEW YORK 143,759
PENN. 62,667
OHIO 395,440
MICHIGAN 169,160
INDIANA 446,478
ILLINOIS 648,892
WISCONSIN 276,674
MINN. 354,295
IOWA 446,952
MISSOURI 97,645
KENTUCKY 97,754
TENNESSE 58,235
N. CAROLINA 95,096
S.C. 78,489
GEORGIA 189,241
FLORIDA 116,120
ALABAMA 92,896
MISS. 42,510
La. 12,158
ARKANSAS 20,693
OKLAHOMA 857
TEXAS 9,927
KANSAS 10,386
NEBRASKA 52,678
SOUTH DAKOTA 17,553
NORTH DAKOTA 25,290
MONTANA 5,244
WYOMING 1,083
COLORADO 3,157
NEW MEXICO 7
IDAHO 3,905
UTAH 119
ARIZONA 62
NEVADA
CALIFORNIA 7
OREGON 7,466
WASHINGTON 21,440
HAWAII 1,996
LEGEND
MINES -
SALES - FIGURES IN SHORT TONS K_2O EQUIVALENT

Outlook

Producers of potash in Saskatchewan face several problems in bringing production up to capacity. Although prorationing is no longer in force, there are constraints from a shortage of labour and a long waiting period for new machines on order. Increases in capacity are unlikely under the present tax system in spite of the policy of the Saskatchewan government to help with financing in exchange for partial equity. A reported $200,000,000 in planned expansions have been postponed by the present producers pending more favourable treatment on combined federal and provincial taxes. However, the possibility exists for the opening of a new mine completely owned and financed by the Saskatchewan government consistent with the provincial policy. The rate of expansion is now in the hands of the provincial government.

Demand for potash in North America is expected to rise steadily in the short-run, although sales will be tied to the supplies of nitrogen and phosphorus, all used in mixed fertilizers. Consumer stockpiles of potash were built up in 1974 and may moderate the volume of shipments necessary to satisfy any increases in demand for 1975.

Offshore demand is expected to increase, especially in Latin America and Asia where Canada has been very successful in selling potash.

Production from the new Zielitz mine in East Germany, Boulby mine in the United Kingdom and imports from the U.S.S.R. will likely preclude any increase in North American Potash sales to Europe.

There is a possibility that a further shift in emphasis from North American to offshore sales will occur in 1975, most likely to India, Japan and Latin American countries. After 1975, incremental changes in world demand will open markets to the Canadian industry if it expands; otherwise the growing markets will be served by the increasing capacity in U.S.S.R. and East Germany.

Table 8. Canada, potash deliveries by product and area, 1973-74

		Agriculture						
		Potassium Chloride						
		Standard	Coarse	Granular	Soluble	Potassium Sulphate	Total Agriculture	Industrial
		(short tons K_2O equivalent)						
Atlantic Provinces	1973	3,012	20,497	—	—	671	24,180	—
	1974	1,304	27,746	—	31	574	29,655	—
Quebec	1973	9,039	37,360	112	—	2,156	48,667	326
	1974	4,857	54,393	1,812	—	2,861	63,923	187
Ontario	1973	16,041	118,346	1,330	162	10,981	146,860	4,558
	1974	5,760	136,857	5,871	101	11,382	159,971	5,780
Prairie Provinces	1973	583	2,454	3,823	724	19	7,603	2,671
	1974	447	3,979	6,880	1,981	20	13,307	1,887
British Columbia	1973	298	1,854	2,924	39	212	5,327	144
	1974	31	6,273	924	14	133	7,375	233
Northwest Territories	1973	—	—	—	—	—	—	901
	1974	—	—	—	—	—	—	1,652
Totals	1973	28,973	180,511	8,189	925	14,039	232,637	8,600
	1974	12,399	229,248	15,487	2,127	14,970	274,231	9,739

Source: Potash Institute of North America.
— Nil.

Table 9. World potash production, sales and inventories, 1972-74

	1972		1973		1974^p	
	Production	Sales	Production	Sales	Production	Sales[1]
	('000 short tons K_2O equivalent)					
U.S.S.R.^{e}	5,989	5,842	6,522	6,510	7,165	7,165
Canada	4,329	4,082	4,698	5,277	6,058	6,332
East Germany^e	2,709	2,712	2,818	2,789	3,158	3,158
West Germany^e	2,700	2,727	2,808	2,815	2,888	2,923
United States	2,659	2,618	2,603	2,865	2,545	2,549
France	1,775	1,819	2,239	2,157	2,285	2,343
Israel	638	602	585	948	661	1,213
Spain	588	589	522	..	459	..
Congo	313	301	292	284	314	308
Italy^e	165	165	..	..	..	..
Others	26	—	1,253	1,241	1,277	1,277
Total	21,891	21,457	24,340	24,886	26,810	27,268

Year-end producer inventories

	1972	1973	1974
U.S.S.R.^{e}	1,213	..	..
Canada	1,147	523	268
United States	469	206	160
East Germany^e	220	..	..
West Germany^e	88	..	..
France	88	..	..
Israel	67	..	..
Others	88	..	..
Total	3,379	..	..

Sources: Saskatchewan Department of Mineral Resources, U.S. Bureau of Mines, *The Journal of World, Phosphorus and Potassium, and World Mining*.
[1] Sales figures are for fertilizer year July 1973 – June 1974, except U.S.S.R., Canada and East Germany.
^{p} Preliminary; ^{e} Estimated; .. Not available.

Table 10. Canada, potash sales by destination

	1973^r	1974		1973^r	1974
	(short tons K_2O equivalent)				
Canada			**United States**		
Alberta	6,563	9,655	Alabama	54,384	92,896
British Columbia	7,243	14,798	Arizona	126	62
Manitoba	2,564	6,140	Arkansas	1,146	20,693
New Brunswick	12,297	10,951	California	—	7
Nova Scotia	3,339	4,928	Colorado	1,539	3,157
Ontario	123,744	151,857	Connecticut	4,306	3,511
Prince Edward Island	7,823	13,265	Delaware	35,511	41,391
Quebec	46,585	61,362	Florida	76,187	116,120
Saskatchewan	1,177	4,769	Georgia	108,863	189,241
Northwest Territories	900	1,147	Hawaii	6,188	1,996
Canada undetermined	—	15,256	Idaho	2,235	3,905
			Illinois	638,980	648,892
Total Canada	212,235	294,128	Indiana	460,931	446,478

Table 10(concl'd)

(short tons K_2O equivalent)

	1973[r]	1974
United States (concl'd)		
Iowa	378,882	446,952
Kansas	4,904	10,386
Kentucky	69,928	97,754
Louisianna	3,534	12,158
Maine	12,177	15,925
Maryland	49,838	58,104
Massachussetts	3,990	3,317
Michigan	145,066	169,160
Minnesota	345,815	354,295
Mississippi	17,726	42,510
Missouri	64,641	97,645
Montana	5,284	5,244
Nebraska	29,347	52,678
New Hampshire	352	214
New Jersey	16,200	14,626
New Mexico	120	—
New York	144,924	143,759
North Carolina	70,244	95,096
North Dakota	21,245	25,290
Ohio	363,095	395,440
Oklahoma	92	857
Oregon	4,902	7,466
Pennsylvania	63,636	62,667
Rhode Island	2,251	1,890
South Carolina	70,182	78,489
South Dakota	13,960	17,553
Tennessee	41,197	58,255
Texas	2,637	9,927
Utah	104	119
Vermont	5,560	4,182
Virginia	75,471	73,635
Washington	19,097	21,440
West Virginia	3,469	4,366
Wisconsin	241,394	276,674
Wyoming	1,509	1,083
Others	—	1,143
Total United States	3,683,169	4,228,648

	1973[r]	1974
Offshore		
Anguilla	—	61
Australia	54,533	36,373
Bangladesh	10,482	4,309
Belgium	250,022	—
Brazil	75,692	307,098
Chile	17,571	10,451
Colombia	—	20,680
Costa Rica	—	11,096
Cuba	2,751	19,624
Ecuador	—	15,424
England	998	30,168
France	23,853	19,438
Guatemala	—	1,984
Guyana	—	710
Holland	3,255	—
Hong Kong	27,432	—
India	197,537	268,803
Indonesia	16,731	21,397
Italy	21,667	10,085
Japan	406,195	500,648
North Korea	88,850	9,664
South Korea	48,864	165,390
Malaysia	31,447	59,690
New Zealand	47,195	10,838
Pakistan	2,010	—
Peru	—	7,748
Philippines	24,984	22,998
People's Republic of China	—	137,935
Salvador	—	6,584
Singapore	6,525	3,732
South Africa	3,060	—
Southwest Africa	—	3,420
South Viet Nam	—	25,968
Taiwan	20,077	77,242
Turkey	—	50
Total Offshore	1,381,731	1,809,608
Grand Total	5,277,135	6,332,384

Source: Saskatchewan Department of Mineral Resources, *Monthly Potash Report.*
[r] Revised; — Nil.

Rare Earths

G.E. WOOD

The rare earth elements, sometimes called the lanthanons or lanthanides, are a group of 15 chemically similar metals having atomic numbers 57 to 71 in Group III of the periodic table of elements. Scandium and yttrium are similar to the rare earth elements in many respects and are usually classed with them.

These elements are neither rare nor earths. By comparison, cerium is more abundant than tin or cobalt and almost three times as abundant as lead. Thulium, less common than all other rare earths except promethium, is more abundant than silver, gold and platinum combined. The metals were originally classified "rare" because they are seldom concentrated in nature like most other elements and their widespread occurrence in the earth's crust was recognized only in recent times. The term "earth" is derived from earlier terminology when insoluble oxides, the common compounds of rare earths, were simply referred to as earths.

Lanthanon-bearing minerals contain all members of the rare earth elements, but either the light (cerium) group or the heavy (yttrium) group predominates in each mineral. The rare earth metals are typically associated with alkaline complexes and pegmatites; and secondary concentration can occur in placer, beach sand and phosphatic sedimentary deposits. Commercial production has been derived from carbonatite occurrences, placer and beach sand deposits, uranium ores and phosphatic rocks. The relative abundance of the various rare earths in the ores presently being mined is not directly related to the market demand for the individual products. As a result, some rare earths products are readily available at low cost, while others, paricularly high-purity metal and compounds, are considerably more expensive. Research continues to explore the properties of the rare earth metals to identify potential new markets but, for some, no significant use has yet been found. Development has proceeded, first, to find markets for those compounds that are available and, second, to find and develop sources of supply to meet changing industrial requirements.

Advances in new markets have occurred at two- to three-year intervals for the past decade. Beginning with the traditional cigarette lighter flints and carbon-arc markets, new uses have grown in glass polishing compound, petroleum catalyst, television tube phosphor, nodular iron, high-strength low-alloy steel and high-strength magnet applications.

When colour television was introduced, the forecast for europium and yttrium consumption in phosphors was one of optimism which led to overproduction by 1967. Part of the problem was a slower than anticipated growth in the television market. A second factor was the overestimate of the quantity of rare earth metals to be used in each television set. Canadian production since 1967 has undergone drastic adjustments; yttrium concentrate suppliers have reduced shipments each successive year until 1971 when deliveries stopped. Shipments of yttrium concentrate from one Canadian producer were resumed in 1973 and continued in 1974.

New markets for specific members of the rare earth group have resulted in increased production of all rare earth metals because of their natural association in ores. Similarly, production costs for some rare earth members, byproducts of the refining process, have diminished. Availability and declining costs have been important factors in the development of new uses. There is growing optimism that the rare earth metals industry will expand at a steady rate now that several markets are well established.

Canadian Industry

From 1966 to 1970, the world's major source of yttrium concentrate was the uranium mines in the Elliot Lake District of Ontario. All rare earths, except promethium, have been detected in these ores. The Elliot Lake ores contain about 0.11 per cent uranium oxide (U_3O_8), 0.028 per cent thorium oxide (ThO_2) and 0.057 per cent rare earth oxides (REO).

Denison Mines Limited, which resumed the production and shipment of yttrium concentrate in 1973 continued to produce in 1974. Under a contract negotiated with a United States company, Molycorp Inc., Denison has a commitment to ship yttrium concentrate to Molycorp until March 1976. Denison had previously shipped yttrium concentrate to Michigan Chemical Corporation, but production was terminated in mid-1970 when the company experienced difficulty in marketing the product. Denison shipped some concentrate in 1971, but the quantity and value was not reported.

During 1966 and 1967, Rio Algom Mines Limited recovered thorium and rare earth concentrate at its Nordic mill, but did not resume production when the milling of uranium ores was transferred to the Quirke mill.

All markets for rare earth metals, with the exception of colour television phosphors, remained strong throughout 1974. The weak demand from the colour television industry was more than compensated for by the improved demand from the manufacturers of iron and steel, petroleum cracking catalysts, and glass.

Rare earth elements, primarily the light element group, are associated with apatite in the Nemegos No. 6 magnetite deposit, which is located in the Chapleau area of Ontario. Multi-Minerals Limited is seeking to develop the deposit, and stated in the 1974 annual report to its shareholders that it was making efforts to determine the feasibility of promoting an integrated complex which would produce pig iron, phosphoric acid and rare earth products.

In addition to the large reserves in Elliot Lake uranium ores, rare earths are also associated with uranium deposits at Agnew Lake, 40 miles east of Elliot Lake and where the rare earth oxide (REO) content is about twice that of Elliot Lake ores, and in the Bancroft area of Ontario.

Table 1. Rare earth elements

Atomic No.	Name	Symbol	Abundance in Igneous Rocks
	Light rare earths		(parts per million)
21	Scandium	Sc	5.0
57	Lanthanum	La	18.3
58	Cerium	Ce	46.0
59	Praseodymium	Pr	5.5
60	Neodymium	Nd	23.8
61	Promethium	Pm	(Not measurable)
62	Samarium	Sm	6.5
63	Europium	Eu	1.1
64	Gadolinium	Gd	6.3
	Heavy rare earths		
39	Yttrium	Y	28.0
65	Terbium	Tb	0.9
66	Dysprosium	Dy	4.5
67	Holmium	Ho	1.1
68	Erbium	Er	2.5
69	Thulium	Tm	0.2
70	Ytterbium	Yb	2.6
71	Lutetium	Lu	0.7
		Total	153.0

Table 2. Canadian shipments of rare earth concentrates

	Y_2O_3 in Concentrate	Values
	(pounds)	($)
1974	...	...
1973	...	...
1972	—	—
1971	...	...
1970	73,000	657,000
1969	85,443	671,500
1968	113,330	936,067
1967	172,551	1,594,298
1966	20,724	130,223

... Statistics withheld; — Nil.

Agnew Lake Mines Limited dewatered the Agnew Lake uranium mine during 1974 and began a $3 million, two-year program, to test a method of underground leaching of uranium ores in the mine.

Phosphorite formations in western Canada contain small quantities of rare earths as do Florida phosphates imported into Canada for the production of phosphoric acid. Other potential sources include apatite-rich carbonatites.

Shipments of rare earth concentrates since 1966 are summarized in Table 2. Statistics for 1971 and 1973 have been withheld to avoid disclosing individual company confidential data.

Denison Mines Limited, the only Canadian producer in 1973 and 1974, reported to its shareholders that it produced 86,788 pounds of yttrium oxide in 1974.

World Industry

The minerals monazite and bastnaesite are the main sources of the cerium group of rare earths. These are processed to recover mixed rare earths for low-value products such as mischmetal or further processed at much higher cost to separate individual rare earths.

Monazite recovery is a byproduct of mining beach sands for rutile, zircon and ilmenite. Australia, India, Brazil, Malaysia and the United States, soon to be joined by South Africa, are the principal producers. In the United States, monazite is recovered from beach sands in Georgia and Florida.

The Molybdenum Corporation of America (Molycorp) mine at Mountain Pass, California, is the main source of concentrates for cerium group rare earths and, unlike monazite, bastnaesite concentrates from this unusual deposit in carbonatite do not contain thorium. The ore, mined in a small, low-cost open pit, grades 8 to 10 per cent rare earth oxides. The rare earth distribution in per cent oxide is cerium 50.0, lanthanum 33.0, neodymium 12.0, praseodymium 4.0, samarium 0.5, gadolinium 0.2, europium 0.1, and yttrium group 0.2. The adjacent mill produces a flotation concentrate grading 60 per cent rare earth oxide, a leached concentrate grading 70 per cent, a calcine grading 90 per cent, and seven modified concentrates. A chemical and solvent extraction plant makes intermediate rare earth products and separates a number of rare earths including europium. Further processing is carried out at Louviers, Colorado; York, Pennsylvania; and Washington, Pennsylvania.

Production from the Mountain Pass mine in 1974 amounted to 43.9 million pounds of REO, compared with 38.7 million pounds in 1973. Shortages of chemical reagents in 1974 contributed to lower mill recovery and less production than would otherwise have been achieved.

Aluminum Company of America (Alcoa) and Molycorp have formed a joint company, Rare Earth Metal Company of America (REMCOA). In 1974 REMCOA successfully completed operation of a pilot electrolytic cell to produce rare earth metals from bastnaesite concentrates. REMCOA decided to proceed to construct a larger 20,000 amp cell with a production capacity of 250,000 pounds of mischmetal a year, at an Alcoa research facility. If this larger cell operates satisfactorily, REMCOA plans to build a full scale production facility.

A former Australian rare earth metals producer may resume operations in the near future. The mine, operated by Mary Kathleen Uranium Limited, produced uranium and a rare earth concentrate until 1963. Uranium production is scheduled to resume in early 1976. Total reserves at the mine, including tailings, contain some 400,000 tons of REO. At a planned annual mining rate of 900,000 tons of ore, the mine could recover about 5,000 tons a year of REO contained in concentrate.

Indian Rare Earths Limited (IRE) was planning late in 1974 to set up a project near Gopalpur in Orissa to produce rare earths oxides, rare earth fluoride and cerium oxide. Output from the Gopalpur plant is designed to supplement IRE's rare earth exports to the United States and Europe from the Manavalakurichi plant in the south of India. All IRE production, which accounts for about 10 per cent of the world's rare earth output is under state control.

In South Africa a large mineral sand mining project was announced for the Richards Bay deposits on the east coast. During 1974 the South African Industrial Development Corporation and Quebec Iron and Titanium Corporation (QIT) were operating a large pilot plant at the site.

A number of new mineral sand projects were revealed in Australia during 1974. A project on Fraser Island off the South Queensland coast was expected to be underway during 1975. Production was expected to be 65,000 tons a year of rutile and zircon. At Eneabba in Western Australia, Western Titanium N.L. made a go-ahead decision to develop a major mineral sands development with a scheduled start-up for mid 1976. Expected output was 60,000–70,000 tons of zircon and over 150,000 tons of ilmenite annually. Also at Eneabba, Allied Minerals N.L., decided to proceed with development of a beach sand project with initial production in July 1975. Annual production was expected to be 200,000–250,000 tons of ilmenite; 40,000–60,000 tons of rutile; 100,000–130,000 tons of zircon; and 10,000–50,000 tons of kyanite and other materials. A third project at Eneabba produced its first shipment of ilmenite to Japan early in 1974. Capacity of the plant at this project is 300,000 tons of heavy minerals a year. Other mineral sand deposits were developed at Jurien Bay in Western Australia by Kamilaroi Mines Ltd. Production of zircon and rutile was expected to begin in 1975. In Sri Lanka (formerly Ceylon), the Ceylon Mineral Sands Corporation plans to construct an integrated mineral sand operation at Pulmoddai by 1975. The new complex will have an annual capacity of 500 tons of monazite.

In Norway, A/S Megon Co. (Megon) completed a full scale production facility to produce high purity yttrium oxide using its own solvent extraction process. The new plant has a capacity of 30–50 tons a year of yttrium oxide. Megon's principal customers are in Western Europe, the United States and Japan.

The mineral xenotime, valuable for its yttrium content, is recovered from heavy mineral rejects of the Malaysian tin industry and from retreatment of monazite concentrate, itself a byproduct, from Western Australia.

Some uranium ores contain the rare earth elements and are an important source for the yttrium group. Solution liquors, following uranium and thorium extraction, are treated to recover the rare earth elements. Canadian production, and potential production in Australia, the Mary Kathleen Uranium Limited and Field Metals and Chemicals Pty. Limited deposits are of this type. The rare earth minerals euxinite, samarskite and fergusonite are another source of the yttrium group, but they are difficult to treat.

Promethium isotopes have half-lives ranging from seconds to 18 years and, therefore, are rare in nature. The commercial source of promethium 147 is from waste fission products in atomic reactors. Its radioactive properties are attractive as a power source in space research as well as in luminescent paints.

The increasing use of rare earth metals in magnets has resulted in product line changes at some rare earth processors and a number of new rare earth magnet fabricators. Th. Goldschmidt A.G. of West Germany has ceased producing all rare earth compounds and has limited its product line to rare earth metals and alloys for use in magnets. Tohoku Metal Industries in

Table 3. Principal world processors of rare earth ores and concentrates

Austria
- Treibacher Chemische Werke Aktiengesellschaft

Belgium
- S.A. de Pont-Brûlé

Brazil
- Commissao National de Energia Nuclear (Industrias Quimicas Reunidas)

Britain
- British Flint and Cerium Manufacturers Limited
- British Rare Earths Limited
- London and Scandinavian Metallurgical Company,
- Rare Earth Products Limited (a Thorium Ltd. and Johnson Matthey Chemicals Limited joint venture)

Finland
- Kemira Oy

France
- Rhône-Poulenc, Etablissements Tricot

West Germany
- Otavi Minen and Eisbahn Ges.
- Th. Goldschmidt A.G.

India
- Indian Rare Earths Limited

Japan
- Ogino Chemical Company
- Nippon Yttrium Company
- Santoku Metal Industry Company
- Shin-Etsu Chemical Industry Company
- Wako Bussan Company

Norway
- A/S Metal Extractor Group of Norway (Megon)

United States
- American Potash and Chemical Corporation
- Lindsay Rare Earth Division*
- Michigan Chemical Corporation
- Molybdenum Corporation of America
- Nucor Corp., Research Chemicals Division
- Reaction Metals Inc., a subsidiary of Rare Earth Industries, Inc.
- Ronson Metals Corporation, Cerium Metals & Alloys Division
- W.R. Grace and Company, Davison Chemical Division
- Gallard-Schlesinger Chemical Manufacturing Corp., Atomergic Chemetals Co. Division
- Transelco, Inc.

U.S.S.R.
- State controlled. Output is sold through Techsnabexport

* The Company's processing facilities located in West Chicago were closed in 1973.

Japan has started marketing a less expensive mischmetal magnet in addition to samarium-cobalt magnets. Shin-Etsu Chemical Industry Company, also in Japan, has begun producing cerium-cobalt magnets. In the United States, Crucible Magnetics Division of Colt Industries Inc. began full scale production of mischmetal and samarium-cobalt magnets in 1974. Varian Associates of Canada Ltd. and Hamilton Precision Metals Co. announced commercial production of samarium-cobalt magnets in 1972. Other United States fabricators of rare earth magnets are Raytheon Co., Electron Energy Corp., Spectra-Flux Corp., Hitachi Magnetics Corp. and Indiana General.

Consumption and uses

Most rare earth metal consumption is in the form of chlorides, oxides, silicides and mischmetal. Small quantities of fluorides, oxalites, chlorates, nitrates and carbonates are used in a number of applications. High purity metal forms are used sparingly, mostly in research work. Traditionally, the rare earth metals, alloys and compounds have been expressed in terms of rare earth oxide (REO) equivalents.

World consumption of rare earth metals approximately doubled in the period 1971–1973, and a further increase occurred during 1974. In the United States, estimated consumption by industries during 1974 was, petroleum catalysts 42 per cent, metallurgical uses 33 per cent, glass, ceramics and other uses 25 per cent. This reversed the situation where metallurgical consumption had surpassed catalytic consumption for the first time in 1973.

Mischmetal is a suitable nodulizing alloy that promotes ductility in cast iron by neutralizing the harmful effects of trace elements which inhibit the formation of nodular graphite. The ductile iron industry has realized significant cost savings through the substitution of mischmetal for more expensive additives.

In recent years, the practice of adding some three pounds of mischmetal or rare earth silicides to each ton of high-strength low-alloy (HSLA) steels has become a general practice to counter the deleterious effects of sulphur. The conventional method of treating undesirable sulphur is to combine it with magnesium, but magnesium sulphide elongates when rolled and the resulting steel is weaker in the transverse direction. The addition of rare earths results in a HSLA steel that is nearly equally strong in the transverse and longitudinal directions. HLSA steels are being used increasingly in gas and oil pipelines, automobiles, trucks, trains, ships, and construction equipment. Mischmetal which is mostly cerium, lanthanum, neodymium and praseodymium, has a stable market in lighter flints. However, the lighter flint market is becoming a less important outlet as mischmetal applications grow in the iron and steel metallurgical fields.

The other major use of the rare earth group is for catalysts in the cracking operation of petroleum refining. Although naturally mixed elements were originally used in catalysts, the trend has been to chloride mixtures of lanthanum, neodymium and praseodymium. Relative consumption in this field has been declining in recent years. Palladium is a substitute for the rare earth elements in petroleum refining catalysts.

The third most important market for rare earth metals, in terms of volume, is the glass polishing industry. Commercial grade cerium and mixed rare earth oxides are used extensively in optical, mirror and plate glass polishing. Plate glass polishing has been reduced since the introduction of the Pilkington float glass process, but there is no comparable substitute for rare earth oxide compounds in high-quality optical polishing.

The glass industry employs rare earth additives for their many unique characteristics. Cerium oxide, in small quantities, is an effective glass decolourizer. Due to their ability to absorb ultra-violet light, cerium and neodymium oxides are used in transparent bottles to inhibit food spoilage and in welders' goggles, sunglasses and optical filters. For glass colouring, praseodymium imparts a yellow-green colour, neodymium a lilac, europium an orange-red, and erbium a pink colour. Lanthanum is a major component of optical glass and cerium glass is used for windows in atomic reactors.

Rare earth oxides and fluorides are used in significant quantities in carbon-arc lamps where a high intensity white light is desirable.

A high-value application is in the electronics field where rare earth oxides are used as phosphors in colour television tubes, temperature compensating capacitors and associated circuit components. Although the volume of europium and yttrium oxides used in colour television phosphors is comparatively small, the value is disproportionately large because of the high degree of purity required in this application. Minor quantities of the rare earth group are used in laser materials, atomic fire extinguishers, nuclear reactor absorption and shielding materials, magnesium and aluminum alloys, brazing alloys, low-corrosion alloys, gemstones, self-cleaning oven catalysts, ceramic and porcelain stains and microwave controls.

An important new market is rare earth-cobalt permanent magnets (RE magnets). Samarium-cobalt permanent magnets are now in use that have two or three times the strength of any conventional permanent magnet. These magnets are usually fabricated by powder metallurgical methods, which facilitate the procedure for inducing a high magnetic flux. High strength permanent magnets are used in special applications, such as aerospace equipment, where the greater cost can be justified in terms of better performance. Recent research has led to the development of less expensive RE magnets. Part of this improvement has resulted from better manufacturing techniques, but a more significant development is the substitution of mischmetal for some more expensive samarium in magnets. Considering all the developments that have occurred within the few years since RE magnets were first discovered, the trend indicates a strong growth rate in use of these magnets for the next several years in electric motors, generators, meters, speakers and frictionless bearings.

Rare earth metals catalysts have been identified as possible inexpensive alternatives to platinoid catalysts in automobile exhaust converters. The rare earth-based converters have shown promise in reducing carbon monoxide and nitrogen oxide emissions, but more research is necessary. Initially, the automotive industry has opted for platinum-based systems to meet emission control standards set for U.S. vehicles in 1975.

Research on rare earth metals uses has taken many directions and some of the more promising investigations are indicated below. Lanthanum-nickel alloy has been suggested as a storage medium for hydrogen under low pressure. Investigations have shown that an equal volume of hydrogen can be stored in one third the space required for liquid hydrogen, and can be released safely. Hydrogen is being considered as a future fuel. The International Nickel Company of Canada, Limited, has developed a dispersion-hardened alloy containing 0.5 per cent yttrium oxide. This alloy is considered to be superior to conventional alloys because it can withstand higher temperatures. The company anticipates application in aircraft engine vanes used to guide hot gases against turbine blades. Europium hexaboride, used as a long-lived neutron absorber, is being promoted as a control in the upcoming generation of fast breeder nuclear reactors. Gadolinium oxide is currently used as a control in existing light water reactors.

Prices

The December issue of *Industrial Minerals* (London) quotes 70 per cent leach bastnaesite concentrate, per pound REO at 40–50 cents; Australian monazite, minimum 55 per cent REO, a long ton fob Australia, $A 155–165; Malayan xenotime concentrate, minimum 25 per cent Y_2O_3 a pound cif $U.S. 3–5.

The prices of the more common pure rare earth metals (cerium, yttrium, landthanum and samarium) declined from a year earlier. A wide spread in prices between different products is a function of the degree of processing, purity, supply and demand. Some typical prices, given in the 26 December, 1974 issue of *American Metal Market* are as follows, per pound: mischmetal (99.8 per cent) $3.45; mischmetal (no Ce) $12.00; cerium oxide (99.9 per cent) $5.50–7.00; cerium metal (99 per cent) $18.00; yttrium oxide $33.00–36.00; yttrium metal powder $200.00; lanthanum oxide (99.9 per cent) $6.00; lanthanum metal (99 per cent) $25.00; neodymium oxide (99.9 per cent) $20.00–25.00; praseodymium (99 per cent) $30.00; thulium metal powder $2,800.00.

Rhenium

J.J. HOGAN

Rhenium is a relatively new metal which was first isolated in 1925. It occurs principally in low-grade porphyry copper ores containing molybdenum, and is recovered as a byproduct from the treatment of molybdenum concentrates. The rhenium content in porphyry copper ore is only a few parts per million (ppm) whereas the molybdenite concentrates produced from these ores have a rhenium content varying from 300 to 2,000 ppm. Rhenium has been identified in some molybdenum, manganese and uranium ores, but in concentrations too low to be of economic significance under present technology and price structure.

Canadian rhenium production comes from the copper – molybdenum ore of Utah Mines Ltd. (Island Copper mine) at Port Hardy, Vancouver Island, British Columbia. The ore occurs mainly in altered volcanics and, in this respect, differs from the porphyry copper deposits which have been the major source of rhenium in the United States and Chile. The metal has also been identified in the porphyry copper ores of Lornex Mining Corporation Ltd. and Brenda Mines Ltd., near Kamloops, British Columbia.

The United States, the largest producer of rhenium metal and salts in the noncommunist world, recovered rhenium mainly from porphyry copper ores in the western states. The producers of rhenium in the United States in 1974 were Cleveland Refractory Metals, Inc. (CRM) of Solon, Ohio, a division of Chase Brass & Copper Co. Incorporated (a subsidiary of Kennecott Copper Corporation); S.W. Shattuck Chemical Co., of Denver, Colorado, a division of Engelhard Minerals & Chemicals Corporation; M & R Refractory Metals, Inc. of Winslow, New Jersey, and Molybdenum Corporation of America (Molycorp) of Washington, Pennsylvania.

Chile recovered rhenium from molybdenite concentrates produced as a byproduct from its large porphyry copper ore deposits. According to data published by the United States Bureau of Mines, 1974 was the first year that Chile exported substantial quantities of rhenium contained in ammonium perrhenate to the United States. In previous years, rhenium exported to the United States was contained in molybdenite concentrates shipped there for treatment. Planned expansion of copper and molybdenum production in Chile by 1976 should result in increased rhenium production.

Other rhenium producing countries are U.S.S.R., Sweden, Belgium, Holland and West Germany. With the exception of the U.S.S.R., these countries recover rhenium from imported molybdenite concentrates from Chile, Peru, Canada and Zaire.

Production

Rhenium is a recent addition to the metals produced in Canada, with production being first recorded in 1972. Utah Mines reported that the rhenium contained in the molybdenite concentrates produced in 1974 at its Island Copper mine varied between 1,100 and 1,500 ppm and averaged about 1,250 ppm. In 1974, shipments of molybdenite concentrates to refineries in the United States and Western Europe totalled about 1,440 short tons. Under present technology the recovery of rhenium contained in molybdenite concentrates is in the range of 50 to 60 per cent. The concentrates are treated on a toll basis, and the recovered rhenium is returned to the company in a refined state as perrhenic acid for subsequent sale.

Statistical data on world output and total value of rhenium are not available. Production of rhenium in the United States was estimated by the U.S. Bureau of Mines at 6,700 pounds in 1974 compared with 7,000 pounds in 1973. Consumption was estimated at 4,500 pounds compared with 4,400 pounds in 1973. United States' stocks of rhenium contained in rhenium powder and ammonium perrhenate on hand on December 31, 1974 were estimated at 26,000 pounds, an increase of 6,000 pounds during the year. Chile is believed to be the next largest producer. The U.S.S.R. recovers rhenium from molybdenite concentrates obtained from its porphyry copper deposits, and production was estimated at 2,500 pounds in 1974 by the U.S. Bureau of Mines.

Rhenium is recovered from flue gases emitted from the roasting of byproduct molybdenite concentrates. Under properly controlled temperature conditions rhenium volatilizes as rhenium heptoxide (Re_2O_7) which is readily soluble in an aqueous solution. Flue-dust particles carrying about 10 per cent of the rhenium contained in the roaster feed are recycled to the roaster. Before flue-gas technology was developed flue dust was the major source of the metal. To extract the rhenium, flue gases are cleaned of dust particles and wet-scrubbed to dissolve the rhenium oxide. The rhenium-bearing solution is conditioned for ion exchange treatment by the addition of certain chemicals to remove impurities. The solution is clarified, and the rhenium is absorbed on an ion exchange resin. Further hydrometallurgical steps are carried out until a high-purity ammonium perrhenate (NH_4ReO_4) is produced which is converted to metal powder by hydrogen reduction. The metal powder is pressed and sintered into bars which are cold-rolled to form different shapes. Perrhenic acid ($HReO_4$) is obtained by the reaction of rhenium heptoxide with water. The cost of producing rhenium powder or rhenium salts is high. Recent research has developed processes whereby rhenium and molybdenum can be recovered from molybdenite concentrates by hydrometallurgy.

Properties and uses

Rhenium has become an important industrial metal because of special or unique properties. The metal is highly refractory, having a melting point of 3,100°C, second to that of tungsten, and maintains strength and ductility at high temperatures even after heating above the crystallization temperature. Its density is 21, exceeded only by that of the platinum metals group. Pure rhenium can be cold-worked, but requires high-temperature recrystallization annealing to ensure maximum ductility. It is difficult to work at normal hot-working temperatures because it tends to become brittle. The metal can be welded by tungsten-arc, inert-gas techniques; the welds being ductile. Rhenium has good corrosion resistance to halogen acids. Rhenium alloyed with tungsten or molybdenum improves the ductility and tensile strength of these metals. At room temperature, rhenium has a high-resistivity property which finds application in the rapid initial heating of filaments and heating elements. Stable oxide film on rhenium does not appreciably increase electrical resistance because the oxides are conductive. This property, plus good resistance to wear and to arc corrosion, makes the metal ideally suited for electrical contacts.

Rhenium powder is used to produce ductile, high-temperature, tungsten-based alloys which are used in the electronic field. Other applications of rhenium are high-temperature thermocouples, temperature controls, heating elements, electronic devices, flashbulb filaments, heat shields and in research and development work.

The major use of rhenium however in 1974 was in bimetallic platinum–rhenium catalysts used in reforming units to produce a high octane gasoline of low-lead and no-lead content.

Outlook

The development of rhenium as an industrial metal has taken place recently and has not shown any clearly defined growth pattern. The potential short-term supply is limited to that available from byproduct molybdenite concentrates from low-grade porphyry copper ores. Research into processes to improve recovery could increase the supply of the metal.

In the short-term, the major demand for rhenium will be its application as a bimetallic rhenium–platinum catalyst in the petroleum refining industry, although the possible substitutions of other metals could lower its use in this field. The metal now available to the market is greater that the demand and stocks are expected to continue to grow. Low known rhenium reserves could be a factor in limiting the development of industrial uses for the metal.

Prices

U.S. prices of rhenium 1974

	Perrhenic Acid (Rhenium Content)	U.S. Producer Powder
	(U.S. $ per pound of rhenium)	
January 1 - January 20	725-900	825-1050
January 21 - June 23	725	825
June 24 - October 31	625	675
November 1 - December 31	600	625

Source: *Metals Week.*

Tariffs

Canada – not specifically enumerated in Canadian tariffs.

United States

Item No.		On and After January 1, 1972
		(%)
628.90	Rhenium unwrought, waste and scrap[1]	5
628.95	Rhenium wrought	9

Source: Tariff Schedules of the United States Annotated (1975) T.C. Publication 706.

[1] Duty on waste and scrap suspended until June 30, 1975.

Salt

A.F. KILLIN

Increased production of mined rock salt (5.9 per cent), fine vacuum salt (2.4 per cent) and brines and recovered salt (34.0 per cent) in 1974 raised Canada's total salt output 10.5 per cent higher than in 1973. The value of salt exported rose 13.2 per cent over 1973, and the tonnage and value of imports declined by 28.5 per cent and 17.7 per cent respectively. The United States of America absorbed 98.3 per cent of Canadian salt exports.

Production and developments in Canada

Canadian salt production falls into three categories: mined rock salt (3 mines); fine vacuum salt (six evaporator plants); and salt in brine (from four brining plants) for chemical manufacture. One fine salt plant was using byproduct salt from a potash solution-mine, and byproduct salt from potash mines was also processed for snow and ice control on roads.

Domestic salt production in 1974* was 6,324,108 tons, shipments totalled 6,312,251 tons valued at approximately $62,238,795; tonnage and value increased from 1973. There was a small increase in the production of rock salt mined — from 3,954,503 tons in 1973 to 4,188,761 tons in 1974. Production of fine vacuum salt increased only slightly, but the production of salt in brines increased sharply to 1,339,740 tons in 1974 from 985,139 tons in 1973. Shipments of rock salt and salt in brines in 1974 showed a marked increase over 1973.

Deposits and occurrences

Salt occurs in solution in seawater, in some spring and lake waters, in many subsurface waters, and in solid form in surface and underground deposits. Although seawaters contain the largest reserve of salt and contribute substantial quantities of solar evaporated salt to the world's annual salt output, underground bedded and dome deposits supply the largest part of mankind's salt requirements.

In Canada, underground salt deposits have been found in all provinces except British Columbia. They have also been found in the District of Mackenzie, Northwest Territories, and there are underground salt deposits in some of the Arctic islands. Bedded rock salt deposits in southwestern Ontario, Saskatchewan and Alberta, and dome deposits in Nova Scotia are the sources of most of Canada's salt output. In past years, salt has been recovered from brine springs and natural subsurface brines in Nova Scotia, New Brunswick, Ontario, Manitoba, Saskatchewan and Alberta. Salt springs are also common to certain parts of British Columbia.

Ontario. Thick salt beds underlie much of southwestern Ontario, extending from Amherstburg northeastward to London and Kincardine, bordering on what is known geologically as the Michigan Basin. As many as six salt beds, occurring in the Upper Silurian Salina Formation and at depths from 900 to 2,700 feet, can be identified and traced from drilling records. Maximum bed thickness is 300 feet with aggregate thickness reaching as much as 700 feet. The beds are relatively flat lying and undisturbed, thereby permitting easy mining.

In 1974 these beds were being exploited through two rock salt mines, one at Goderich and one at Ojibway, and through brining operations at Goderich, Sarnia and Windsor. Domtar Chemicals Limited's Sifto Salt division at Goderich, was hampered by strikes. A ten-day strike at the evaporator plant was followed by a Great Lakes vessel strike that forced closure of the Goderich mine for twenty-four days and prevented salt shipments for two months. An expansion program at the Goderich mine to bring productive capacity to 2.25 million tons of salt a year is virtually complete.

The Canadian Salt Company Limited installed a new primary crushing station and storage bin underground at its Windsor mine.

Atlantic region. Salt deposits occur in isolated subbasins of a large sedimentary basin that underlies the northern mainland of Nova Scotia and extends westward under the bordering areas of New Brunswick, northeastward under Cape Breton Island and under Prince Edward Island, the Magdalen Islands and southwestern Newfoundland. The salt beds occur within the Mississippian Windsor Group and are generally folded and faulted. The deposits appear to be steeply dipping tabular bodies or domes and brecciated structures of rock salt.

* Source: Statistics Canada, Catalogue 26-009, December 1974.

Table 1. Canada, salt production and trade, 1973-74

	1973		1974[p]	
	(short tons)	($)	(short tons)	($)
Production (shipments)				
By type				
Mined rock salt	3,788,040	26,283,000	3,768,633[e]	
Fine vacuum salt	746,274	16,873,000	693,036[e]	..
Salt content of brines used or shipped and salt recovered in chemical operations	1,030,313	6,475,000	1,242,331[e]	..
Total	5,564,627	49,631,000	5,704,000[e]	..
By province				
Ontario	4,161,436	33,166,178	4,225,000	35,900,000
Nova Scotia	751,855	8,316,340	822,000	10,205,000
Saskatchewan	284,834	4,621,469	275,000	5,180,000
Alberta	330,278	3,366,995	350,000	4,790,000
Manitoba	36,224	160,000	32,000	150,000
Total	5,564,627	49,630,982	5,704,000	56,225,000
Imports				
Total salt and brine				
United States	584,175	3,607,000	333,196	2,571,000
Mexico	309,361	529,000	304,272	857,000
Bahamas	27,182	142,000	16,162	116,000
Italy	5,894	74,000	—	—
Norway	896	35,000	635	35,000
Netherland Antilles	—	—	7,728	19,000
Poland	—	—	1,305	19,000
West Germany	502	18,000	462	13,000
Other countries	65	15,000	73	6,000
Total	928,075	4,420,000	663,833	3,636,000
Exports				
United States	..	5,948,000	..	6,683,000
United Kingdom	..	61,000	..	102,000
Greenland	..	—	..	18,000
Bermuda	..	9,000	..	10,000
Leeward and Windward Islands	..	4,000	..	9,000
Belgium and Luxembourg	..	—	..	5,000
Guyana	..	2,000	..	5,000
Jamaica	..	—	..	5,000
Other countries	..	27,000	..	14,000
Total	..	6,051,000	..	6,851,000

Source: Statistics Canada.
[p] Preliminary.
.. Not available.
— Nil.
[e] Estimated.

In New Brunswick, the Department of Natural Resources continued a joint federal-provincial exploration program in which holes were drilled in 1973 to identify and evaluate evaporite deposits in the Moncton Basin. Two of these holes intersected potash and salt and the third glauberite and salt.

The only salt production in the Atlantic provinces in 1974 was from a rock salt mine and associated evaporator plant at Pugwash, Nova Scotia, and a brining operation at Amherst, Nova Scotia.

Table 2. Canada, salt production and trade, 1965-74

	PRODUCTION[1]					
	Mined Rock	Fine Vacuum	In Brine and Recovered in Chemical Operations	Total	Imports	Exports
			(short tons)			($)
1965	2,399,919	558,346	1,289,796	4,248,061	441,601	4,996,509
1966	2,180,671	571,497	1,376,654	4,128,822	509,548	3,588,000
1967	3,023,397	554,337	1,417,894	4,995,628	567,012	5,926,000
1968	3,230,305	553,280	1,080,739	4,864,324	644,153	5,921,000
1969	3,007,256	557,028	1,093,481	4,657,765	695,638	5,107,000
1970	3,607,336	609,252	1,142,308	5,358,896	618,021	7,430,000
1971	4,045,894	625,552	870,458	5,541,904	922,013	7,029,000
1972	3,901,099	638,520	877,306	5,416,925	1,023,910	4,987,000
1973	3,788,040	746,274	1,030,313	5,564,627	928,075	6,051,000
1974[p]	3,768,633[e]	693,036[e]	1,242,331[e]	5,704,000[e]	663,833	6,851,000

Source: Statistics Canada.
[1] Producers' shipments.
[p] Preliminary.
[e] Estimated by Statistics Section, Mineral Development Sector.

In Quebec, the Quebec Mining Exploration Company (SOQUEM) continued exploration for salt on the Magdalen Islands.

Prairie Provinces. Salt beds underlie a broad belt of the Prairie Provinces extending from the extreme southwestern corner of Manitoba, northwestward across Saskatchewan and into the north-central part of Alberta. Most of the salt deposits occur within the Prairie Evaporite Formation, which constitutes the upper part of the Middle Devonian, Elk Point Group, with thinner beds occurring in Upper Devonian rocks. Depths range from 600 feet at Fort McMurray, Alberta, to 3,000 feet in eastern Alberta, central Saskatchewan and southwestern Manitoba, and to 6,000 feet around Edmonton, Alberta, and across to southern Saskatchewan. Cumulative thicknesses reach a maximum of 1,300 feet in east-central Alberta. The beds lie relatively flat and undisturbed. The same rock sequence contains a number of potash beds that are being exploited in Saskatchewan.

Salt was produced from these deposits at four locations in the Prairie Provinces in 1974 — Saskatoon and Unity, Saskatchewan, and Lindbergh and Fort Saskatchewan, Alberta. In addition, naturally occurring subsurface salt brines in Manitoba were used for caustic soda and chlorine manufacture at Brandon. Fine salt was also produced from byproduct brines from a potash-solution mine at Belle Plaine, Saskatchewan. International Minerals & Chemical Corporation (Canada) Limited, at Esterhazy, Saskatchewan, supplied a significant quantity of salt, from waste salt from potash mining, for snow and ice control on roads.

Recovery method

Canadian producers employ three different methods for the recovery of salt from depth for the production of dry salt and for direct use in the chlor-alkali industry. The method employed depends upon the deposit and the type of salt required by the consumer. Conventional mining methods are used to mine rock salt deposits that are relatively shallow and are located in areas convenient to large markets that do not require a high-purity product.

Brining methods are used to recover salt from subsurface deposits as well, usually from greater depths. The brine can be evaporated to produce high-purity fine vacuum salt or can be used directly in the manufacture of chemicals. Salt is similarly recovered from natural subsurface brines.

The third method recovers salt as a coproduct of potash mining, a practice quite common in Europe. In Canada, this technique is being used on a commercial scale at the only solution-type potash mine which lends itself to the recovery of a good-quality salt brine. The other potash producers generally regard the waste salt as unmarketable, although some shipments have been made for snow and ice control.

A fourth method (not used in Canada) is by solar evaporation of sea or salty lake waters, a process commonly used in warm, arid climates.

Table 3. Canada, summary of salt producing and brining operations, 1973

Company	Location	Initial Production	Remarks
Nova Scotia			
The Canadian Rock Salt Company Limited	Pugwash	1959	Rock salt mining at a depth of 630 feet. A new level is being developed 200 feet below the 630-foot level. Plant expansion underway.
	Pugwash	1962	Dissolving rock salt fines for vacuum pan evaporation.
Domtar Chemicals Limited	Amherst	1947	Brining for vacuum pan evaporation.
Ontario			
Allied Chemical Canada, Ltd.	Amherstburg	1919	Brining to produce soda ash.
The Canadian Rock Salt Company Limited	Ojibway	1955	Rock salt mining at a depth of 980 feet. New crushing and storage space installed underground.
The Canadian Salt Company Limited	Windsor	1892	Brining, vacuum pan evaporation and fusion.
Dow Chemical of Canada, Limited	Sarnia	1950	Brining to produce caustic soda and chlorine.
Domtar Chemicals Limited	Goderich	1959	Rock salt mining at a depth of 1,760 feet. Expansion of rock salt mine virtually completed.
	Goderich	1880	Brining for vacuum pan evaporation.
Prairie Provinces			
Dryden Chemicals Limited	Brandon, Man.	1968	Pumping natural brines to produce caustic soda and chlorine.
Northern Industrial Chemicals Ltd.[1]	Saskatoon, Sask.	1968	Brining to produce caustic soda and chlorine.
Domtar Chemicals Limited	Unity, Sask.	1949	Brining, vacuum pan evaporation and fusion. Expansion of plant by 30 per cent underway.
The Canadian Salt Company Limited	Lindbergh, Alta.	1968	Brining, vacuum pan evaporation and fusion. New evaporation unit will increase capacity by 50 per cent.

Table 3. (concl'd)

Company	Location	Initial Production	Remarks
Prairie Provinces (concl'd)			
Dow Chemical of Canada, Limited	Fort Saskatchewan, Alta.	1968	Brining to produce caustic soda and chlorine.
The Canadian Salt Company Limited	Belle Plaine, Sask.	1969	Producing fine salt from byproduct brine from potash mine.

[1] Managed by Canadian Industries Limited.

Rock salt mining

Access to rock salt deposits for conventional mining is through vertical shafts, normally 16 feet in diameter, serving the mining zone at depths of 630 to 1,760 feet. Mining is normally by the room-and-pillar method, the dimensions depending on the depth and thickness of the salt deposit. Rooms vary from 30 to 60 feet in width and from 18 to 50 feet in height, and pillars vary from about 60 to 200 feet square. Extraction rates range from 40 to 60 per cent. The mining operation consists of undercutting, drilling, blasting, loading and primary crushing. Underground haulage is by shuttle cars, trucks and conveyor belts. Milling involves crushing, screening and sizing; at one mine the milling is done underground. The products, ranging in size from about one half inch to a fine powder, normally have a purity of 96 per cent, or better. Most of the gypsum, anhydrite and limestone impurities are removed by crushing and screening. Small amounts of the coarser salt fractions are further beneficiated by use of electronic sorters.

Most of the mined rock salt in Canada is shipped in bulk by water, rail and road, much of it being used for snow and ice control.

Table 4. World salt production 1972-74

	1972	1973^p	1974^e
	(000 short tons)		
United States	45,021	43,911	46,225
People's Republic of China	19,800	20,000	20,700
U.S.S.R.	13,400	13,400	13,800
West Germany	9,329	10,427	10,800
United Kingdom	10,730	10,200	10,500
India	7,187	7,721	8,000
Canada	5,542	5,565	5,704
France	5,773	6,044	6,240
Mexico	5,025	5,100	5,270
Italy	4,429	4,886	5,000
Australia	4,400^e	4,400^e	4,500
Poland	3,318	3,394	3,500
Other countries	28,987	30,477	30,088
Total	162,941	165,525	170,327

Sources: U.S. Bureau of Mines *Minerals Yearbook* Preprint 1973 and U.S. Bureau of Mines *Commodity Data Summaries* January 1975: for Canada, Statistics Canada.
^{p} Preliminary.
^{e} Estimated.

Brining and vacuum pan evaporation

Brining is essentially a system of injecting water into a salt deposit to dissolve the salt and then pumping a saturated salt solution to the surface. Water injection and brine recovery can be accomplished in a single borehole with casing and tubing or in a series of two or more cased wells. A brine field normally has from 2 to 20 wells, depending on the quantity of brine needed for the surface operation. Depths of the brine fields in Canada range from 1,100 to 6,500 feet. Saturated salt brine contains 26 per cent NaCl, which amounts to about three pounds of salt per gallon of fluid. At the surface, the brine is either evaporated to produce fine vacuum salt or used directly in the manufacture of chemicals.

Canadian producers use a vacuum-pan process to evaporate the brine and produce fine salt. The brine is purified to remove gypsum and other impurities and then fed into a series of three or four large cylindrical steel vessels under vacuum for a triple- or quadruple-effect evaporation. The salt crystallizes and is removed as a slurry; it is then washed, filtered and dried. Product purity is generally 99.5 per cent or better.

Final processing involves screening, the introduction of additives, compression into blocks, briquettes and tablets, or compaction, recrushing and packaging to prepare as many as 100 different salt products. In some cases, small quantities are melted at a temperature of about 1,500°F and allowed to cool. This produces a fused salt, which is particularly suitable for use in water softeners.

Table 5. Canada, available data on salt consumption 1971-74

	1971	1972	1973[e]	1974[e]
	(short tons)			
Industrial chemicals	1,643,455	1,693,150	1,726,000	1,769,000
Snow and ice control[1]	1,919,550	2,204,485	2,222,541	2,445,655
Slaughtering and meat packing	43,610	41,049	47,000	48,000
Food processing				
Fish products	13,653	16,428	16,000	16,000
Bakeries	13,603	14,739	16,000	16,000
Miscellaneous food preparation	19,145	18,542	19,000	20,000
Fruit and vegetable preparation	21,693	20,110	19,000	20,000
Breweries	917	989	1,000	1,100
Dairy factories and process cheese	12,231	9,441	12,000	12,000
Leather tanneries	7,587	13,552	12,000	12,000
Soaps and cleaning preparations	4,233	2,252	4,000	4,000
Dyeing and finishing textiles	835	1,992	3,000	3,300
Artificial ice	850	880	1,000	1,000
Pulp and paper mills	48,382	32,804	51,000	52,000
Grain mills[2]	50,335	56,210	55,000	56,000
Fishing industry[e]	90,000	90,000	90,000	92,000

Sources: Statistics Canada; Salt Institute.
[1] Fiscal year ending June 30. [2] Includes feed and farm stock salt in block and loose forms.
[e] estimated by Mineral Development Sector.

Canadian consumption and trade

Salt is marketed in at least 100 different forms, packages and containers and its direct and indirect uses number in the thousands. The largest single market for salt in Canada is for snow and ice control on highways and city streets. By comparison with other uses, this market is new, having expanded in Canada from less than 100,000 tons in 1954 to an estimated 2.45 million tons in 1974.

The next largest consumer of salt is the industrial chemical industry, particularly the manufacture of caustic soda (sodium hydroxide) and chlorine. Salt for four caustic soda and chlorine plants is obtained from on-site brining or natural brines; others use mined rock salt or imported solar salt. Other industrial chemicals that require significant quantities of salt in the manufacturing process include sodium carbonate (soda ash), sodium chlorate, sodium bicarbonate, sodium chlorite and sodium hypochlorite.

The pattern of Canada's salt trade has changed considerably in the past few years. Because of its low unit value and availability in most key market areas, salt is seldom hauled long distances, except in the case of seaborne and intercoastal shipments where greater mileage entails little additional cost.

Canadian exports of salt increased in 1973 and 1974, the principal market being the United States. Imports of salt have been declining over the last two years. The principal countries exporting salt to Canada are the United States with 50 per cent; Mexico, 45.8 per cent; and Bahamas, 2.4 per cent.

Outlook

Continued increase in demand for salt used in snow and ice control and a steady demand for salt used in industrial chemicals provide a solid base for growth in the domestic salt industry. The present recession in business activity in North America may have a temporary effect on the growth of the industry.

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
			(¢ per 100 lb)	
92501-1	Common salt (including rock salt)			
	On and after Jan. 1, 1971	free	1/2	5
	On and after Jan. 1, 1972	free	free	5
92501-2	Salt for use of the sea or gulf fisheries	free	free	free
92501-3	Table salt made by the admixture of other ingredients when containing not less than 90 per cent of pure salt	(%)	(%)	(%)
	On and after Jan. 1, 1971	5	6	15
	On and after Jan. 1, 1972	5	5	15
92501-4	Salt liquors and sea water	free	free	free

United States

Item No.		On and After Jan. 1, 1972
420.92	Salt in brine	5%
		(¢ per 100 lb)
420.94	Salt in bulk	0.8
420.96	Salt, other	free

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Sand and Gravel

D.H. STONEHOUSE

Unconsolidated granular mineral material produced by the natural disintegration of rock under weathering and erosion processes is termed either "sand" or "gravel." The terms relate to grain size rather than to composition. Sand is defined very generally as passing a 3/8-inch sieve, almost all passing a No. 4 (0.187-inch) sieve, and almost all remaining on a No. 200 (0.003-inch) sieve. Gravel is that granular material remaining on a No. 4 sieve — the cut-off between commercial sand and gravel. Material finer than 200-mesh is called silt or clay, depending on the particle size.

Commercial sand and gravel deposits are generally classified into one of four categories according to origin or method of deposition. Deposits that are composed of sand and gravel that had been carried by rivers and streams are referred to as fluvial deposits. They exhibit limited size gradation, and the distribution of size ranges and shapes can vary greatly, depending on whether the streams had been meandering, fast-flowing, narrow or shallow. Glacial deposits were distributed from massive ice sheets over large areas of Canada and the United States as well as other countries. They consist of rock particles of various types, shapes and sizes and display little sorting or gradation. Marine and lake deposits are usually of hard, tough material, well segregated and well worn to rounded shapes. Unstratified mixtures of sand and gravel, covering the complete size range and occurring on top of the parent rock, are termed residual deposits. These are not usually of commercial importance because of the large amount of softer clays associated with the mass.

Activity in the construction industry in Canada, particularly the heavy or engineering construction segment, determines to a great extent the amount of aggregate produced and used. As a supplier of raw materials to a volatile and cyclical industry, the sand and gravel industry must, in turn, be capable of rapid adjustment between "go" and "no go" situations. Preliminary estimates indicate shipments of sand and gravel during 1974 amounted to approximately 242 million tons.

The Canadian industry

Sand and gravel deposits are widespread throughout Canada, and large producers have established "permanent" plants as close to major consuming centres as possible. Urban expansion has greatly increased demand for sand and gravel in support of major construction. Paradoxically, urban spread has not only tended to overrun operating pits and quarries but has extended, at times, to areas containing mineral deposits, thereby precluding the use of these resources. Further complications have arisen in recent years as society has become increasingly aware of environmental problems and of the need for planned land utilization. Municipal and regional zoning must be designed to determine and regulate the optimum utilization of land, but must not be designed to provide less than optimum resource utilization. Industry must locate to minimize the environmental effects of plant operations. Also, provision must be made for rehabilitation of pit and quarry sites in order to ensure the best sequential land use. The frequency with which small quarries and pits materialize to supply short-lived, local demands, leaving unsightly properties, has prompted action by municipal and provincial governments to control or to prohibit such activity.

Ideally, the exploitation of sand, gravel and stone deposits should be done as part of the total land use planning package, such that excavations are designed to conform with a master plan of development and even to create new land forms. Ontario seems to be leading other provinces in enacting legislation to control pit and quarry licensing, operation and rehabilitation; and its new laws are typical of what can be expected in other provinces. Ontario regulations apply to operations in designated areas and to rehabilitation of depleted sites. Controls and zoning can significantly reduce reserves of these building materials.

In addition to large aggregate operations usually associated with some other phase of the construction industry such as a ready-mix plant or an asphalt plant, there are many smaller, privately owned producers serving small, localized markets. These are often operated on a seasonal or part-time basis. Many larger operations are short-term, intermittently serving as a supply arm of a heavy construction company and providing material for a given project. Provincial departments of highways operate regional or divisional quarries to supply roadbed material for new and repair work. Exploitation by such a large number of widely diversified groups not only makes control difficult, it also provides great obstacles to the collection of accurate total production data.

Materials competitive with sand and gravel include crushed stone and the lightweight aggregates, depending on the application considered. It has been estimated that total aggregate consumption in some Canadian urban centres could reach 18 tons per capita by 1980. Estimates have indicated that available sand and gravel supplies in some regions will be depleted by the 1990s. This could make outlying deposits not only attractive but necessary and could also encourage development of underwater deposits. Marine aggregates now account for about 12 per cent of total sand and gravel production in the United Kingdom, the world's largest producer from such resources. It is not completely impossible that areas of concentrated population, such as the eastern seaboard of the United States, where reserves of aggregates are already becoming depleted, will have to import their requirements, perhaps from offshore by boat or barge. Large tonnages of crushed limestone are exported annually from Canada's west coast quarries, particularly from Texada and Aristazabal islands, for cement, lime and aggregate use in Oregon and Washington.

Table 1. Canada, construction spending by provinces, 1973-75

	1973[1]	1974[2]	1975[3]
	(millions of dollars)		
Newfoundland	497.8	594.8	605.7
Prince Edward Island	115.3	109.8	108.7
Nova Scotia	620.8	694.0	745.5
New Brunswick	517.3	728.2	835.1
Quebec	4372.8	5519.0	6339.0
Ontario	7135.0	8402.4	9369.3
Manitoba	888.7	985.0	1021.2
Saskatchewan	699.8	918.2	1075.6
Alberta	2333.8	2749.4	3265.1
British Columbia	2678.8	3115.0	3513.4
Yukon and Northwest Territories	309.4	397.2	369.1
Canada	20,169.5	24,213.0	27,247.7

Source: Statistics Canada.
[1] Final. [2] Preliminary. [3] Forecast.

The main uses for sand and gravel are: as fill, granular base- and finish-course material for highway construction; coarse and fine aggregates in concrete manufacture; coarse aggregate in asphalt production and fine aggregate in mortar and concrete blocks. Specifications vary greatly depending on the intended use and many tests are required to determine the acceptability of aggregates for certain applications. Particle size distribution of aggregates, as assessed by grading tests or sieve analysis, affects the uniformity and workability of a concrete mix as well as the strength of the concrete, the density and strength of an asphalt mix and the durability, strength and stability of the compacted mass when aggregates are used as fill or base-course material. Of importance also are tests to determine the presence of organic impurities or other deleterious material, the resistance of the aggregate to abrasion and to freeze-thaw cycles, the effects of thermal expansion, absorption, porosity, reactivity with associated materials and surface texture.

The use of sand and gravel as backfill in mines continues along with increasing use of cement and mill tailings for this purpose. Abrasive sands, glass sand, foundry sands and filter sands are also produced.

Even the common products such as sand and gravel require a sales and distribution effort which depends upon forecast data supplied by monitoring relevant indicators. One such indicator is the number of regional housing starts which, in turn, can be projected to determine future needs for roads, driveways, shopping centres and schools. Heavy construction awards can be used to provide an estimate of the quantity of aggregate required for given projects, over given periods of time.

There is no standard price for sand and gravel, but prices are determined regionally or even locally by production and transportation costs, by the degree of processing required for a given end use and by the quantity of material required for a particular project. Increased land values, reduction of reserves and added rehabilitation expenditures should result in higher prices.

Sand and gravel must be quarried, screened, washed, stockpiled and transported in large volume to compensate for the relatively low unit value received. Transportation and handling often double the plant cost, making it necessary to utilize close-in reserves and influencing the scope of exploration for new deposits. The need for an inventory of aggregate materials surrounding regions of large population growth cannot be too strongly emphasized.

Unit trains, or more precisely "hook and haul" trains, have been used to transport aggregate into the Toronto area in minimum loads of 4,000 tons at negotiated freight rates. The wide physical distribution of consumers within the area being served causes difficulties with such a system as further handling and transporting is required.

Table 2. Canada, production (shipments) sand and gravel by provinces, 1972-74

	1972		1973		1974p	
	('000 st)	($000)	('000 st)	($000)	('000 st)	($000)
Newfoundland	5,433	6,829	6,466	8,371	6,500	8,500
Prince Edward Island	1,578	1,097	1,632	1,680	1,300	1,600
Nova Scotia	9,896	9,732	11,348	12,524	11,800	13,200
New Brunswick	7,561	4,585	9,553	10,550	9,100	10,500
Quebec	44,993	20,916	51,543	32,486	53,200	35,500
Ontario	76,380	64,320	80,568	74,408	84,500	80,100
Manitoba	14,763	14,970	12,782	14,484	12,500	14,300
Saskatchewan	8,512	4,449	6,836	5,203	8,200	6,600
Alberta	20,556	17,807	18,607	17,852	18,900	18,400
British Columbia	35,522	33,395	34,126	35,879	36,200	41,300
Canada	225,194	178,100	233,461	213,437	242,200	230,000

Source: Statistics Canada.
p Preliminary.

Table 3. Canada, production (shipments) sand and gravel, by uses, by areas, 1972-73

		Atlantic Provinces	Quebec	Ontario	Western Provinces	Canada
		('000 short tons)				
Roads	1972	18,931	35,869	42,944	51,797	149,541
	1973	22,979	39,013	42,322	36,356	140,670
Concrete aggregate	1972	1,511	4,822	16,116	11,397	33,846
	1973	1,479	5,299	17,242	13,928	37,948
Asphalt aggregate	1972	2,476	1,242	5,314	4,416	13,448
	1973	2,461	2,185	4,480	5,066	14,192
Railroad ballast	1972	205	168	782	2,323	3,478
	1973	270	696	259	3,654	4,879
Mortar sand	1972	82	218	1,361	531	2,192
	1973	96	155	2,054	829	3,134
Backfill for mines	1972	128	77	721	3	929
	1973	84	175	846	326	1,431
Other fill	1972	1,123	2,566	9,034	8,832	21,555
	1973	1,461	2,330	12,826	11,902	28,519
Other uses	1972	12	31	108	54	205
	1973	169	1,690	539	290	2,688
Total sand and gravel	1972	24,468	44,993	76,380	79,353	225,194
	1973	28,999	51,543	80,568	72,351	233,461

Source: Statistics Canada with breakdown by Statistics Section, Mineral Development Sector.

Table 4. Canada, exports and imports of sand and gravel, 1972-74

	1972		1973		1974p	
	(short tons)	($)	(short tons)	($)	(short tons)	($)
Exports						
Sand and gravel						
United States	697,138	997,000	880,350	937,000	393,121	775,000
West Germany	22	1,000	373	8,000	—	—
Belgium and Luxembourg	—	—	99	8,000	—	—
Other countries	17	3,000	202	—	503	6,000
Total	697,177	1,001,000	881,024	953,000	393,624	781,000
Imports						
Sand and gravel, not elsewhere stated						
United States	1,067,532	1,032,000	1,136,055	1,280,000	1,733,489	2,465,000
United Kingdom	—	—	200	1,000	—	—
Other countries	101	17,000	11	1,000	341	20,000
Total	1,067,633	1,049,000	1,136,266	1,282,000	1,733,830	2,485,000

Source: Statistics Canada.
— Nil.

Outlook

On average, total aggregate consumption will rise in line with population increases, housing requirements and construction in general. Sand and gravel consumption will continue in competition with crushed stone and, in some applications, with lightweight aggregates. New resource reserves must be located, assessed and made part of any community development planning or regional zoning, with optimum land and resource utilization in mind. In the search for new sources of sand and gravel some countries are turning to the sea bed. The use of huge pumps and specially equipped ships to draw gravel from the sea floor and deposit it in attendant barges is already common practice in Britain. Such methods of obtaining aggregates can have far reaching environmental effects.

Prices for graded, washed and crushed gravel and sand will show slow but steady increase based on greater property costs, more sophisticated operating techniques and equipment, pollution and environmental considerations and higher labour costs.

Table 5. Canada, production (shipments) sand and gravel, by uses, 1972-73

	1972	1973
	('000 short tons)	
Roads — construction, maintenance, ice control	149,541	140,670
Concrete aggregate	33,846	37,948
Asphalt aggregate	13,448	14,192
Railroad ballast	3,478	4,879
Mortar sands	2,192	3,134
Backfill for mines	929	1,431
Other fill	21,555	28,519
Other uses	205	2,688
Total sand and gravel	225,194	233,461
$000	178,100	213,437

Source: Statistics Canada with breakdown by Statistics Section, Mineral Development Sector.

Table 6. Canada, production (shipments) and trade, sand and gravel, 1964-74

	Production	Imports	Exports
		(short tons)	
1964	193,791,358	593,455	461,464
1965	205,260,264	570,977	687,941
1966	217,271,189	566,800	700,255
1967	215,212,700	757,603	601,419
1968	205,234,509	683,490	496,525
1969	201,581,498	859,898	457,918
1970	202,656,000	502,739	1,240,192
1971	213,291,000	675,275	774,726
1972	225,194,000	1,067,633	697,177r
1973	233,461,000	1,136,266	881,024
1974p	242,200,000	1,733,830	393,624

Source: Statistics Canada.
p Preliminary. r Revised.

Selenium and Tellurium

G.E. WOOD

SELENIUM

Selenium is a rare earth metal which occurs sparsely disseminated throughout the earth's crust, where it is the 69th element in order of abundance. Selenium was first discovered in 1817 by the Swedish chemist Berzelius. Selenium occurs in minerals associated with copper, lead and iron sulphides. Commercial production is from electrolytic copper refinery slimes and from flue dusts from copper and lead smelters. Therefore, the quantity of selenium produced in any particular year is dependent upon the level of production in the world primary copper refining industry. Countries producing selenium include the United States, Canada, Japan, Russia, Belgium and Luxembourg, Sweden, Mexico, Yugoslavia, Finland, Peru, Australia and Zambia. A significant amount of selenium is also produced each year from secondary sources.

Production of selenium in all forms, from Canadian copper refineries plus refined selenium from domestic primary materials in 1974 was 591,000 pounds valued at $9,309,000 compared with 521,110 pounds valued at $4,762,946 in 1973. Refined production from all sources, including imported material and secondary sources, was 736,233 pounds in 1974 compared with 580,537 pounds in 1973. Canada was the second largest producer of selenium in the noncommunist world in 1974, surpassed only by Japan, and has an important influence on world prices.

Domestic consumption in 1974 amounted to 30,479 pounds compared with 22,435 pounds in 1973.

Table 1 gives details of Canadian selenium production, exports and consumption in 1974 and 1973. It can be seen that year-to-year reported production in all forms by province can show considerable variation, as can the amount of refined production from secondary sources. The value of selenium production increased sharply in 1974 reflecting mainly the large price increases which occurred during the year.

As shown in Tables 1 and 2, Canada's production of selenium is almost entirely exported. The quantity of selenium exported each year varies in a wide range and also often differs from production in the same year. The United States is Canada's major market, followed by the United Kingdom. These two trading partners purchased 93 per cent of Canada's selenium exports in 1974.

In the third quarter of 1974, production of selenium in the United States was adversely affected by a 42-day strike by copper industry workers in Arizona. The unusually high consumption of selenium in the United States in 1974 necessitated increased imports from Canada and releases of 125,900 pounds from stockpile by the General Services Administration (GSA).

Canadian Copper Refiners Limited at Montreal East, Quebec, operates Canada's largest selenium recovery plant. The company's refinery treats anode copper from the Noranda smelter of Noranda Mines Limited, the Murdochville smelter of Gaspé Copper Mines, Limited, both in Quebec, and blister and anode copper from the smelter of Hudson Bay Mining and Smelting Co., Limited at Flin Flon, Manitoba. The selenium plant can produce commercial-grade metal (99.5 per cent Se), high-purity metal (99.9 per cent Se) and a variety of metallic and selenium compounds. Annual capacity is 500,000 pounds of selenium in metal and salts.

The 180,000 pound-a-year selenium recovery plant of The International Nickel Company of Canada, Limited (Inco) at Copper Cliff, Ontario, treats tankhouse slimes from the company's Copper Cliff copper refinery and its Port Colborne, Ontario, nickel refinery. The marketable product is minus 200 mesh selenium powder (99.5 per cent Se).

Consumption and uses

Selenium is used in the manufacture of glass, steel, electronic components, explosives, animal and poultry feeds, fungicides, pigments and in xerography.

Selenium metal is marketed in two grades, namely commercial, with a minimum content of 99.5 per cent Se; and high purity, with a minimum content of 99.99 per cent Se. Other forms in which selenium is available include ferroselenium, nickel selenium, selenium dioxide, barium selenite, sodium selenate, sodium selenite and zinc selenite. Consumption by industrial sectors in the United States in 1974 is estimated to have been as follows: electronic components, 45 per cent; ceramic and glass, 34 per cent; chemicals, 13 per cent; and other uses, 8 per cent.

An important use of selenium in the electrical field is in the manufacturing of rectifiers used in electroplating, welding, battery charging and in other similar applications. Selenium is used in specialty transformers, varying in size from a fraction of a watt to 500 kw. Xerography (electrostatic printing), a dry photocopying or photographing process, uses a large quantity of selenium. The photoelectric (photogalvanic) cells, which find application in light-sensitive instruments, are a small consumer of selenium.

The glassmaking industry is one of the major consumers of selenium. Small quantities added to the glass batch neutralize the greenish tinge imparted to glass by iron impurities in the sand. Selenium is meeting with some competition from cerium in this application. The brilliant ruby-red glass used in traffic and other signal lenses, automotive taillights, marine equipment, infrared equipment and decorative tableware is produced by adding larger quantities of selenium to the glass batch. An increasing amount of selenium is used in tinted "black" glass which is used as the outer facing of many highrise office buildings.

Selenium has wide application in the chemical industry; the most important being the manufacture of the orange-red-maroon cadmium sulphoselenide pigments. They have considerable light stability, maintain their brilliance and are resistant to heat and chemical action. Their most important application is in the expanding high-temperature, cured-plastic industry, but they are also used to colour ceramics, paints, enamels and inks.

In proportions ranging from 0.2 to 0.35 per cent, selenium imparts improved machinability to stainless steel without affecting its corrosion resistance properties, and in lesser amounts improves the forging characteristics of steel. Small quantities of iron selenide, from 0.01 to 0.05 per cent, are widely used as an additive in steel casting to prevent pinhole porosity.

Finely ground metallic selenium and selenium diethyldithiocarbamate (selenac) are used in natural and synthetic rubber to increase the rate of vulcanization and to improve the aging and mechanical properties of sulphurless and low-sulphur rubber. Selenac is used as an accelerator in butyl rubber.

Selenium is used in the organic chemical and pharmaceutical industries; in the manufacture of cortisone and nicotine acids; in the preparation of various proprietary medicines for the control of dermatitis in human beings and animals; and in the control of certain diseases in animals and poultry. It is known that selenium is an essential element for normal physical

Table 1. Canada, selenium production, exports and consumption 1973-74

	1973		1974[p]	
	(pounds)	($)	(pounds)	($)
Production				
All forms[1]				
Ontario	94,950	867,843	124,000	1,953,000
Manitoba	117,200	1,071,208	44,000	693,000
Quebec	271,119	2,478,028	405,000	6,379,000
Saskatchewan	37,841	345,867	18,000	284,000
Total	521,110	4,762,946	591,000	9,309,000
Refined[2]	580,537		736,233	..
Exports (metal)				
United States	501,800	5,751,000	607,100	10,877,000
United Kingdom	213,600	2,148,000	258,800	4,177,000
Japan	3,800	20,000	21,300	414,000
Argentina	12,800	130,000	14,000	209,000
Netherlands	39,600	369,000	8,800	129,000
Brazil	25,000	244,000	10,200	124,000
West Germany	—	—	2,300	50,000
Other countries	26,500	257,000	5,000	46,000
Total	823,100	8,919,000	927,500	16,026,000
Consumption[3] (selenium content)	22,435	..	30,479	..

Source: Statistics Canada.
[1] Recoverable selenium content of blister copper treated at domestic refineries plus refined selenium from domestic primary materials. [2] Refinery output from all sources, including imported material and secondary sources. [3] Available data, consumption of selenium products (metal, metal powder, oxide), selenium content, as reported by consumers.
[p] Preliminary; .. Not available; — Nil.

development and prevents white muscle disease in livestock and poultry. Growing attention in this field could result in a large new market for selenium as a feed supplement. In the United States, the Food and Drug Administration has proposed that selenium be added to poultry and swine feed. However, selenium is highly toxic to both livestock and to human beings if consumed in excessive quantities.

Table 2. Canada, selenium production, exports and consumption, 1965-1974

	Production			
	All Forms[1]	Refined[2]	Exports Metals[3]	Consumption[4]
	(pounds)			
1965	512,077	514,595	451,200	15,888
1966	575,482	546,085	588,100	20,533
1967	724,573	754,360	539,400	21,017
1968	635,510	620,033	787,100	21,440
1969	599,415	820,277	872,300	15,572
1970	663,336	854,452	686,100	15,730
1971	718,440	885,931	571,500	15,686
1972	582,060	720,392	508,300[r]	20,677
1973	521,110	580,537	823,100	22,435
1974[p]	591,000	736,233	927,500	30,479

Source: Statistics Canada.
[1] Recoverable selenium content of blister copper treated at domestic refineries, plus refined selenium from domestic primary material. [2] Refinery output from all sources, including imported material and secondary sources. [3] Exports of selenium metal, metal powder, shot, etc. [4] Consumption (selenium content), as reported by consumers.
[p] Preliminary; [r] Revised.

Table 3. Noncommunist world production of selenium, 1972-74

	1972	1973	1974[e]
	(pounds)		
Japan	738,000	789,000	800,000
Canada	582,000	521,000	591,000
United States	769,000	627,000	504,000
Sweden	140,000	120,000	140,000
Belgium–Luxembourg	147,000	106,000	130,000
Other countries	193,000	238,000	253,000
Total	2,569,000	2,401,000	2,418,000

Sources: For Canada, Statistics Canada. For other countries, U.S. Bureau of Mines *Minerals Yearbook 1972* and U.S. Bureau of Mines Commodity Data Summaries, January 1975.
[e] Estimated.

Table 4. Canada, industrial use of selenium 1972-74

	1972	1973	1974
	(pounds of contained selenium)		
By end use			
Glass	15,354	18,873	22,241
Other[1]	5,323	3,562	8,238
Total	20,677	22,435	30,479

Source: Statistics Canada Consumers' Reports.
[1] Steel, pharmaceuticals.

A small amount of selenium is used in the manufacture of delay-action blasting caps.

Interest has been revived in the use of selenium in the photogalvanic cell, which converts light energy to electrical energy, as new sources of energy are sought to offset fuel and energy shortages. Also, with respect to the energy situation, an increased demand for selenium-tinted windows, which have a lower heat conductivity than conventional glass, is expected.

Outlook

Selenium production is primarily a byproduct of copper refining, but the relationship is trending towards a lower proportion of selenium output as existing selenium-rich copper reserves are exhausted. An increasing amount of copper production is being derived from selenium-poor ores. Furthermore, environmental standards are leading to technical changes in copper extraction processes that may result in lower selenium recoveries unless a new technology is developed to extract selenium.

It is likely that Canadian production of selenium will decline in the near-term for the reasons mentioned above, and also because of the expected decline in Canadian refined copper production in 1975. The growth in demand for selenium will probably result in pressures which will produce a trend towards higher prices.

The United States exhausted its stockpile of selenium during the second quarter of 1974.

Prices

As can be seen from the accompanying table, selenium prices in the United States rose steadily during 1974 to end the year at $18 a pound for commercial grade material and $21 a pound for high-purity grade. Merchant prices ended the year at $11 a pound for commercial grades.

According to *Metals Week*, United States selenium prices per pound for the year 1974 were as follows:

	Commercial Grade	High-Purity Grade		Commercial Grade	High-Purity Grade
January 1 to February 6	$11.00–$12.00	$14.00	May 1 to May 12	$15.00–$18.00	$18.00
February 7 to March 7	$11.00–$12.00	$14.00–$15.00	May 13 to May 14	$15.00–$18.00	$21.00
March 8 to March 10	$12.00–$15.00	$18.00	May 15 to December 31	$18.00	$21.00
March 11 to April 30	$15.00	$18.00			

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
92804-4	Selenium metal	5%	10%	15%

United States

Item No.		
420.50	Selenium dioxide	free
420.52	Selenium salts	free
420.54	Other selenium compounds	5%
632.40	Selenium metal, unwrought, other than alloys, waste and scrap	free
632.84	Selenium metal alloys, unwrought	9%
633.00	Selenium metals, wrought	9%

European Communities

Item No.		Conventional Rate of Duty
28.04 C.11	Selenium metal	free

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706. Official Journal of the European Communities, 1 Nov. 1974.

TELLURIUM

Like selenium, tellurium is recovered in Canada from the tankhouse slimes of the two electrolytic copper refineries and the Port Colborne nickel refinery. It is refined by the same two companies, namely Canadian Copper Refiners Limited at Montreal East, Quebec, and The International Nickel Company of Canada, Limited at Copper Cliff, Ontario.

Production of tellurium in all forms from Canadian ores amounted to 54,000 pounds, valued at $314,000 compared with 1973 production of 92,284 pounds, valued at $560,164. Tellurium production is related to selenium output because tellurium is a co-product of selenium recovery. Refined output from all sources, including imported material for the years 1974 and 1973, was 119,031 pounds and 93,205 pounds, respectively.

Canadian Copper Refiners Limited has an annual capacity to produce 60,000 pounds of tellurium in the form of powder, stick, lump and dioxide. The Copper Cliff refinery has capacity to produce 18,000 pounds of tellurium a year in the form of dioxide.

Consumption and uses

Tellurium is mainly recovered as a byproduct of copper refining and the supply is, therefore, related to copper production. Under present technological practices, a low ratio of recovery is obtained but is adequate to meet demand. Low production, and the

Table 5. Canada, tellurium production and consumption, 1973-74

	1973		1974p	
	(pounds)	($)	(pounds)	($)
Production				
All forms[1]				
Quebec	62,772	381,026	30,000	138,000
Ontario	15,346	93,150	20,000	137,000
Manitoba	10,709	65,004	3,000	28,000
Saskatchewan	3,457	20,984	1,000	11,000
Total	92,284	560,164	54,000	314,000
Refined[2]	93,205	..	119,031	..
Consumption[3](refined)	1,222	..	981	..

Source: Statistics Canada.
[1] Recoverable tellurium content of blister copper treated, plus refined tellurium from domestic primary material. [2] Refinery output from all sources, including imported material and secondary sources. [3] Available data, reported by consumers.
p Preliminary; .. Not available.

odour and toxicity of tellurium continue to inhibit its use in industry. When it is absorbed into the body by direct contact or inhalation, tellurium has an adverse physiological effect, resulting in a strong garlic odour imparted to the breath and perspiration.

Most of the commercial grade tellurium sold by the primary producers is in the form of slab, stick, lump, tablet and powder. It is also sold as copper and iron alloys.

Table 6. Canada, tellurium production and consumption, 1965-74

	Production		Consumption
	All Forms[1]	Refined[2]	Refined[3]
		(pounds)	
1965	69,794	71,730	1,870
1966	72,239	72,745	862
1967	73,219	70,105	981
1968	70,991	65,926	4,605
1969	62,048	72,664	3,532
1970	58,333	64,634	880
1971	24,488	43,558	1,178
1972	45,649	58,446	1,419
1973	92,284	93,205	1,222
1974p	54,000	119,031	981

Source: Statistics Canada.
[1] Includes recoverable tellurium content of blister copper, not necessarily recovered in year designated, plus refined tellurium from domestic primary metal. [2] Refinery production from all sources, including imported material and secondary sources. [3] Available data, reported by consumers.
p Preliminary.

In the United States, consumption by major use is estimated to be: iron and steel products–62 per cent; nonferrous metal products–19 per cent; rubber products–11 per cent; chemicals–6 per cent; other–2 per cent.

The primary metal industries are by far the largest consumers of tellurium. Added to copper and low carbon and alloy steels, the machinability is greatly improved. In stainless steel castings it reduces or prevents pinhole porosity. A very small quantity of tellurium added to molten iron controls the chill depth of grey-iron castings. An alloy, containing 99.5 per cent copper–0.5 per cent tellurium is used in the manufacture of welding tips and communications equipment because it can be hot- or cold-worked, and the thermal and electrical conductivity is only slightly less than that of copper. Up to 0.1 per cent tellurium in

Table 7. Noncommunist world production of tellurium, 1972-74

	1972	1973	1974e
		(pounds)	
United States	257,000	241,000	194,000
Japan	77,000	94,000	100,000
Canada	46,000	92,000	54,000
Peru	40,000	40,000	45,000
Total	420,000	467,000	393,000

Sources: For Canada, Statistics Canada. For other countries, U.S. Bureau of Mines Minerals Yearbook, 1972; U.S. Bureau of Mines Commodity Data Summaries, January 1975.
e Estimated.

lead forms an alloy that has improved resistance to wear, vibration breakdown and corrosion, and, because of these properties, is used to sheath marine cables and to line tanks subject to chemical corrosion.

Tellurium, as a component of alloys containing gallium, bismuth and lead, is used in thermoelectric devices for the direct conversion of heat into electricity, and for cooling as a result of its Peltier effect. A thermonuclear heart pacemaker that employs the thermoelectric principle is under development. In the device, nuclear power provides heat, and a tellurium alloy converts the heat to electrical energy. The minimum life of this experimental pacemaker is reported to be ten years.

Tellurium is used as a secondary vulcanizing agent in natural and synthetic rubber in which it increases toughness and resistance to abrasion and heat. These characteristics made possible its application for the jacketing of portable electric cable used in mining, dredging and welding and for specialized conveyor belting. Tellurium is employed to eliminate porosity in thick rubber sections and as an accelerator for butyl applications.

Some tellurium is consumed in glass and ceramic production to develop blue-to-brown coloration; in the preparation of insecticides and germicides; and in the manufacture of delay-electric blasting caps and pigments.

Outlook

Supply is largely limited to that which is available from copper output and, as in the case of selenium, new copper production is increasingly derived from tellurium-poor ores. The short- to medium-term outlook is for limited availability of the metal and a static or slow growth in demand. Substitutes are readily available for the major uses and will tend to constrain price changes to modest increases.

Price

As in the case of selenium, and most other metals, the price of tellurium rose substantially during 1974. At the beginning of the year the United States price was $7.00 a pound and rose to $9.00–$10.00 a pound on December 2.

According to *Metals Week*, the United States tellurium price per pound for slab in 150-pound lots increased as follows:

January 1 to April 30	$7.00
May 1 to May 5	$7.00–$9.00
May 6 to December 1	$9.00
December 2 to December 31	$9.00–$10.00

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
92804-5	Tellurium metal	5%	10%	15%

United States

Item No.		
421.90	Tellurium compounds	5%
427.12	Tellurium salts	5%
632.48	Tellurium metal, unwrought, other than alloys, and waste and scrap (duty on waste and scrap suspended to June 30, 1975)	4%
632.84	Tellurium metal alloys, unwrought	9%
633.00	Tellurium metal, wrought	9%

European Communities

Item No.		Conventional Rate of Duty
28.04	C.III Tellurium metal	2.4%

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706. Official Journal of the European Communities, 1 Nov. 1974.

Silica

G.H.K. PEARSE

Silica (SiO_2) occurs as the mineral quartz in a variety of rocks and unconsolidated sediments. Although the mineral is one of the most abundant, making up an estimated 12 per cent of the earth's crust, commercial sources of silica are presently restricted to uncommonly pure sands, sandstones, quartzites and vein quartz. Further, because of its low unit value, an economically viable deposit should normally be mineable by low-cost open-pit methods and, ideally, be located close to consuming areas in order to minimize transportation costs.

The principal uses for silica are: as the chief constituent in glass; as metallurgical flux; in the manufacture of silicon carbide; as an ore of silicon and ferrosilicon; as foundry sand for metal castings; in sand blasting; and as filler materials in tile, asbestos pipe, concrete and bricks.

Production of silica in Canada in 1974 was 2.69 million short tons, virtually no change from 1973. The tonnage remains short of the record 3.2 million tons shipped in 1970.

Most of the silica produced in Canada is low-value lump silica and silica sand consumed as a metallurgical flux. High-quality silica sand suitable for the manufacture of glass is produced by two companies in Canada. Indusmin Limited, the largest, operates beneficiation plants in southern Ontario and Quebec. Steel Brothers Canada Ltd. quarries high-grade silica sandstone on Black Island in Lake Winnipeg and processes the material at the company's plant located at Selkirk, Manitoba. This company acquired the quarry and plant from The Winnipeg Supply and Fuel Company, Limited in 1972.

Canada imports high-grade silica sand for use in glass manufacturing, sand suitable for foundry castings, silica and crystallized quartz and silica brick. In 1974, imports, virtually all from the United States, totalled 1.07 million tons, marginally lower than in 1973.

Principal producers and developments

Newfoundland. Newfoundland Enterprises Limited, a subsidiary of Armand Sicotte & Sons Limited, produces silica from a quarry at Villa Marie, on the Avalon Peninsula. The silica is hauled by truck about 12 miles to Long Harbour where it is used as a flux in the manufacture of elemental phosphorus by Erco Industries Limited. Erco's $40 million phosphorus plant requires about 100,000 tons of silica annually.

Quebec. Indusmin Limited produces a wide variety of silica products at its mill near Saint-Canut, Quebec. In addition to quarrying Potsdam sandstone adjacent to the Saint-Canut mill, the company quarries a friable Precambrian quartzite from a deposit near Saint-Donat. Material from the Saint-Donat quarry is trucked about 50 miles to the Saint-Canut mill for processing. Products produced at Saint-Canut include silica sand suitable for glass and silicon carbide manufacture; foundry sand; and silica flour for use as a filler in tiles, asbestos pipe, concrete blocks and bricks. The silica sand suitable for glass manufacture is marketed in Quebec, while much of the product suitable for use in the construction industry is sold in Ontario. The balance of Quebec's silica sand requirements for glass manufacture is imported from the United States.

Union Carbide Canada Mining Ltd. quarries quartzitic sandstone at Melocheville, Beauharnois County, for use in ferrosilicon manufacture at Beauharnois. Fines from this operation are used in foundry work, cement manufacture and as a metallurgical flux.

Baskatong Quartz Products Ltd. produces lump silica and crushed quartz from a deposit on the southwest shore of Lake Baskatong. The lump silica is used in the manufacture of silicon metal and, to a lesser extent, as grinding pebble. The crushed quartz is sold for use as exposed aggregate in decorative concrete. A new 52,000-ton-a-year ferrosilicon plant is slated to come on stream at Bécancour, Quebec in 1976. The company, S.K.W. Electro-Metallurgy Canada Ltd. will obtain its raw material from a high-purity silica deposit 25 miles north of Baie St-Paul in Charlevoix County which will be operated by Baskatong Quartz Products. The silica will be shipped by truck to Baie St-Paul and thence by rail, 140 miles to Bécancour. Silica production

Table 1. Canada, silica production and trade, 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Production, quartz and silica sand[1]				
By province				
Quebec	907,044	5,276,015	738,000	5,128,000
Ontario	1,181,348	3,360,622	1,250,000	4,000,000
Manitoba	367,642	1,286,206	390,000	1,635,000
Saskatchewan	133,115	120,000	140,000	140,000
Alberta	. .	362,217	. .	400,000
Newfoundland	. .	363,443	. .	310,000
British Columbia	32,187	173,678	35,000	200,000
Nova Scotia	. .	109,000	. .	143,000
Total	2,765,944	11,051,181	2,686,000	11,956,000
By use				
Flux	1,485,230	3,125,000	. .	. .
Ferrosilicon	257,323	821,098	. .	. .
Glass and fibreglass	229,917	2,092,352	. .	. .
Other uses[2]	793,474	5,012,731	. .	. .
Total	2,765,944	11,051,181	. .	. .
Imports				
Silica sand				
United States	1,064,662	5,788,000	1,053,696	7,558,000
United Kingdom	—	—	41	4,000
Belgium and Luxembourg	22,695	83,000	—	—
West Germany	2	2,000	—	—
France	1	1,000	—	—
Total	1,087,360	5,874,000	1,053,737	7,652,000
Silex and crystallized quartz				
United States	1,092	182,000	1,825	267,000
Netherlands	—	—	7	9,000
Brazil	—	—	. .	4,000
Mexico	—	—	10	2,000
Total	1,092	182,000	1,842	282,000
Firebrick and similar shapes, silica				
United States	3,612	766,000	11,561	2,294,000
Japan	—	—	3,822	1,356,000
Netherlands	—	—	769	47,000
United Kingdom	—	—	155	19,000
West Germany	26	4,000	5	4,000
Total	3,638	770,000	16,312	3,720,000
Exports				
Quartzite				
United States	114,044	190,000	158,526	330,000
Barbados	1	. . .	—	—
Total	114,045	190,000	158,526	330,000

Source: Statistics Canada.
[1] Producers' shipments, include crude and crushed quartz, crushed sandstone and quartzite and natural silica sand. [2] Includes foundry use, sand blasting, silica brick, concrete products, chemical manufacture, building products and silicon carbide.
p Preliminary.
— Nil. . . Not available for publication. . . . Less than one thousand dollars.

will commence in the fall of 1975.

Ontario. Indusmin Limited quarries a high-grade silica deposit on Badgeley Island in Georgian Bay. The deposit consists of very pure Precambrian Lorraine quartzite. A grinding and processing plant at Midland and a primary crushing plant at the deposit some 120 miles north of Midland, across Georgian Bay, came on stream during the first half of 1970. The Badgeley Island operation has a capacity of approximately 1 million tons a year of washed lump silica and fine material. The Midland plant capacity is about 500,000 tons a year of refined silica products. Primary products from the crushing plant on Badgeley Island are shipped directly to manufacturers of ferrosilicon and silicon metal, and to the Midland grinding plant for further processing. Products from the Midland plant go to glass, ceramic, chemical and other industries in Ontario.

The Midland plant production has been unsatisfactory from the start because of difficulties experienced with crushing, grinding and classification circuits. An unacceptable percentage of fines is produced, and modifications to these circuits have had limited success. The fines must be removed to meet glass grade specifications and research into uses for the large volume of fines is actively being pursued.

Manitoba. Steel Brothers Canada Ltd. quarries friable sandstone of the Winnipeg Formation at Black Island in Lake Winnipeg. The sandstone is then barged to the company's processing plant at Selkirk where it is washed, sized and packaged for sale. The company provides silica sand for a large portion of the western Canada market. Silica sand suitable for the manufacture of glass containers is shipped to Alberta. The majority of the remaining production is consumed in the Manitoba market, largely as foundry sand. In addition to the silica sand operation, the company quarries quartzite and sand for The International Nickel Company of Canada, Limited's smelter at Thompson, Manitoba, for use as a metallurgical flux.

Saskatchewan. Hudson Bay Mining and Smelting Co., Limited obtains silica for smelter flux from Pleistocene glacial sand deposits in Saskatchewan, adjacent to its operations at Flin Flon Manitoba.

Alberta. Sil Silica Ltd. quarries Pleistocene dune sands at Bruderheim, 40 miles northeast of Edmonton. A washing and flotation plant upgrades material running 93 per cent silica, 3 per cent alumina, 1 per cent clay and 0.75 per cent iron oxide to products suitable for fibreglass manufacture, sand blasting and foundry use. Since operations started in 1971, capacity has tripled to more than 60,000 tons a year. Reserves are adequate for many years.

British Columbia. Pacific Silica Limited ceased production of silica for ferrosilicon and silicon carbide in August 1968 at its deposit near Oliver, British Columbia. Stucco dash and roof chips are being produced from existing stockpiles.

Uses and specifications

The principal uses of lump silica, silica sand and crushed quartzite, together with specifications by consuming industry, are as follows:

Lump silica. *Silica flux.* Massive quartz, quartzite, sandstone and unconsolidated sands are used for flux in smelting base-metal ores where iron and basic oxides are slagged as silicates. Because free silica is the active slagging agent, the free silica content should be as high as possible. Minor amounts of impurities such as iron and alumina are tolerable. Lump silica used as a flux is usually minus one-plus 5/16 inch in size.

Silicon and silicon alloys. Lump quartz, quartzite and well cemented sandstones are used in the manufacture of silicon, ferrosilicon and other silicon alloys. Lump silica 3/4 to 5 inches in size, obtained by crushing quartzite or indurated sandstone, is used in the manufacture of ferrosilicon. Chemical specifications are: silica, 98.0 per cent; alumina (Al_2O_3), less than 1.0 per cent; iron (Fe_2O_3) plus alumina, not over 1.5 per cent; lime and magnesia, each less than 0.2 per cent. Phosphorus and arsenic should be absent.

Silica brick. Quartz and quartzite crushed to minus 8 mesh are used in the manufacture of silica brick for high-temperature refractory furnaces. Chemical specifications for this use are: silica, 96 to 98 per cent; alumina, less than 0.1 per cent; combined iron and alumina, less than 1.5 per cent. Other impurities such as lime and magnesia should be low.

Aggregate. Crushed and sized quartz and quartzite are used as exposed aggregate in precast concrete panels for buildings, slabs, sidewalks and for other decorative landscape purposes.

Other uses. Lump quartz and quartzite are used as lining material in ball and tube mills and as lining and packing for acid towers. In some instances, naturally occurring quartzitic pebbles are used as grinding media in the crushing of various nonmetallic ores.

Silica sand. *Glass.* High-purity, natural occurring sand or material produced by crushing quartzite or sandstone is used in the manufacture of glass. Minor amounts of certain elements are particularly objectionable because they act as powerful colourants. For example, chromium should not exceed six parts per million and cobalt not over two parts per million.

Silicon carbide. Silica sand used in the manufacture of silicon carbide should have a silica content of at least 99 per cent. Iron and alumina should be less than 0.1 per cent each; lime, magnesia and phosphorus should be absent. Sand, should be plus 100 mesh, with the bulk of it plus 35 mesh.

Hydraulic fracturing. Sand is used in the hydraulic fracturing of oil-bearing strata to increase open pore spaces, thus increasing the productivity of the oil well. Sand utilized for this purpose should be clean and dry, have a high compressive strength, be free of acid-consuming constituents and have a grain size between 20 and 35 mesh. Grains should be well rounded to facilitate placement in the formation in order to provide maximum permeability.

Foundry sand. Naturally occurring sand or material produced by crushing friable sandstone is used in the foundry industry for moulding. For foundry purposes, the chemical composition of the sand is not as important as its physical properties. For the end-use, a highly refractory sand having rounded grains with frosted or pitted surface is preferred. Grain sizes vary between 20 and 200 mesh. Rounded grains are preferable to angular fragments because they allow maximum permeability of the mould and maximum escape of gas during casting.

Sodium silicate. Sand for the manufacture of sodium silicate should contain more than 99 per cent silica, less than 0.25 per cent alumina, less than 0.05 per cent lime and magnesia combined and less than 0.03 per cent iron (Fe_2O_3). All sand should be between 20 and 100 mesh.

Other minor uses. Coarsely ground, closely sized quartz, quartzite, sandstone and sand are used as abrasive grit in sandblasting and in the manufacture of sandpaper. Various grades of sand are used as filtering media in water-treatment plants; silica is also required in portland cement manufacture where there is insufficient silica in the limestone or other raw material used in the process.

Silica flour. Silica flour produced by the fine grinding of quartzite, sandstones and lump quartz is used in the ceramics industry for enamel frits and pottery flint. For use in enamels, the silica flour must be over 97.5 per cent silica, with alumina (Al_2O_3) less than 0.5 per cent and iron (Fe_2O_3) less than 0.2 per cent. Silica flour is also used as an inert filler in rubber and asbestos cement products, as an extender in paints and as an abrasive agent in soaps and scouring pads. It is used increasingly in autoclave-cured concrete products such as building blocks and panels, approximately 45 pounds of silica flour being used for each 100 pounds of portland cement consumed.

Quartz crystal. Quartz crystal with desirable piezoelectric properties is used in radio-frequency control, radar and other electronic devices. Natural crystal for this purpose must be perfectly transparent and free from all impurities and flaws. The individual crystals should weigh 100 grams or more and measure at least two inches in length and one inch or more in diameter. Much of the world's crystal requirement is met by natural crystal from Brazil; however, natural crystal is being rapidly replaced by excellent quality, synthetic crystal grown in the laboratory from quartz "seed". Artificial quartz crystals are oriented for the cutter

Table 2. Canada, silica production and trade, 1965-74

	Production	Imports		Exports	Consumption
	Quartz and[1] Silica Sand	Silica Sand	Silex or Crystallized Quartz	Quartzite	Quartz and Silica Sand
			(short tons)		
1965	2,433,685	834,780	5,104	111,533	3,156,466
1966	2,299,660	1,013,285	288	156,038	3,372,668
1967	2,610,740	952,459	142	56,200	3,501,186
1968	2,554,565	1,107,000	116	64,086	3,684,424
1969	2,300,374	1,285,228	35	81,488	3,526,264
1970	3,238,037	1,296,537	205	64,945	4,386,433
1971	2,553,884	1,420,278	312	100,664	3,755,133
1972	2,663,836	1,368,845	9	137,569	3,935,666[r]
1973	2,765,944	1,087,360	1,092	114,045	3,937,450
1974	2,686,000	1,053,737	1,842	158,526	. .

Source: Statistics Canada.
[1] Includes silica to make silica brick.
[r] Revised.
. . Not available.

prior to delivery. The high degree of purity permits product yields at least four times that of natural quartz crystal.

There is no production of quartz crystal in Canada, and only a small demand exists. Domestic requirements are met mainly by imports, chiefly from the United States, with minor amounts from Brazil. Quartz Crystals Mines Limited, Toronto, produced minor amounts from an occurrence near Lyndhurst, Ontario, several years ago.

A quartz-crystal stockpile of 182.8 tons was sold by the Canadian Government during the year.

Table 3. Canada, available data on consumption of silica, by industries, 1972-73

	1972[r]	1973
	(short tons)	
Smelter flux[1]	1,616,718	1,485,230
Glass manufacture (incl. glass fibre)	804,401	752,830
Foundry sand	921,960	925,845
Artificial abrasives	166,018	179,609
Ferrosilicon	171,979	149,903
Metallurgical use	80,565	79,798
Concrete products	18,534	17,986
Gypsum products	6,135	10,774
Asbestos products	48,522	47,987
Chemicals	23,295	25,169
Fertilizer, stock, poultry feed	11,991	7,339
Other	65,548	254,980
Total	3,935,666	3,937,450

Source: Statistics Canada for source data. Classification by Statistics Section, Mineral Development Sector.
[1] Producers' shipments of quartz and silica for flux purposes.
[r] Revised.

Outlook

The economic downturn which began in mid-1974 is expected to reduce the demand for silica in all sectors in 1975. Requirements for smelter flux, the major consuming sector, will be down by as much as 15 per cent. Similarly, softness in housing construction, auto manufacture and other industries will result in a marked decline in the demand for silica. On the other hand, sales potential through displacement of imports is a strong factor and this along with the start up of Baskatong Quartz Products Ltd.'s new mine in Charlevoix County, could neutralize the negative effect on domestic production. Output in 1975, therefore should remain around 2.7 million tons and a surge in growth is expected for 1976.

Tariffs

Canada

Item No.		
29500-1	Ganister and sand	free
29700-1	Silex or crystallized quartz, ground or unground	free

United States

Item No.		(¢ per lt)
513.11	Sand containing 95% or more silica, and not more than 0.6% of oxide of iron	
	On and after Jan. 1, 1972	25
513.14	Sand, other	free
514.91	Quartzite, whether or not manufactured	free
523.11	Silica, not specially provided for	free

Sources: The Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. Tariff Schedules of the United States Annotated (1975), T.C. Publication 706.

Silicon, Ferrosilicon and Silicon Carbide

MICHEL A. BOUCHER

For most of 1974, world demand for silicon metal and ferrosilicon was high and prices reached unprecedented levels. At the end of the year, however, demand slackened and prices declined. The demand for ferrosilicon depends to a great extent on steel production, and demand for silicon metal depends mainly on the production of steel and aluminum alloys, and to a much smaller extent, on copper alloys production. In all three cases demand was strong for most of the year and then declined. The manufacture of ferrosilicon and silicon metal is energy intensive, and there is no doubt that the energy crisis adversely affected the supply of these two commodities. Statistics are not available for silicon carbide consumption, but demand is reported to be growing at some 10 per cent a year.

Canada

The production of silicon, ferrosilicon and silicon carbide is energy-intensive. All plants are located near a source of inexpensive electricity.

Both Union Carbide Canada Limited and Chromium Mining and Smelting Corporation Limited (Chromasco) obtain high-quality quartzitic sandstone from a quarry at Melocheville, near Beauharnois, Quebec. Relatively low-cost power rates, location on the St. Lawrence-Great Lakes waterway transport system, and access to nearby quartzite make Beauharnois a favourable production location. Union Carbide also obtains high-quality quartzitic sandstone from a quarry near Lac Baskatong in the Mont-Laurier area of Quebec, but these reserves will soon be depleted.

Typical production data for a ton of 48–50 per cent Fe–Si is as follows:

Material	Tons
Quartzite (98 per cent SiO_2)	1.15
Pea-size coke (89 per cent fixed C)	0.26
Nut coal (73 per cent fixed C)	0.35
Wood chips	0.30
Shredded steel scrap	0.53
Electrode paste	32 kg
Energy consumption	4,900 kWh/ton

Two typical quartzite analyses for silicon metal production are as follows:

Element	per cent	per cent
SiO_2	99.67	99.34
Fe_2O_3	0.08	0.06
Al_2O_3	0.07	0.17
CaO	0.01	0.07
Loss on ignition	0.12	0.18

Silicon carbide production requires a silica of similar chemical composition to the one shown above, but the Al_2O_3 content must be smaller than 0.1 per cent.

Most of the 85 and 95 per cent Si grade ferrosilicon produced at Chromasco is used at the company's specialty products plant at Haley, Ontario, where ferrosilicon is employed as a reductant in the reduction of calcined dolomite to magnesium metal.

Union Carbide provides about 90 per cent of the silicon metal requirements of the Aluminum Company of Canada, Limited (Alcan). Silicon metal is consumed at aluminum smelters in Arvida, Beauharnois and Shawinigan in Quebec, and at Kitimat, British Columbia.

Union Carbide Corporation, the parent of Union Carbide Canada Limited, is a major world supplier of ferroalloys with five plants in the United States, three in Canada, two in Europe, and one in Africa. Union Carbide Corporation also owns a Norwegian subsidiary, A/S Meraker Smelteverk, that can produce 12,000 tons of ferrosilicon and 28,000 tons of silicon metal, largely for the European Economic Community Market. Union Carbide is a major world producer of ferroalloys, with plants in Canada, the United States, Europe and Africa.

Chromasco plans to start its new 24,000 kw ferrosilicon furnace by mid-1975. The furnace will be capable of producing some 30,000 tons a year of ferrosilicon (principally the 50 per cent Si grade) at Beauharnois, Quebec.

Seuddeutsche Kalkstickstoff-Werke (SKW), a West German subsidiary of Hoechst AG and a state-owned holding firm, is building a $40 million silicon metal and ferrosilicon plant at Bécancour, Quebec. When

(text continued on page 448)

Table 1. Canada, silicon, ferrosilicon and silicon carbide production facilities, 1974

Producer	Plant location	Product	Production capacity
			(short tons)
Chromium Mining & Smelting Corporation, Limited	Beauharnois, Que.	Fe–Si (50%)	20,000
	Beauharnois, Que.	Fe–Si (50%)	30,000[1]
	Beauharnois, Que.	Fe–Si (75%)	5,000
	Beauharnois, Que.	Fe–Si (85%)	2,000
Union Carbide Canada Limited	Beauharnois, Que.	Fe–Si (50%)	60,000
	Chicoutimi, Que.	Fe–Si (75%)	20,000
	Beauharnois, Que.	Si (1% Fe, 0.5% Fe, 0.35% Fe)	14,000
S.K.W. Electro-Metallurgy Canada Ltd.[2]	Becancour, Que.	Fe–Si (50%)	25,000
		Si	25,000
Canadian Carborundum Company, Limited	Shawinigan, Que.	SiC	50,000
Norton Company of Canada, Limited	Cap de la Madeleine, Que.	SiC	23,000
Electro Refractories & Abrasives Canada Ltd.	Cap de la Madeleine, Que.	SiC	7,000
Exolon Company of Canada, Ltd.	Thorold, Ont.	SiC	10,000
General Abrasive (Canada) Limited	Niagara Falls, Ont.	SiC	15,000
Norton Company of Canada, Limited	Niagara Falls, Ont.	SiC	12,000

Source: Compiled from various sources by the Department of Energy, Mines and Resources, Ottawa.
[1] To be in production in mid-1975. [2] Under construction.

Table 2. Canada, ferrosilicon, silicon carbide and some other ferroalloys[1], exports and imports, 1973–74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Exports				
Ferrosilicon				
United States	23,017	2,761,000	32,695	4,754,000
United Kingdom	21,264	2,807,000	14,600	3,732,000
Japan	190	70,000	482	222,000
Australia	980	367,000	305	134,000
Dominican Republic	399	84,000	227	78,000
Switzerland	—	—	157	58,000
Angola	—	—	607	55,000
Argentina	—	—	12	39,000
Other countries	4,964	679,000	526	91,000
Total	50,814	6,768,000	49,611	9,163,000

Table 2 (concl'd)

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Exports (concl'd)				
Silicon carbide, crude and grains				
United States	102,494	15,665,000	100,883	15,827,000
United Kingdom	2	1,000	145	27,000
Dominican Republic	—	—	—	1,000
Total	102,496	15,666,000	101,028	15,855,000
Ferroalloys, nes				
United States	1,861	911,000	2,447	1,492,000
Argentina	655	766,000	112	439,000
Australia	81	90,000	112	357,000
United Kingdom	1,639	1,980,000	298	356,000
Japan	215	520,000	91	246,000
Spain	494	137,000	37	143,000
Brazil	290	19,000	569	41,000
Other countries	1,162	206,000	140	116,000
Total	6,397	4,629,000	3,806	3,190,000
Imports				
Ferrosilicon				
United States	4,556	1,582,000	4,919	2,513,000
Yugoslavia	5,975	1,427,000	4,553	1,581,000
Norway	2,518	746,000	1,604	811,000
France	232	83,000	354	217,000
United Kingdom	1	...	171	146,000
Other countries	960	297,000	39	25,000
Total	14,242	4,135,000	11,640	5,293,000
Silicomanganese, including silico spiegel				
United States	7,285	1,448,000	471	180,000
South Africa	1,147	139,000	126	21,000
Yugoslavia	1,105	221,000	—	—
Norway	1,213	198,000	—	—
Total	10,750	2,006,000	597	201,000
Ferroalloys, nes				
Greece	18,178	11,539,000	8,619	6,878,000
United States	4,440	2,670,000	5,986	5,029,000
Dominican Republic	4,049	4,007,000	3,019	3,092,000
Brazil	282	785,000	274	997,000
France	874	399,000	1,421	928,000
United Kingdom	37	91,000	60	181,000
West Germany	18	8,000	110	131,000
Other countries	4,495	988,000	21	21,000
Total	32,373	20,487,000	19,510	17,257,000

Source: Statistics Canada.
[1] Important other ferroalloys are discussed in the mineral reviews of the respective metals; e.g., those of manganese, nickel, titanium.
p Preliminary; nes Not elsewhere specified; — Nil; ... Less than one thousand dollars.

operation begins in mid-1976, the plant will produce 25,000 tons of silicon metal and 25,000 tons of ferrosilicon a year for the aluminum and steel industries. Some 60 per cent of the production will be sold in North America, mainly to the United States, and 40 per cent will go to Europe, Japan and other steel producing countries. The plant is located in an area where electricity is readily available and labour costs relatively low. Most of the raw materials will come from Quebec.

Over 90 per cent of the production of silicon carbide, crude and grains is exported, with almost all of it going to the United States in an unprocessed form. Ontario is the only province in Canada that processes silicon carbide and makes such products as grinding wheels and bonded abrasives. During the year, Shinano Electric Refining Co. Ltd., one of the four leading silicon carbide producers in Japan, was investigating the possibility of building a 50,000-metric-tons silicon carbide plant in Canada.

World production and foreign developments

There are no up-to-date statistics on ferrosilicon production in the world. However, it is known that the United States and the U.S.S.R. are the two largest producers. Norway is the largest exporter, followed by the U.S.S.R., Canada and France.

Table 3. Ferrosilicon production and trade, 1972

	Production	Imports	Exports
	(short tons, gross weight)		
Austria	..	14,707	..
Belgium and Luxembourg	..	37,304	..
Canada	..	9,564	53,295
France	..	..	60,852
West Germany	..	141,775	15,508
India	34,702	..	..
Italy	..	27,230	..
Japan	..	18,883	2,980
Norway	..	..	234,093
South Africa	..	..	27,672
Sweden	63,687	15,222	24,742
United Kingdom	..	133,448	334
United States	670,689	39,600	7,367
U.S.S.R.	..	..	153,552
Yugoslavia	..	..	34,003

Sources: *Metal Bulletin, Handbook* 1974; for Canada, Statistics Canada; for U.S., Bureau of Mines *Minerals Yearbook*, Preprint 1972.
.. Not available.

In 1970, world production of ferrosilicon, irrespective of grade, was estimated at 2,380,000 metric tons. Table 4 shows Canada's position as a producer and supplier of ferrosilicon.

Table 4. Ferrosilicon production, consumption, exports, 1970

Country	Production	Consumption	Exports
		(metric tons)	
United States	645,000	625,000	41,000
U.S.S.R.	600,000	475,000	125,000
Japan	300,000	323,000	—
Norway	194,000	—	216,000
France	170,000	127	47,000
Canada	100,000	56,000	50,000
Italy	78,000	101,000	2,000
Sweden	45,000	44,000	20,000

Source: Roskill Information Services Ltd.
— Nil.

In 1974, total world production of silicon metal, excluding that of the U.S.S.R., is estimated at 380,000 tons, while consumption is estimated at 400,000 tons.

Production capacity statistics for silicon metal are not available, however, an estimate of the production capacity of the major producers in 1971 was prepared by Roskill Information Services Ltd. and is reproduced below.

Table 5. Estimated silicon metal capacity in 1971, by country

Country	Estimated capacity
	(metric tons)
United States	140,000
France	114,000
Japan	75,000
Norway	49,000
Others	146,000

Source: Roskill Information Services Ltd.

Table 6 shows the major countries producing silicon carbide in Europe, North America and the Far East.

Several countries are planning new silicon and ferrosilicon facilities for 1975 and 1976. In Iceland, Union Carbide intends to build a plant at Hvalfjordur for the production of 75 per cent ferrosilicon. The smelter would be operated by a joint venture corpora-

Table 6. Estimated silicon carbide capacity in 1973, by country

Country	Estimated capacity
	(metric tons)
Canada	120,000
United States	100,000
Japan	80,000
Norway	60,000
West Germany	46,000
Italy	26,000
France	18,000

Sources: Department of Energy, Mines and Resources, Ottawa. *Industrial Minerals*, March 1973 *Modern Casting*, January 1974.

tion to be owned 65 per cent by the Government of Iceland and 35 per cent by Union Carbide. The plant site was chosen because of potential availability of low cost hydro power in that area. Completion of the operation is scheduled for 1976. The plant will produce approximately 50,000 tons a year of 75 per cent ferrosilicon, and is expected to incorporate the latest available pollution control technology in order to comply with Icelandic environmental protection laws.

In the Philippines, Electro Alloys will bring a 16,000 ton-a-year ferrosilicon plant into production by 1976. The plant will be built on the Island of Mindanas and electricity will be supplied by a hydroelectric plant now being built.

In Japan, Nippon Refining and Concentrating plans to construct a 16,000-ton-a-year ferrosilicon plant at Kohma by early 1976. Also in Japan, Showa Denko plans to increase silicon metal production at its Kanose plant by 3,000 tons a year by mid-1975. The Iranian Industrial Credit Bank is also studying plans for construction of a 30,000-ton-a-year ferrosilicon plant in Japan.

In Australia, Consolidated Gold Fields Australia Ltd. is planning to build a plant to produce silicon and ferrosilicon. The plant would have a production capacity of 30,000 tons a year of silicon and 57,000 tons a year of ferrosilicon. Start up date is 1976 for ferrosilicon and 1977 for silicon. Production would be exported, mostly to Japan and the United States.

In the United States, Ohio Ferro-Alloys is planning a new ferrosilicon plant at Philo, Ohio. In October, the company started construction of its 35,000-ton-a-year silicon plant at Montgomery, Alabama. Union Carbide is expanding its ferrosilicon plant at Ashtabula, Ohio and also its silicon plant at Alloy, West Virginia.

The Norwegian Government reported that hydro-electricity will not be available for further expansion of ferrosilicon production in Norway. The proposed 24,000-metric-ton-a-year silicon plant that was to be built at Tyssedal, Norway will quite probably be postponed also. In South Africa, Silicon Smelters (SS) is going ahead with a 30,000-ton-a-year silicon metal plant in Withop Transvaal. The plant is expected to be on stream late in 1975. The participants in SS are Alcan, Foote Mineral Company and British Oxygen Limited. With the exception of the United States and Japan, all new plants will be built where electricity is available and not expensive.

Uses

Silicon alloys in iron and steel. Silicon alloys are second in importance only to manganese as a ferroalloy additive in steelmaking. Silicon alloys include ferrosilicon, silvery pig iron, silicomanganese, ferrochromium-silicon, ferromanganese-silicon and other metal silicides, all of which are principally used in metallurgical

Table 7. Canada, consumption, exports and imports of ferrosilicon, 1965–74

	Consumption	Exports		Imports	
	(short tons)	(short tons)	($)	(short tons)	($)
1965	33,811	46,424	4,706,724	6,260	1,799,546
1966	37,664	38,023	3,784,105	5,877	1,629,368
1967	34,807	41,929	4,189,328	21,740	3,534,000
1968	51,449	47,215	5,424,665	9,816	2,615,000
1969	50,737	48,499	5,257,000	9,050	2,010,000
1970	55,728	49,984	8,284,000	10,446	2,386,000
1971	43,619	53,150r	8,699,000r	10,380	2,679,000
1972	46,594	53,295r	7,188,000r	9,564	2,663,000
1973	61,520	50,814	6,768,000	14,242	4,135,000
1974p	. .	49,611	9,163,000	11,640	5,293,000

Source: Statistics Canada.
p Preliminary; . . Not available; r Revised.

Table 8. Canada, ferrosilicon production[1], 1965–73

	Ferrous Industry[2]	Other Industries[3]	Total
		(short tons)	
1965	59,068	14,907	73,975
1966	53,263	16,547	69,810
1967	42,387	12,609	54,996
1968	78,456	10,392	88,848
1969	77,587	12,599	90,186
1970	86,352	8,914	95,266
1971	71,984[r]	14,405	86,389
1972	77,026[r]	13,299	90,325
1973	74,891	23,201	98,092

Source: Statistics Canada.
[1] Producers' shipments. [2] Estimated by the Mineral Development Sector. [3] Principally abrasives industry.
[r] Revised.

industries. Ferrosilicon accounts for the largest tonnage of silicon alloys produced. Silicon, introduced in the form of ferrosilicon and silicon metal into molten steel, is an effective and economical deoxidizer.

Silicon additions of up to 0.3 per cent in standard alloy steels increase their tensile and yield strengths. At higher silicon contents, the hardenability of steel and its yield strength are increased, but with a loss of ductility and impact resistance. Probably the most important silicon-containing alloy steels are electrical (sheet) steels. Silicon reduces to a minimum those oxides and carbides that have strong magnetic properties, and for this reason, steel that is used for making electrical lamination sheets usually contains from 0.5 to 5.0 per cent silicon. Grain-oriented silicon steels are used in the construction of cores of transformers, generators and electric motors.

Silicon is added to stainless steels to improve the heat-resisting qualities of chrome, nickel-chrome and chrome-tungsten steels, and to improve their oxidation resistance at high temperatures. Carbon steels for making springs usually contain 0.5 to 2.0 per cent silicon, with 0.6 to 1.0 per cent manganese. Silicomanganese can be used to introduce both manganese and silicon to the metal.

The amount of gases, chiefly oxygen, dissolved in liquid steel and the amount of gases released during solidification determine the types of ingots: semi-killed, capped and rimmed. The term "killed" indicates that steel has been deoxidized sufficiently for it to lie perfectly still when poured into an ingot mould. The amount of silicon added to a killed steel will be from about 0.1 to 0.5 per cent. The other three types require lesser amounts, down to 0.05 per cent or nil in a rimmed steel.

Ferrosilicon and silicon alloys. Ferrosilicon contains from 45 to 95 per cent silicon. Silvery pig iron is made in blast furnaces and contains up to 12 per cent silicon. Byproduct ferrosilicon from the manufacture of fused alumina abrasive in electric resistance furnaces contains from 16 to 18 per cent silicon.

The lower grades of ferrosilicon (below 25 per cent Si) are not suitable for ladle addition because the large amount required would have an excessive chilling effect on steel; they are used as bath (melt) additions and are available in the form of pigs or coarse lumps. The most extensively-used silicon alloy is 50 per cent ferrosilicon. It is used as a deoxidizer and alloying agent in the production of killed and semi-killed steels. The 65 per cent ferrosilicon is used as a ladle addition. The 75 and 90 per cent ferrosilicon grades are used for high-alloy steels requiring large additions of silicon. The 85 per cent grade is used mainly by cast-iron foundries. Sil-X is a briquetted mixture of ferrosilicon and sodium nitrate. The low-aluminum grade (0.40 per cent Al maximum) 50 per cent ferrosilicon is used as a source of silicon for electrical steels containing less than 2 per cent silicon. High-silicon ferrosilicon is also used in the silicothermic method of producing low-carbon ferroalloys, such as ferromolybdenum, ferrotungsten and ferrovanadium. Magnesium ferrosilicon containing about 9 per cent magnesium, 42 to 46 per cent silicon and 0.3 per cent cerium is used in making ductile iron and pipeline steel.

Silicon carbide. Silicon carbide is used as an abrasive where hardness is required, and large amounts are now used in ferrous metallurgy as a fuel in the basic oxygen process. When it is added to molten metal, a vigorous exothermic reaction results from the oxidation of both silicon and carbide to produce a hotter melt. In the United States more than half of the silicon carbide production is used in ferrous metallurgy. Silicon carbide is also used in refractories where high heat resistance and chemical stability are required. Sintered silicon carbide is characterized by its changing of resistance according to the change of electric voltage; and so it is used on various circuits, e.g., as a spark killer or as a lightening arrester.

Silicon metal. Silicon metal having a purity of approximately 98 per cent is obtained by carbon reduction of high-purity silica material in the submerged-arc electric furnace. Over half of silicon metal output is used as a deoxidizer in the production of steel. Most of the remainder is used in the manufacture of aluminum alloys by permanent mould and die-casting operations. It is alloyed with aluminum in amounts ranging up to 13 per cent to improve such casting qualities as fluidity during casting and freedom from hot-shrinkage and hot-cracking. Silicon also increases the corrosion resistance, hardness and tensile strength of aluminum

Table 9. Canada, manufacturers' shipments of silicon carbide, 1963–73

	Crude Silicon Carbide	
	(short tons)	($)
1963	78,370	11,040,000
1964	85,433	11,398,000
1965	98,545	13,967,000
1966	108,351	14,777,000
1967	96,212	13,564,000
1968	109,174	16,192,000
1969	108,197	15,815,000
1970	114,764	17,653,000
1971	103,484	15,798,000
1972	114,808	17,880,000
1973	118,281	18,985,000

Source: Statistics Canada.

Table 10. Canada, exports of silicon carbide, 1964–74

	(short tons)	($)
1964	81,058	10,625,294
1965	90,902	12,243,784
1966	98,878	12,831,523
1967	87,166	11,461,930
1968	102,924	14,690,146
1969	103,501	14,974,000
1970	105,996	15,976,000
1971	93,859	13,593,000
1972	104,388	15,051,000
1973	102,496	15,666,000
1974p	101,028	15,855,000

Source: Statistics Canada.
p Preliminary.

alloys to provide improved impact toughness and resistance to friction. Silicon metal is alloyed with copper to produce silicon bronzes with up to 3 per cent silicon. Such alloys have good working qualities and excellent corrosion resistance. Silicon metal can be used as a ladle addition to deoxidize steel and can also serve as an alloying element in the production of steel and iron castings. Because of its unique chemical characteristics, silicon metal is a basic raw material in the production of silicon-type lubricants, hydraulic fluids, resins, plastics, enamels and rubber. Purified silicon metal possesses semiconductive properties which make it suitable for use in miniaturized electronic circuits.

Outlook

Most of the ferrosilicon produced is consumed by the steel industry. Steel production is expected to remain more or less static for the next couple of years. Several new ferrosilicon production facilities are expected to come on stream between 1975 and 1977 which means that an oversupply of ferrosilicon is probable during that period. Most of the silicon metal is consumed by the steel and aluminum industries. The production of aluminum is also expected to be more or less static in the next couple of years, so silicon metal should be much more available in 1975–76 than it was in 1974. Because of its broader uses, silicon carbide consumption is less dependent on steel production, and demand for the product should remain strong in 1975. Because of the high energy requirements and pollution costs associated with the production of silicon, ferrosilicon and silicon carbide, new production facilities will be built in countries with low energy costs and areas of low population density.

Prices

Due to an acute shortage of ferrosilicon and silicon during the year, prices reached an unprecedented level. At the end of the year demand for both products slackened, due to a decrease in demand for steel and aluminum, but ferrosilicon and silicon products had almost doubled in price over the previous year.

Prices published by Metals Week in December 1973 and 1974.

		1973	1974
		(U.S. ¢)	
Ferrosilicon, pound contained silicon, fob shipping point, freight equalized to nearest main producer, carload lots, lump bulk			
High-purity (% Si)			
	75	21.6	38.5
	85	21.3	..
	90	20.3	..
Regular	50	15.0–17.5	33.5
Silicon metal, pound contained silicon, fob shipping point, freight equalized to nearest main producer, carload lots, lump bulk			
(% max. Fe)	(% max. Ca)		
0.35	0.07	30.9	59.9
0.50	0.07	29.2	58.2
1.00	0.07	27.0	55.0
Magnesium ferrosilicon 44/48 Si			
(% Mg)	(% Ce)		
9		23.95	..
9	0.5	26.25	..
5	0.5	19.80	..
35 – 40 zirconium silicon		33.75	51.00

Prices published by American Metal Market in December 1973 and 1974

	1973	1974
	(U.S. ¢)	
SMZ alloy: 60 – 65% Si, 5.7% Mn, 5 – 7% Zr, 15 – ton lots, per pound of alloy	23.0	33.0
Calcium-silicon and calsibar alloy, fob producer, 15–ton lots, per pound	24.75	57.0
Electric furnaces silvery pig iron, fob Niagara Falls	(U.S.$)	(U.S.$)
16% Si, per ton	105.00	105.00
22% Si, per gross ton	121.00	121.00

. . Not available.

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
	Ferrosilicon, an alloy of iron and silicon, effective June 4, 1969			
37503-1	Containing 8% or more by weight of silicon and less than 60%, per pound or fraction thereof, on silicon content	free	free	1.75¢
37504-1	Containing 60% or more by weight of silicon and less than 90%, per pound or fraction thereof, on silicon content	free	0.75¢	2.75¢
37505-1	Containing 90% or more by weight of silicon, per pound or fraction thereof, on silicon content	free	2.5¢	5.5¢

United States

Item No.		
519.21	Crude silicon carbide	free
519.37	Silicon carbide in grains, ground pulverized or refined, per pound	0.4¢
607.50	Ferrosilicon containing over 8% but not over 60% by weight of silicon, per pound, on silicon content	free
607.51	Ferrosilicon containing over 60% but not over 80% by weight of silicon, per pound, on silicon content	0.5¢
607.52	Ferrosilicon containing over 80% but not over 90% by weight of silicon, per pound, on silicon content	1¢
607.53	Ferrosilicon containing over 90% by weight of silicon, per pound, on silicon content	2¢
607.55	Ferrosilicon chromium	10%
607.57	Ferrosilicon manganese, per pound, on Mn content	0.46¢ + 3.5%

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Silver

J.G. GEORGE

Canada's primary* production of silver in 1974, estimated at 43,765,000 ounces**, was 3.72 million ounces less than the all-time high of 47,487,589 ounces produced in 1973. The decrease was mainly attributable to reduced byproduct output by both the Sullivan mine of Cominco Ltd. at Kimberley, B.C. because of a four-month labour strike, and the Nos. 12 and 6 mines of Brunswick Mining and Smelting Corporation Limited at Bathurst, N.B. because of illegal work stoppages and a 66-day labour strike. Reduced ore production by Echo Bay Mines Ltd. at its silver–copper property near Port Radium in the Northwest Territories as well as reduced output from the lower grade silver–cobalt ores mined in the Cobalt area of northern Ontario by Agnico-Eagle Mines Limited and the Silverfields Division of Teck Corporation Limited also helped account for the decline in Canadian production. Increases in output in Newfoundland, Nova Scotia, New Brunswick, Manitoba and the Yukon Territory were more than offset by declines in the other silver-producing provinces and the Northwest Territories. Ontario was again, by far, the leading silver-producing province, primarily because of the substantial byproduct silver produced at the Kidd Creek base-metal mine of Ecstall Mining Limited near Timmins. Output in the Cobalt area of northern Ontario was only about half of that produced in 1973. In spite of a significant reduction in silver output in 1974, the value of Canadian production increased substantially from $120.0 million in 1973 to $202.0 million in 1974 because of higher prices.

Four base-metal mines that produce byproduct silver began or resumed operations in 1974, namely Nigadoo River Mines Limited near Bathurst, N.B., Sturgeon Lake Mines Limited in northwestern Ontario, and Purcell Development Co. Ltd. and Dankoe Mines Ltd. in southeastern British Columbia. Four silver base-metal mines ceased operations in 1974; one for economic reasons and because of damage by an avalanche, namely Consolidated Columbia River Mines Ltd. in British Columbia, and three because of adverse economic conditions or exhaustion of ore reserves, namely Dresser Minerals, Division of Dresser Industries, Inc. in Nova Scotia, Anaconda Canada Limited in New Brunswick and Placid Oil Company in British Columbia.

Canada's exports of silver in ores, concentrates and as refined metal totalled 40,713,027 ounces in 1974, or almost 8.4 million ounces less than the corresponding amount in 1973. The United States continued to be the major market, importing more than 77 per cent of Canada's total exports. Canadian imports of refined silver increased from 8,754,786 ounces in 1973 to 28,745,359 ounces in 1974. Most of the imports came from the United States with smaller quantities coming from the United Kingdom and Mexico.

Domestic production

Mine production. The principal source of silver was again base-metal ores, which accounted for almost 97 per cent of total production. The major portion of the remaining three per cent came from silver–cobalt ores mined in the Cobalt district of northern Ontario and the balance was byproduct recovery from lode and placer gold ores. The principal mine producers of silver in Canada are listed in Table 4. The accompanying map shows their approximate locations. The four largest producers in declining order of output were Ecstall Mining Limited (Texasgulf Inc.) and Mattabi Mines Limited in Ontario, United Keno Hill Mines Limited in the Yukon Territory and Brunswick Mining and Smelting Corporation Limited in New Brunswick. Base-metal ores mined by these four producers accounted for some 44 per cent of total Canadian silver production. The largest producer in the Cobalt area of Ontario was Teck Corporation Limited, Silverfields Division, with output of 850,648 ounces.

* As reported by Statistics Canada and defined in footnote 1 of Table 1 herein.

**Wherever used in this review, the term "ounce" refers to the "troy ounce".

Metal production. Production of refined silver in 1974 at the five Canadian primary silver refineries was as follows:

	Production[1] Refined Silver	Annual Rated Capacity[2]
	(ounces)	
Brunswick Mining and Smelting Corporation Limited, Smelting Division, Belledune, New Brunswick	2,085,000	2,500,000
Canadian Copper Refiners Limited, Montreal East, Quebec	19,413,000	25,000,000
Cominco Ltd., Trail, British Columbia	6,621,000	12,000,000
Royal Canadian Mint, Ottawa, Ontario	196,793[3]	7,000,000[4]
The International Nickel Company of Canada, Limited, Copper Cliff, Ontario	1,910,000[5]	. .

[1] Production of refined silver includes silver produced or derived from domestic and imported ores and concentrates as well as secondary materials. The largest portion of such refined silver was, however, derived from domestic ores and concentrates. Figures were obtained from annual reports of companies and of the Royal Canadian Mint. [2] As at December 31, 1974. [3] Silver derived from refining gold bullion. [4] Total capacity for producing gold and silver, of which about 10% is silver. [5] Silver delivered to markets.
. . Not available.

Canadian Copper Refiners Limited at Montreal East, Quebec, was again Canada's largest producer of refined silver, recovering it from the treatment of anode and blister copper. The silver refinery of Cominco Ltd. at Trail, British Columbia, was the second-largest producer, recovering byproduct silver in the processing of lead and zinc ores and concentrates. Cominco's refined silver output was substantially lower than that of 1973 because of a four-month shutdown of its metallurgical plants at Trail resulting from a labour strike. Other producers of refined silver were The International Nickel Company of Canada, Limited, at Copper Cliff, Ontario (from nickel-copper concentrates); and the Royal Canadian Mint at Ottawa, Ontario (from gold bullion). At Belledune, New Brunswick, Brunswick Mining and Smelting Corporation, Limited, Smelting Division, recovered byproduct silver bullion from lead concentrates treated in a blast furnace.

At its electronic materials plants at Trail, B.C., Cominco Ltd. also produced high-purity silver metal with metallic impurities totalling one part per million or less. This specialty metal product was manufactured mainly for applications in the electronics industry such as solder preforms, brazing preforms and lead wire.

(text continued on page 456)

Table 1. Canada, silver production, trade and consumption, 1973-74

	1973		1974*p*	
	(ounces)	($)	(ounces)	($)
Production[1]				
By province and territories				
Ontario	19,617,406	49,553,568	17,674,000	81,566,000
British Columbia	7,619,413	19,246,637	6,235,000	28,772,000
Yukon Territory	6,073,973	15,342,856	6,158,000	28,420,000
New Brunswick	3,568,678	9,014,480	4,382,000	20,222,000
Northwest Territories	5,420,344	13,691,789	4,252,000	19,621,000
Quebec	3,050,999	7,706,823	2,860,000	13,198,000
Manitoba	1,082,763	2,735,059	1,303,000	6,011,000
Newfoundland	572,918	1,447,191	647,000	2,985,000
Saskatchewan	458,241	1,157,517	227,000	1,046,000
Nova Scotia	22,838	57,689	27,000	124,000
Alberta	16	40	—	—
Total	47,487,589	119,953,649	43,765,000	201,965,000

Table 1 (concl'd)

	1973		1974p	
	(ounces)	$	(ounces)	$
By source				
Base-metal ores	44,969,860	113,593,866	42,361,000	195,487,000
Gold ores	266,747	673,803	214,000	987,000
Silver–cobalt ores	2,249,041	5,681,077	1,189,000	5,486,000
Placer gold ores	1,941	4,903	1,000	5,000
Total	47,487,589	119,953,649	43,765,000	201,965,000
Refined silver[2]	25,596,479	..	27,177,366	..
Exports				
In ores and concentrates				
United States	13,397,375	22,751,000	10,815,538	32,264,000
Japan	6,276,511	11,779,000	5,510,429	21,603,000
Belgium and Luxembourg	2,170,645	3,769,000	947,677	2,853,000
West Germany	3,327,901	5,632,000	880,202	2,608,000
United Kingdom	—	—	384,894	1,006,000
Netherlands	515,200	176,000	563,401	507,000
Italy	487,504	354,000	166,564	382,000
Others	26,923	76,000	105,572	299,000
Total	26,202,059	44,537,000	19,374,277	61,522,000
Refined metal				
United States	20,976,372	53,557,000	20,724,890	96,333,000
Belgium and Luxembourg	1,534,018	3,850,000	321,341	1,067,000
Jamaica	135,242	432,000	89,384	411,000
United Kingdom	29,741	61,000	116,102	391,000
Trinidad and Tobago	206,971	518,000	70,299	342,000
Spain	3,401	9,000	8,935	42,000
Others	19,148	51,000	7,799	39,000
Total	22,904,893	58,478,000	21,338,750	98,625,000
Imports				
Refined metal				
United States	7,322,302	18,599,000	23,114,534	102,948,000
United Kingdom	878,876	2,252,000	5,000,268	15,752,000
Mexico	538,568	1,404,000	478,137	2,271,000
Others	15,040	33,000	152,420	638,000
Total	8,754,786	22,288,000	28,745,359	121,609,000
Consumption, by use				
Sterling	2,856,346	..	2,253,335	..
Silver alloys	1,195,340	..	1,845,481	..
Wire and rod	56,360	..	99,748	..
Other[3]	12,762,883	..	6,472,719[4]	..
Total	16,870,929	..	10,671,283[4]	..

Source: Statistics Canada.
[1]Includes recoverable silver in: ores, concentrates and matte shipped for export; crude gold bullion produced; blister and anode copper produced at Canadian smelters; base bullion produced from domestic ores; and silver flotation concentrates treated at domestic smelters. [2] From all sources, domestic and imported materials of both primary and secondary origin. [3] Includes sheet, silver salts, coinage and miscellaneous uses. [4]Includes silver used in Cdn. silver dollars but excludes silver used in Olympic silver coins.
p Preliminary; — Nil; .. Not available.

Table 2. Canada, silver production, trade and consumption, 1965-74

	Production		Exports				
	All Forms[1]	Refined[2] Silver	In Ores and Concentrates	Refined Silver	Total	Imports, Refined Silver	Consumption,[3] Refined Silver
				(ounces)			
1965	32,272,464	20,630,190	12,245,877	11,268,110	23,513,987	13,413,434	30,170,097
1966	33,417,874	21,298,325	11,850,469	12,221,142	24,071,611	14,477,787	21,303,704
1967	36,315,189	20,658,556	10,407,418	13,735,675	24,143,093	5,383,872	14,576,608
1968	45,012,797	34,611,344	21,502,022	28,104,562	49,606,584	14,060,635	13,598,358
1969	43,530,941	38,678,520	21,883,028	34,658,937	56,541,965	19,168,785	5,747,068
1970	44,250,804	30,725,450	21,819,924	24,199,524	46,019,448	4,319,357	6,034,028
1971	46,023,570	20,544,196	25,562,579	18,201,371	43,763,950	722,815	7,050,956
1972	44,792,209	22,740,796	22,143,806 r	19,825,475	41,969,281 r	1,217,678	8,424,314
1973	47,487,589	25,596,479	26,202,059	22,904,893	49,106,952	8,754,786	16,870,929
1974 p	43,765,000	27,177,366	19,374,277	21,338,750	40,713,027	28,745,359	10,671,283[4]

Source: Statistics Canada.
[1]Includes recoverable silver in: ores, concentrates and matte shipped for export; crude gold bullion produced; blister and anode copper produced at Canadian smelters; base bullion produced from domestic ores; and silver flotation concentrates treated at domestic smelters. [2] From all sources, domestic and imported materials of both primary and secondary origin. [3] Includes consumption for coinage. [4]Includes silver used in Cdn. silver dollars but excludes silver used in Olympic silver coins.
p Preliminary; r Revised.

World production, consumption and economic factors

New production of silver in the noncommunist world in 1974, according to an estimate of Handy and Harman*, was 240.0 million ounces, or 5.8 million ounces less than in 1973. In 1974 noncommunist world consumption for both industrial and coinage uses was 448.0 million ounces, compared with 492.5 million ounces consumed in 1973. The gap between new production and consumption was 208 million ounces, or considerably less than in 1973.

Consumption of silver for coinage in the noncommunist world in 1974, according to Handy and Harman, was 33.0 million ounces, about 12.0 million ounces more than in 1973. Except for minor quantities used in 1971 in the minting of commemorative coins and in 1972 in the minting of silver dollars, silver had not been used in the production of Canadian coinage since 1968. On November 14, 1973 the Royal Canadian Mint struck the first new Olympic coin. It marked the beginning of production of coins containing 92.5 per cent silver to commemorate the Olympic Games to be held in 1976. The coins are of $5 and $10 face value and the total face value of all such coins to be issued may be up to $450 million as provided by legislation contained in a special Act of Parliament given Royal Assent July 27, 1973. The total amount of silver involved in minting the Olympic coins could be up to 58 million ounces, and the total number of coins issued could exceed 60 million. The overall program consists of seven separate series of coins, with each series being comprised of four different coins, two of $5 face value and two of $10 face value, and with different designs for all 28 coins.

In the first half of 1974 the Royal Canadian Mint completed production of the first series of the Olympic coins. Minting of the second series began in mid-1974. Late in the same year, production of the second series was completed and minting of the third series commenced. According to figures published in the annual report of the Royal Canadian Mint it produced and delivered to the Olympic Coin Programme, in 1973, 543,098 pieces of the $5 face value coins and 537,898 pieces of the $10 face value coins containing a total of about 1.17 million ounces of silver. For 1974 the corresponding figures were 3,981,140 pieces of the $5 coins and 3,949,878 pieces of the $10 coins containing a total of approximately 8.57 million ounces of silver.

Considerable progress was achieved in 1974 in construction of the new Winnipeg, Manitoba Division of the Royal Canadian Mint and it was expected to be in commercial production early in 1975.

Based on preliminary figures, Canada in 1974 was again the world's largest mine producer of silver; other leading producers were the U.S.S.R., Peru, Mexico and the United States.

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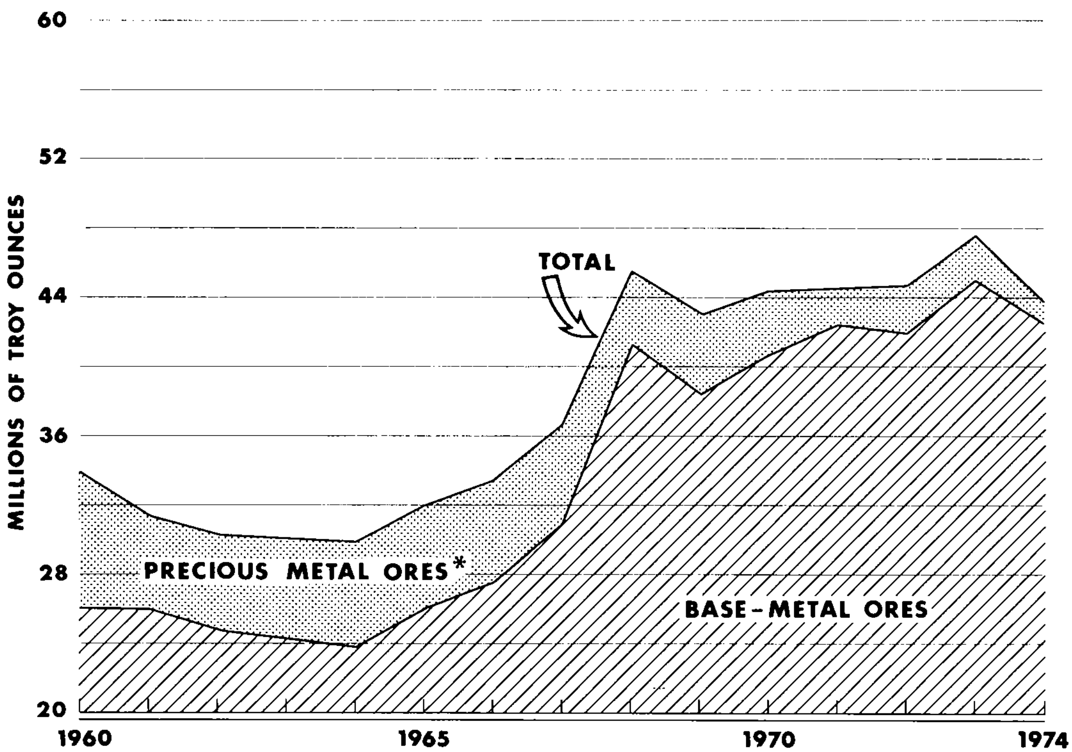
* *The Silver Market 1974*, compiled by Handy and Harman, a large U.S. silver consumer.

PRIMARY SILVER PRODUCTION in CANADA by SOURCE

MINERAL DEVELOPMENT SECTOR
DEPARTMENT OF ENERGY, MINES AND RESOURCES

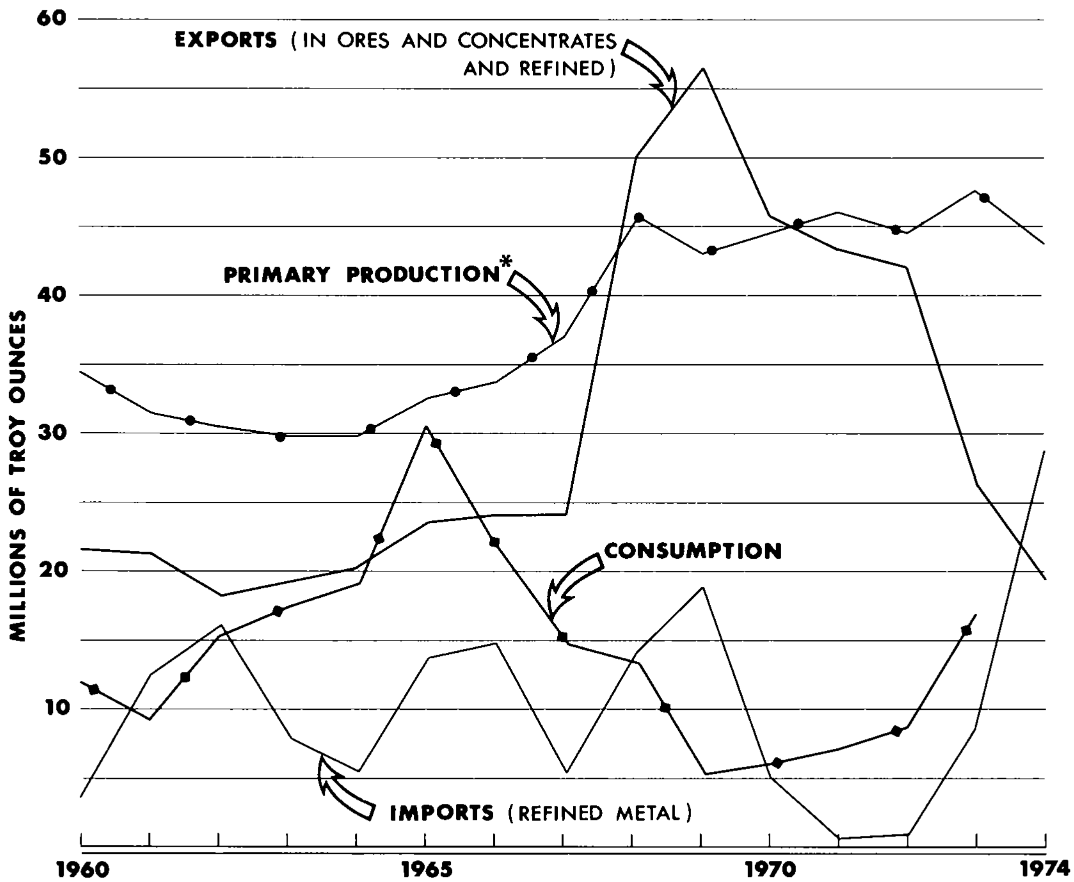


* Mostly from Silver-cobalt ores; some from Gold ores.

New production of silver in the United States decreased from 37.4 million ounces in 1973 to 33.8 million ounces in 1974. In the United States, the world's largest silver consumer, consumption for industrial uses and coinage was 177.0 and 1.0 million ounces, respectively, in 1974. The large deficit in requirements was again met by imports, demonetized coinage, secondary silver derived from discarded jewelry, silverware, films, etc., liquidation of speculative holdings and withdrawals from industrial and United States Treasury stocks. Most of the requirements for United States coinage were again obtained from Treasury stocks (Balance in Mint only) which, in the form of bullion, coin bars and coinage metal fund silver, declined during 1974 from 45.1 to 44.0 million ounces, excluding 139.5 million ounces contained in the strategic stockpile. On April 12, 1973, the U.S. Office of Emergency Preparedness (OEP) announced a revised stockpile objective of 21.7 million ounces of silver, 117.8 million ounces less than the inventory and previous objective. The excess stockpiled silver thus became available for disposal, but could not be sold without congressional approval. It was suggested that some 110.0 million ounces of the new stockpile excess of 117.8 million ounces be sold to U.S. industrial consumers and the remaining 7.8 million ounces be held for potential U.S. coinage requirements. The President's proposed stockpile disposal legislation, which included the release of 117.8 million ounces of silver, was introduced in Congress as bills H.R. 7153 and S. 1849 on April 18 and May 21, 1973, respectively. The bills were referred to a subcommittee of the House

SILVER IN CANADA

MINERAL DEVELOPMENT SECTOR
DEPARTMENT OF ENERGY, MINES AND RESOURCES



* As reported by Statistics Canada and defined in Footnote 1 to Table 1.

Armed Services Committee but, as of December 31, 1974, no action had been taken by the Congress on either of the bills. Therefore, the proposed stockpile reduction and the rate of its disposal have yet to be determined.

In 1974, the U.S. Mint continued the minting of Eisenhower dollar coins, containing 40 per cent silver, in special sets for numismatists. Production of these commemorative coins began in May 1971 and 150 million were authorized in a provision included in Public Law PL-91-607 signed by former President Nixon on December 31, 1970. The use of the metal in these special coins will not have any significant effect on the silver market as the United States Treasury Department, in 1970, had already set aside the silver (about 47 million ounces) that would be required. Part of these requirements resulted from a transfer of 25.5 million ounces from the strategic stockpile to the

United States Mint. The transfer was made in the second quarter of 1971 and since then the silver inventory in the strategic stockpile has remained at 139,500,000 ounces.

Public Law PL-93-127 was enacted October 18, 1973 directing the Secretary of the U.S. Treasury to mint, prior to July 4, 1975, 45 million silver-clad alloy coins commemorating the Bicentennial of the American Revolution in 1976. The legislation also authorized the minting of not more than an additional 15 million of such coins if there is public demand for them. The coins will contain 40 per cent silver and will be minted in 25¢, 50¢ and $1.00 denominations. The total of 45 million coins will require 8.07 million ounces of silver but, if the maximum quantity of 60 million coins are issued, the total amount of silver required will be 10.76 million ounces. The silver for these coins will be supplied from current U.S. Treasury stocks.

On October 29, 1974 U.S. Public Law PL-93-463 was enacted. It is known as the Commodity Futures Trading Commission Act of 1974 and provides the Federal regulation of all commodities, including silver, traded on commodity exchanges. As of December 31, 1974, regulations under this act had not been issued, so the ultimate effect on trading in silver futures could not then be evaluated.

Mexico and Peru held discussions about mid-1974 and again in the early part of 1975 concerning the establishment of the "Association of Silver Exporting Countries" to help maintain "equitable" price levels for the metal in world markets. Mexico and Peru together accounted for more than 25 per cent of world mine production of silver in 1974 and are significant exporters of silver. Up until late 1975 no further information was available concerning the proposed association.

In February 1974, the government of India announced removal of the embargo against exports of silver bullion, sheets and plates, thus removing a long-standing ban on silver shipments abroad. It is thought that total Indian exports of silver in 1974 amounted to about 27 million ounces. Some observers expected Indian silver exports in 1975 would be substantially greater than those in 1974. It was also reported that North Korea exported a few million ounces of silver to world markets in 1974.

The Coeur mine near Wallace, in northern Idaho, has been leased by American Smelting and Refining Company (Asarco) under an agreement with Coeur d'Alene Mines Corporation. Expenditure of about $10 million is being made to equip this silver–copper property for production with a capacity of 2.2 million ounces of silver a year. Underground mine development work continued in 1974 and a new 450-ton-a-day concentrator was expected to be completed by mid-1976. Press reports stated that ore reserves were estimated at 834,000 tons* of probable ore averaging 25 ounces of silver a ton and one per cent copper, and 261,000 tons of inferred ore grading 25.9 ounces of silver a ton and 1.1 per cent copper.

Park City Ventures continued development work at the Ontario Mine near Park City, Utah. The production shaft was being deepened at this zinc–lead–silver property and work continued on construction of a 750-ton-a-day concentrator near the shaft. Operations were expected to begin about April 1975 with annual mine output of silver expected to reach 1.2 million ounces at full capacity. Park City Ventures is a partnership owned 60 per cent by The Anaconda Company and 40 per cent by American Smelting and Refining Company.

By the end of 1974, design and construction of the 8,000-ton-a-day processing plant was nearing completion at the Pueblo Viejo gold–silver property in the Province of Sanchez Ramirez in the Dominican Republic. Operations were expected to begin about April 1975. The plant is being designed to produce 350,000 ounces of gold and 1,500,000 ounces of silver a year in the form of Doré bullion. Arrangements have been made with a refinery in Switzerland to refine and market the bullion. Additional diamond drilling information has confirmed the previous oxide ore reserve calculations of 30,000,000 tons of gold–silver ore grading 0.1258 ounce of gold and 0.76 ounce of silver a ton. Drilling has also indicated a sulphide zone containing 17 million tons averaging 2.19 per cent zinc, 0.252 per cent copper, 0.131 ounce of gold and 1.12 ounces of silver a ton. The open-pit property, which is operated by Rosario Dominicana, S.A., is owned 40 per cent by Rosario Resources Corporation (of New York City), 40 per cent by Simplot Industries (a U.S. corporation) and 20 per cent by the Central Bank of The Dominican Republic. The project has been estimated to cost $41,000,000.

Mexico, which has a few mines that operate primarily for the extraction of silver, was expected to increase its mine output of the metal by several million ounces during the next two years. By 1976, or possibly towards the end of 1975, it could regain its position as the world's leading silver producer.

The Lampazos mine of Mineral Lampazos in the State of Sonora, Mexico, was scheduled to begin operations in January 1975 at a rate of 1.5 million ounces of silver a year. It would mark the beginning of an expansion program under way at several mines in Mexico which could increase the country's mine output of silver to a rate of about 50 to 55 million ounces a year by late 1976.

Shaft sinking, underground mine development work and surface-plant construction continued in 1974 at the three silver–gold mines, Las Torres, Peregrina and Cebada, in Mexico, near the city of Guanajuato about 230 miles northwest of Mexico City. A central

* The short ton (2,000 pounds avoirdupois) is used throughout unless otherwise stated.

concentrator, to treat 2,000 metric tons of ore a day, was also under construction on a site adjacent to the Las Torres (Mother Lode) mine. Ore from underground development work at the three mines has been stockpiled on surface at the Las Torres mine and will be used as the initial mill feed. Mill operations were expected to begin early in 1976, at which time there should be some 100,000 metric tons of ore in the surface stockpile. The aggregate ore reserves of the three mines, based on diamond drilling information, have been estimated at 4 million metric tons, grading an average of about 11.6 ounces of silver and 0.09 ounce of gold a metric ton after allowing for 15 per cent dilution. When full production is reached by the three mines, about 8 million ounces of silver and 50,000 ounces of gold are expected to be produced annually. The gold will be sold to the Bank of Mexico as provided by law, and the silver concentrates will be sold to the silver refinery of Industrias Penoles, S.A. The company operating the project is Compania Minera Las Torres, S.A., which is owned 30 per cent by Pure Silver Mines Limited (a Canadian company with headquarters in Toronto, Ontario), 37 per cent by Compania Fresnillo, S.A., and 33 per cent by Industrias Penoles, S.A. Penoles is one of Mexico's largest private mining enterprises. Total cost of bringing the three mines into production has been estimated at $39 million U.S. Negotiations continued with a consortium of three Canadian banks, the Toronto-Dominion Bank, the Royal Bank of Canada and the Canadian Imperial Bank of Commerce, which are expected to provide a substantial portion of the senior financing required to bring the properties into production.

The rising trend in silver prices that began early in 1972 continued in 1973, and became more pronounced in 1974 which was probably the most chaotic period in the history of world silver markets. The price not only reached a new record high in 1974 of more than double the previous record, but the violence of the fluctuations was in excess of any experienced so far. In spite of a decline in world consumption of silver, increased speculative activity, continuing world-wide inflation, and monetary uncertainties, as well as a decline in visible stocks, were the main factors which caused the sharp rise in prices in 1974.

On the New York Commodity Exchange, Inc. (Comex), one of the principal futures markets for contracts in silver in the United States, the volume of trading in silver in 1974 amounted to 757,055 contracts of 10,000 ounces each and 608,860 contracts of 5,000 ounces each, compared with 1,237,860 contracts of 10,000 ounces each traded in 1973. Effective September 27, 1974 Comex reduced the size of its silver futures contract from 10,000 to 5,000 ounces. Comex first started trading the 10,000-ounce contract in June 1973. The volume of silver traded on the Chicago Board of Trade in 1974 amounted to 1,505,789 contracts of 5,000 ounces each, compared with 1,642,272 contracts of the same size traded in 1973. The volume of silver traded on the MidAmerica Commodity Exchange at Chicago, Illinois, in 1974 was 587,256 contracts of 1,000 ounces each, compared with 401,021 contracts of the same size in 1973. The Pacific Commodities Exchange, Inc. (PCE), with headquarters in San Francisco, California, began trading in silver futures July 23, 1974. The volume of silver traded on the PCE in 1974 was 1,767 contracts of 1,000 ounces each. Silver traded on the London Metal Exchange was 641,910,000 ounces in 1974 compared with 644,100,000 ounces in 1973.

New York Commodity Exchange, Inc. silver stocks at the end of 1974 were 67.97 million ounces compared with 64.30 million ounces at December 31, 1973.

Table 3. World production[1] of silver, 1973-74

	1973	1974[e]
	(ounces)	
Canada	47,488,000	43,765,000
U.S.S.R.[e]	41,000,000	42,000,000
Peru	42,021,000	41,000,000
Mexico	38,788,000	37,546,000
United States	37,827,000	33,762,000
Australia	22,423,000	21,615,000
Japan	8,552,000	7,314,000
Chile	5,035,000	6,646,000
Poland	4,800,000	6,000,000
Bolivia[2]	5,803,000	5,385,000
Yugoslavia	4,302,000	4,702,000
Sweden	4,690,000	4,500,000
Honduras	3,152,000	3,661,000
Spain	3,635,000	3,600,000
France	4,176,000	3,328,000
Morocco	3,518,000	3,137,000
East Germany[e]	4,000,000	3,000,000
Republic of South Africa	3,652,000	2,994,000
Argentina	2,441,000	2,400,000
Ireland	1,839,000	1,980,000
Philippines	1,892,000	1,706,000
Zaire	1,995,000	1,649,000
Papua, New Guinea	1,581,000	1,628,000
Other countries	14,317,000	13,930,000
Total	308,927,000	297,248,000

Sources: Statistics Canada for Canada for 1973 and 1974. All other statistics from United States Department of the Interior, Bureau of Mines, Mineral Industry Surveys, Gold and Silver in June 1975.

[1] Recoverable content of ores and concentrates produced. [2] Includes production by the State mining company, Corporacion Minera de Bolivia (COMIBOL), plus the exports of medium and small (private sector) mines.

[e] Estimated.

Chicago Board of Trade silver in storage, at the end of 1974, and registered for delivery against futures' contracts was 19.47 million ounces compared with 27.29 million ounces at December 31, 1973. Both figures for the Chicago exchange are exclusive of some additional silver that may have been in stocks at such times but not registered for future delivery. Pacific Commodity Exchange, Inc. stocks at December 31, 1974 were 55,000 ounces. London Metal Exchange stocks at the end of 1974 were 11.97 million ounces compared with 16.26 million ounces at the end of 1973. United States industrial stocks* on December 31, 1974 were reported to be some 49.33 million ounces compared with about 38.42 million ounces at the end of 1973.

In June 1974 it was reported that the Winnipeg Commodity Exchange (WCE), at Winnipeg, Manitoba, was considering the establishment of a futures market for trading in silver if it could arrange a workable system for delivering this commodity to buyers. Any such trading in silver would complement the trading in gold which began on the WCE late in 1972. As of the end of 1974 no arrangement had been made by the WCE to trade in silver.

Outlook

Canada's primary production** of silver in 1975 is forecast to be some 39 million ounces and is expected to range between 38 and 48 million ounces annually from 1976 to 1980.

The drop in demand in 1974 resulted mainly from a general slowing down of economic activity in the major industrialized nations. With the world-wide economic recession accelerating in the first half of 1975, a further decline in silver consumption is expected in 1975.

The reduced consumption will continue to exceed primary production by a wide margin since mine output of silver is largely related to the production of the major base-metal ores. About 80 per cent (some 95 per cent in Canada) of the world's mine output of silver is derived as a byproduct or coproduct in the mining of such ores and, accordingly, the supply of newly mined silver continues to depend more on the production of base-metal ores than on the demand for silver.

In the near-term there should be no real shortage for industrial requirements. Sufficient quantities of secondary silver, speculative holdings, greater Indian exports and some hoarded silver coins will continue to find their way into the market. Because of higher prices and the increasing emphasis being placed on recycling in both the governmental and industrial sectors of the economy, greater quantities of secondary silver are expected to reach the market.

* Refiner, fabricator and dealer stocks.

** As defined in the footnote to Table 1.

The rising trend in world consumption of silver, which began in 1972 and continued in 1973, reversed itself in 1974. Furthermore, world silver consumption could decline again in 1975, mainly because of the slowing down of business activity, but the long-term demand for silver for both industrial uses and coinage (especially commemorative coins) is expected to increase significantly.

Silver prices were very volatile in 1974, mainly in response to speculative activity which was fostered by widespread monetary unrest and inflationary pressures. Prices held at levels well in excess of 1973 quotations and with new record-high prices being established. It is expected that prices will be erratic again in 1975 with the average for the year being somewhat lower than that for 1974. In the short-term there is little hope for price stability, mainly because of continuing recessionary pressures and monetary uncertainties. The long-term price trend should be upward, with price fluctuations above and below the trend line. Such variations will depend not only on the basic law of supply and demand, but also on speculative reaction to economic, monetary, political and social developments as they occur.

Canadian Developments

Atlantic provinces. Silver production in the Atlantic provinces was significantly greater in 1974 than in the previous year mainly because of byproduct output from Nigadoo River Mines Limited. Operations were resumed early in 1974 at Nigadoo's silver–zinc–lead–copper property near Bathurst, New Brunswick. The property had been idle since January 1972 when mining and milling operations were suspended following economic and labour problems. Also contributing to the higher silver production in the Atlantic provinces in 1974 was greater byproduct output by American Smelting and Refining Company at its zinc–lead–copper–silver mine at Buchans, Newfoundland. Silver output in 1973 at the Buchans mine was sharply curtailed when a 6½-month labour strike interrupted operations. Buchans ore reserves of about 1,500,000 tons at the end of 1974 were sufficient for another five years of operation at current rates of production.

As a result of an extensive exploration program, proven and probable zinc–lead ore reserves at the No. 12 mine of Brunswick Mining and Smelting Corporation Limited near Bathurst, New Brunswick, were substantially increased to 90,070,000 tons* averaging 13.2 per cent combined zinc and lead and 2.80 ounces of silver a ton at the end of 1974 compared with 84,720,000 tons of much the same grade at the end of 1973. Work commenced on the new $48 million project to expand production from the No. 12 mine from 6,350 to 7,500 tons of ore a day by 1976 and to 11,000 tons daily by 1979. The project includes sinking of a new shaft to a depth of 4,300 feet. Before the end of 1974 construction had begun on the new headframe and shaft sinking was underway. At the No. 6 open-pit mine proven zinc–lead ore reserves declined from 3,442,000 tons at the end of 1973 to 2,379,000 tons at December 31, 1974. Work to prepare for driving a 4,000-foot ramp to explore for ore below the pit was started. Overall ore production at the Nos. 12 and 6 mines was substantially lower in 1974 than in 1973 because of a 66-day labour strike and a number of illegal work stoppages.

Underground diamond drilling in 1974 at the property of Nigadoo River Mines Limited near Bathurst, New Brunswick, was aimed at outlining the "Anthonian Zone" which could add considerably to the mine's ore reserves. The zone is now being developed, and indications are that its grade will be better than mine average.

The mining and exploration sectors in New Brunswick have been among the most buoyant of any of the Canadian provinces, partly because New Brunswick's mineral taxation policies have been such as to encourage the maximum amount of exploration, development and processing by the private sector of the mining industry.

Quebec. Silver output in Quebec, derived mostly from base-metal ores, was somewhat lower in 1974 than in 1973.

Lemoine Mines Limited was incorporated early in 1974 and plans to develop to production the copper–zinc–gold–silver discovery made in Lemoine township by Patino Mines (Quebec) Limited late in 1973. The deposit is located 37 miles by road southeast of the town of Chibougamau and consists of a nearly massive sulphide lens which has been diamond drilled to a depth of 1,000 feet from surface. Proven and probable ore reserves total some 625,000 tons to a depth of 1,000 feet grading 4.5 per cent copper, 10.8 per cent zinc, 0.138 ounce of gold and 2.70 ounces of silver a ton. Shaft sinking to a depth of 1,000 feet has begun with the aim of bringing the property into production by late 1975 at a rate of 300 to 500 tons of ore a day.

Late in 1974 the Lake Dufault Division of Falconbridge Copper Limited announced that as of December 31, 1974 its Norbec mine would cease operations and be placed on a care-and-maintenance basis. The mine became uneconomic to operate because of escalating costs and depressed copper markets. The Norbec portion of the concentrator tonnage is to be made up from the Norbec ore stockpile.

In December 1972, Orchan Mines Limited acquired the zinc–copper–silver property of Norita Quebec Mines Limited about eight miles northeast of the main Orchan mine in the Matagami Lake area of northwestern Quebec. Diamond drilling has indicated a deposit of 1,637,000 tons averaging 7.6 per cent zinc, 0.7 per cent copper and 1.0 ounce of silver a ton before allowing for dilution. The Norita site preparation has been completed and a mining plant erected. A shaft was collared and sinking to a depth of 1,660 feet began early in 1974. Orchan plans to bring the Norita property into production in 1976 at a rate of 900 tons of ore a day to be processed at the Orchan concentrator.

In the latter part of 1974 Manitou-Barvue Mines Limited and Noranda Mines Limited reached an agreement whereby the latter would investigate the feasibility of bringing back into production Manitou-Barvue's zinc–silver property in Barraute township in northwestern Quebec. Before the end of 1974, the Barvue open pit had been completely dewatered and pumping out the underground workings was expected to begin. When production ceased at the property in 1957 the mineralized deposit contained 4.0 million tons grading 3.5 per cent zinc and 1.2 ounces of silver a ton to the 600-foot level.

In August 1974, it was announced that Selco Mining Corporation Limited and Pickands Mather & Co. of Cleveland, Ohio, had made a major silver base-metals discovery in Brouillan township about 70 miles due west of Mattagami Lake Mines Limited in northwestern Quebec. It has been reported that the deposit contains in excess of 25 million tons, but further drilling and engineering studies will be required to confirm such reports. Selco and Pickands Mather are equal partners in the venture. The discovery led to massive stakings of mining claims in the area concerned.

Selco Mining Corporation Limited and Muscocho Explorations Limited continued diamond drilling of their jointly owned silver base-metals deposit in the Frotet Lake area about 50 miles north of Chibougamau. In May 1974, it was reported that the deposit contains some 900,000 tons grading 1.93 per cent copper, 4.20 per cent zinc, 1.08 ounces of silver and 0.021 ounce of gold a ton.

Ontario. Ontario was again, by far, the leading silver-producing province with its output in 1974 accounting for some 40 per cent of Canadian mine production. The largest producer was again Ecstall Mining Limited, which recovered over 10.5 million ounces in lead, copper and zinc concentrates at its Kidd Creek property, the largest single mine producer of silver in Canada. In the Cobalt area of northern Ontario some 1.2 million ounces were derived from silver–cobalt mines. Output was significantly lower than in 1973 because of the reduced quantities and lower grades of ores produced.

Ecstall Mining Limited completed its second year of underground mining at its Kidd Creek mine and at the end of 1974 about 40 per cent of its ore production came from underground operations. In 1974 Ecstall Mining Limited embarked on a $300—$350-million program to cover an expansion of mine production from 3.6 to 5.0 million tons of ore a year and the construction of a 130,000-ton-a-year copper smelter and refinery complex at its Kidd Creek property. The final decision to proceed with these projects was made after the Ontario government amended its mineral tax legislation. Included in the refinery complex is a silver refinery. The copper refinery is expected to come on stream in 1978 and the silver refinery could follow by as much as two years later, although there is a possibility that it will open simultaneously with the copper refinery. It is anticipated that the silver refinery will have an annual capacity of 10–12 million ounces of refined silver. This capacity should be sufficient to process the silver content of the copper concentrates at maximum planned production. To open its second underground mine at the Kidd Creek property a new shaft is being sunk from surface to a depth of 5,200 feet. At December 31, 1974, ore reserves above the 2,800-foot level were estimated at 36.1 million tons of proven ore and 51.9 million tons of probable ore. Overall average grade of the reserves was estimated at 6.11 per cent zinc, 2.66 per cent copper, 0.20 per cent lead and 2.56 ounces of silver a ton. No definite estimate of ore reserves below the 2,800-foot level has yet been made.

Mattabi Mines Limited (60 per cent owned by Mattagami Lake Mines Limited and 40 per cent by Abitibi Paper Company Ltd.) completed its second year of full production with a substantial decrease in by-product output of silver. The decrease in 1974 resulted from reduced quantities and lower grade of ore mined. Mattabi's silver output in 1975 could be somewhat less than that of 1974.

Concentrator tune-up operations began in September 1974 at the silver base-metals property of Sturgeon Lake Mines Limited in the Sturgeon Lake district of northwestern Ontario. The property, which is being mined by open-pit methods, is 67 per cent owned by Falconbridge Copper Limited, with the remaining 33 per cent interest being held by NBU Mines Limited. Although concentrator capacity is 1,200 tons of ore a day, milling operations were at a much lower rate in 1974 and commercial production was not expected to begin until 1975. This mine will add significantly to Canadian mine output of silver. Ore reserves at December 31, 1974, were estimated at 2,172,000 tons grading 2.80 per cent copper, 10.19 per cent zinc, 1.42 per cent lead, 5.82 ounces of silver and 0.021 ounce of gold a ton.

In 1974 Mattagami Lake Mines Limited decided to bring into production its Lyon Lake property about 5 miles east of the Mattabi mine. There are five known ore zones on the property, the last and deepest of which was discovered in the spring of 1974. It is planned to develop the presently known orebodies from a single vertical shaft and to produce at a rate of 1,000 tons of ore a day by September 1977. A mining plant is being erected and shaft sinking was scheduled to start by April 1, 1975. Diamond drilling has indicated 3,100,000 tons to the 1,000 foot horizon grading 6.20 per cent zinc, 1.15 per cent copper, 3.30 ounces of silver and 0.11 ounce of gold a ton after allowing for dilution.

Manitoba – Saskatchewan. The Ruttan copper–zinc–silver mine of Sherritt Gordon Mines, Limited in northern Manitoba completed its first full year's operation at the end of 1974. The byproduct silver output of the Ruttan mine, together with that produced at Sherritt Gordon's Fox mine in the same area, exceeded the aggregate amount of byproduct silver produced in 1974 by the various base-metal mines operated by Hudson Bay Mining and Smelting Co., Limited near Flin Flon and Snow Lake, Manitoba.

Sherritt Gordon proceeded with development work by underground methods on that portion of the Ruttan orebody that lies beneath the open-pit ore zone. A preliminary re-estimate of the original 1971 program showed that about $40 million more would be required over the next four to five years to bring the underground mine into production. Ore reserves at the Ruttan property at December 31, 1974, without allowance for dilution, were 45,900,000 tons grading 1.45 per cent copper and 1.52 per cent zinc. At the Fox mine the access decline to deepen the mine from the 2,000 to the 2,200-foot level was completed. Ore reserves at the Fox mine at the end of 1974, without allowing for dilution, were 10,700,000 tons grading 1.95 per cent copper and 2.07 per cent zinc.

Sherritt Gordon's outside exploration work in 1974 was conducted in Canada, mainly in northwestern Ontario. Late in 1974 the Manitoba government, as part of its overall mineral policy, brought in new mineral disposition regulations which, among other things, provided for the provincial government's participation in all new mineral exploration in the province up to 50 per cent. Sherritt Gordon, however, found these new regulations to be commercially unacceptable and decided to stop exploring in Manitoba.

The remainder of the silver output in Manitoba and Saskatchewan came from ten base-metal mines operated by Hudson Bay Mining and Smelting Co., Limited near Flin Flon and Snow Lake, Manitoba. The ten mines included the new Centennial mine which produced a small amount of ore from development work. At the Centennial mine, which is scheduled to begin production in 1975, the access decline to the orebody below Lake Athapapuskow was completed and shaft sinking was expected to begin in January 1975. Ore reserves to the 1,200-foot level are 1.4 million tons grading 2.06 per cent copper, 2.6 per cent zinc and 0.70 ounce of silver and 0.04 ounce of gold a ton. Development work continued at the company's new Westarm mine on the west arm of Schist Lake about nine miles south of Flin Flon. Diamond drilling has

(text continued on page 473)

Table 4. Principal silver (mine) producers in Canada, 1974 and (1973)

Company and Location	Mill or Mine Capacity	Grade of Ore Produced: Silver	Copper	Lead	Zinc	Ore Produced	Silver Contained in Concentrates Produced	Remarks
	(tons of ore/day)	(oz/ton)	(%)	(%)	(%)	(tons)	(ounces)	
Newfoundland								
American Smelting and Refining Company (Buchans Unit), Buchans	1,250 (1,250)	3.25 (3.45)	1.01 (1.00)	6.28 (6.48)	11.24 (11.51)	264,000 (124,000)	741,438 (375,615)	At end of 1973 company reported about six years' ore reserves remaining.
Consolidated Rambler Mines Limited, Ming mine, Baie Verte	1,200 (1,200)	0.57 (0.46)	3.16 (3.05)	— (—)	— (—)	183,201 (210,375)	90,054 (73,250)	In process of sinking vertical shaft to 2,050-ft horizon for future ore extraction.
Nova Scotia								
Dresser Minerals, Division of Dresser Industries, Inc., Walton	— (120)	. . (5.43)	. . (0.27)	. . (6.68)	. . (1.00)	. . (8,178)	25,190 (44,477)	Due to depletion of sulphide ore reserves, mining and milling of sulphide ore reserves ceased in 1973. The 25,190 oz silver was contained in concentrates shipped from stockpile in 1974.
New Brunswick								
Anaconda Canada Limited, Caribou mine, Restigouche Co.	700 (1,000)	2.30 (. .)	3.76 (3.4)	1.86 (. .)	3.95 (3)	163,432 (45,000)	84,738 (. .)	Operations ceased late 1974 because economically mineable copper ore reserves exhausted.
Brunswick Mining and Smelting Corporation Limited, Bathurst, Nos. 12 and 6 mines[1]	10,000 (9,850)	2.32 (2.53)	0.38 (0.34)	2.96 (2.81)	6.70 (7.00)	2,607,965 (3,288,081)	2,918,721[2] (4,994,799)	Company commenced in 1974 on $48,000,000 expansion program centered around new production shaft.
Heath Steele Mines Limited, Newscastle	3,100 (3,100)	1.98 (1.83)	1.04 (0.86)	1.72 (1.64)	4.39 (4.90)	1,085,495 (1,077,816)	1,184,840 (1,098,918)	Continued to sink new No. 5 shaft and to increase mill capacity.
Nigadoo River Mines Limited, Bathurst	1,000 (—)	3.74 (—)	0.33 (—)	2.53 (—)	2.74 (—)	205,691 (—)	619,353 (—)	Mining operations resumed in January 1974.
Quebec								
Campbell Chibougamau Mines Ltd., Main Mine, Cedar Bay, Henderson and Grandroy mines, Chibougamau	4,000 (4,000)	0.22 (0.24)	1.03 (1.30)	— (—)	— (—)	960,552 (1,186,842)	110,472 (182,844)	Operations suspended during most of July 1974 due to a wildcat strike.

Clinton Copper Mines Ltd., Notre-Dame des Bois	ore custom-milled	0.951 (—)	2.64 (—)	0.48 (—)	2.50 (—)	52,656 (—)	42,363 (—)	Mine production began January 1, 1974 but, because of labour and economic problems, mine operated for only 44 days, with ore treated in Sullivan Group concentrator.
Falconbridge Copper Limited, Lake Dufault Division, Millenbach and Norbec mines, Noranda	1,500 (1,500)	0.99 (1.41)	2.38 (3.65)	— (—)	3.54 (4.41)	553,187 (555,292)	434,065 (558,489)	Potential new ore zone discovered from surface exploration.
Falconbridge Copper Limited, Opemiska Division, Perry and Springer mines, Chapais	3,000 (3,000)	0.32 (0.34)	1.85 (2.14)	— (—)	— (—)	927,059 (1,062,818)	253,144[2] (299,530)	In April 1974 began sinking of new Cooke shaft to a planned depth of 1,978 feet.
Gaspe Copper Mines, Limited, Needle Mountain and Copper Mountain mines, Murdochville	33,750 (33,750)	0.05 (0.05)	0.61 (0.62)	— (—)	— (—)	10,630,690 (6,729,078)	620,733 (342,147)	Mine production should increase substantially in 1975 due to improvement in operations.
Madeleine Mines Ltd., Ste-Anne-des-Monts	2,500 (2,500)	0.22 (. .)	1.27 (1.31)	— (—)	— (—)	804,390 (713,980)	178,276 (164,200)	Surface and underground exploration planned.
Manitou-Barvue Mines Limited, Golden Manitou mine[3], Val d'Or	1,600 (1,600)	2.58 (2.96)	. . (—)	0.35 (0.30)	2.20 (2.07)	225,303 (197,930)	404,810 (439,631)	Exploration at the mine continued in 1974 but at a slower rate than desired due to shortages of mining and drilling personnel.
Mattagami Lake Mines Limited, Matagami	3,850 (3,850)	0.88 (0.84)	0.62 (0.57)	— (—)	7.5 (7.4)	1,406,265 (1,387,251)	453,253 (434,252)	New 3-year labour agreement signed in second quarter 1974.
Noranda Mines Limited, Horne Division, Noranda	2,200 (3,200)	0.59 (0.56)	2.8 (2.51)	— (—)	— (—)	390,000 (485,783)	138,083 (167,140)	Company proposes to develop two small copper orebodies 30 miles northwest of Noranda.
Normetal Mines Limited, Normetal	838 (1,000)	1.1 (1.37)	0.97 (1.38)	— (—)	4.58 (4.86)	250,492 (297,889)	142,000 (238,640)	Mine expected to cease operations about June 1975 due to exhaustion of ore reserves.
Orchan Mines Limited, Matagami	1,900 (2,000)	0.50 (0.69)	1.18 (1.16)	0.05 (—)	4.78 (5.77)	364,030 (450,230)	58,397 (93,993)	Operations in 1974 hampered by shortage of skilled labour.
Patino Mines (Quebec) Limited, Chibougamau	2,800 (2,800)	0.200 (0.186)	1.56 (1.61)	— (—)	— (—)	859,332 (973,395)	123,147 (132,187)	Operations suspended November 16, 1974 by a labour strike which was still in effect at end of 1974.

Table 4. (cont'd)

Company and Location	Mill or Mine Capacity	Grade of Ore Produced: Silver	Copper	Lead	Zinc	Ore Produced	Silver Contained in Concentrates Produced	Remarks
	(tons of ore/day)	(oz/ton)	(%)	(%)	(%)	(tons)	(ounces)	
Quebec (concl'd)								
Sullivan Mining Group Ltd., Stratford Centre	1,500 (1,500)							
Cupra Division		1.112 (1.092)	2.49 (2.41)	0.59 (0.66)	4.78 (4.88)	87,474 (89,814)	83,725 (63,588)	Central concentrator for both Cupra and D'Estrie mines.
D'Estrie Mining Company Ltd.		1.155 (1.227)	2.56 (2.74)	0.61 (0.74)	2.72 (3.16)	162,081 (130,265)	160,557 (102,831)	Proven ore reserves August 31, 1974 were: 919,700 tons grading 3.07% copper, 1.81% zinc, 0.64% lead, 1.178 ounces silver and 0.016 ounce gold per ton.
Ontario								
Agnico-Eagle Mines Limited, Trout Lake No. 3 shaft mine, Cobalt district	400 (400)	. . (43.66)	. . (. .)	— (—)	— (—)	. . (27,028)	462,864 (1,130,966)	Arranged 21-year lease on two contiguous mining claims which include former Coniagas and Trethewey mines.
Ecstall Mining Limited (Texasgulf Inc.), Kidd Creek mine, Timmins	10,000 (10,000)	3.17 (3.72)	1.75 (1.61)	0.30 (0.33)	9.20 (9.78)	3,723,865 (3,609,657)	10,553,000 (10,452,021)	Plans to expand underground mine, to build a copper smelter and refinery and increase mill capacity by 33%.
Falconbridge Nickel Mines Limited, Ontario mines, Sudbury district	12,100 (12,100)	. . (. .)	. . (. .)	— (—)	— (—)	4,337,000 (4,293,000)	. . (. .)	Late in 1974 company launched a $95,000,000 smelter environmental improvement program at its Sudbury operations which includes an acid plant.
Mattabi Mines Limited, Sturgeon Lake	3,000 (3,000)	4.31 (5.31)	0.91 (1.10)	0.91 (1.06)	8.81 (11.37)	1,138,965 (1,111,765)	3,409,000[4] (4,182,324)[4]	Planning for the development and mining of the underground portion of the orebody is continuing.
Noranda Mines Limited, Geco Division, Manitouwadge	5,000 (5,000)	1.56 (1.63)	1.72 (1.70)	0.20 (. .)	4.72 (4.53)	1,826,704 (1,463,585)	2,058,000 (1,648,135)	Operations were hampered in 1974 by shortages of miners and skilled tradesmen.

Selco Mining Corporation Limited, South Bay Division, Uchi Lake area	500 (500)	3.0 (3.18)	2.0 (1.86)	.. (..)	13.0 (13.04)	195,000 (191,614)	450,000[2] (480,844)	Began deep development program including deepening shaft from 700 to 2,100 ft.
Sturgeon Lake Mines Limited, Sturgeon Lake	1,200 (—)	4.58 (—)	2.05 (—)	1.09 (—)	7.59 (—)	82,592 (—)	133,200 (—)	Tune-up of the concentrator began in September 1974.
Teck Corporation Limited, Silverfields Division, Cobalt district	270 (270)	9.2 (13.0)	0.4[e] (0.4)	— (—)	— (—)	87,891 (96,556)	850,648 (1,210,000)	Indicated ore reserves at September 30, 1974 totalled 324,000 tons grading 11.1 oz silver a ton, which included 159,400 tons broken ore grading 10.7 oz silver a ton.
The International Nickel Company of Canada, Limited, Sudbury and Shebandowan, Ont., and Thompson, Man.	85,900 (85,900)	.. (..)	.. (..)	— (—)	— (—)	22,000,000 (19,410,303)	1,910,000[5] (2,170,000)[5]	In January 1974 production from the Crean Hill mine was resumed on a regular basis.
Willroy Mines Limited, Willroy and Willecho mines, Manitouwadge	1,700 (1,700)	1.37 (1.42)	0.42 (0.98)	0.23 (0.17)	3.06 (2.74)	394,154 (430,486)	314,725[2] (433,337)	Ore reserves at December 31, 1974 were sufficient for two more years' operations at current rate of production.
Manitoba – Saskatchewan								
Hudson Bay Mining and Smelting Co., Limited, Flin Flon and Snow Lake districts	8,500 (8,500)	0.63 (0.747)	2.34 (2.448)	0.12 (..)	3.22 (3.611)	1,574,948 (1,815,027)	771,862 (976,470)	New 3-year labour agreement covering all nine unions in Flin Flon — Snow Lake area became effective October 1, 1973.
Sherritt Gordon Mines, Limited Fox mine, Lynn Lake	3,000 (3,000)	0.33 (..)	2.104 (2.013)	— (—)	1.98 (2.072)	1,008,111 (963,416)	299,555 (..)	The access decline to deepen the mine from the 2,000-ft level to the 2,200-ft level was completed.
Ruttan mine, Ruttan	10,000 (10,000)	0.20 (..)	1.065 (1.14)	— (—)	1.676 (..)	3,358,257 (1,518,052)	662,062 (..)	In 1974 the company began an extensive program of underground diamond drilling.
The International Nickel Company of Canada, Limited, Thompson, Man.	(included with this company's listing for Ontario)							
British Columbia								
Bethlehem Copper Corporation, Highland Valley, (formerly Bethlehem Copper Corporation Ltd.)	16,000 (16,000)	.. (..)	0.505 (0.581)	— (—)	— (—)	6,346,402 (6,339,122)	178,120 (165,832)	Because of a cutback in operations by the smelters to whom Bethlehem Copper was shipping, Bethlehem was asked to reduce its shipments of copper concentrate by 15% in the early part of 1975.

Table 4. (cont'd)

Company and Location	Mill or Mine Capacity	Grade of Ore Produced: Silver	Copper	Lead	Zinc	Ore Produced	Silver Contained in Concentrates Produced	Remarks
	(tons of ore/day)	(oz/ton)	(%)	(%)	(%)	(tons)	(ounces)	
British Columbia (cont'd)								
Bradina Joint Venture, Houston	— (500)	— (4.88)	— (0.43)	— (1.02)	— (4.57)	— (98,471)	— (283,363)	Mining and milling operations suspended August 31, 1973.
Brenda Mines Ltd., Peachland	24,000 (24,000)	. . (. .)	0.186 (0.203)	— (—)	— (—)	9,549,588 (8,867,800)	230,013 (245,986)	In 1974 operations were hampered by shortages of operating supplies, particularly grinding balls and one flotation reagent.
Cominco Ltd., Sullivan mine, Kimberley	10,000 (10,000)	1.41 (1.76)	. . (. .)	4.11 (4.97)	4.49 (4.99)	1,416,489 (2,214,415)	1,653,334 (3,328,727)	Operations suspended July 1 to October 31, 1974 due to labour strike.
Consolidated Columbia River Mines Ltd., Ruth-Vermont mine, Golden (formerly Columbia River Mines Ltd.)	500 (500)	— (5.02)	— (0.09)	— (3.69)	— (5.08)	— (26,957)	— (87,123)[e]	Mine closed down in January 1974.
Dankoe Mines Ltd., Keremeos	400 (—)	10.0 (—)	. . (—)	. . (—)	. . (—)	24,351 (—)	218,424 (—)	Mining and milling operations resumed April 1, 1974.
Gibraltar Mines Ltd., McLeese Lake, Cariboo district	40,000 (40,000)	. . (. .)	0.40 (0.484)	— (—)	— (—)	13,397,264 (15,082,231)	. . (. .)	Commenced mining Granite Lake Stage 1 pit.
The Grandby Mining Company Limited, Granisle mine, Babine Lake	13,000 (13,000)	. . (0.09)	0.446 (0.472)	— (—)	— (—)	4,780,857 (4,565,105)	178,317 (183,036)	Company is studying further improvements to its Granisle plant which may involve additional capital expenditures in 1976.
The Granby Mining Company Limited, Phoenix Copper Division, Greenwood	2,750 (2,750)	0.134 (0.177)	0.446 (0.50)	— (—)	— (—)	1,012,426 (1,003,815)	85,204 (78,618)	Installation of a new ball mill in March 1974 enabled concentrator to maintain its production rate.

Granduc Operating Company, Stewart	8,000 (8,000)	0.216 (. .)	1.23 (1.25)	— (—)	— (—)	2,708,731 (2,797,949)	584,265 (623,005)	Mainly due to declining copper prices and rising operating costs, Granduc announced in December 1974 that its 1975 ore production would be only 50% of that of 1974.
Kam-Kotia Mines Limited, Silmonac mine, Slocan district	140 (150)	12.76 (14.45)	. . (. .)	3.28 (5.36)	4.16 (5.41)	12,034 (14,015)	150,214 (190,134)	Positive ore reserves are limited, but probable ore reserves at end of 1974 were sufficient to maintain economic operations at current metal prices for several months.
Lornex Mining Corporation Ltd., Highland Valley	45,000 (38,000)	. . (. .)	0.457 (0.424)	— (—)	— (—)	16,445,460 (13,986,958)	515,684^e (479,127)	Current conditions preclude any plans for expansion or additional exploration. Development has been curtailed and production forecast for 1975 is less than capacity.
Placid Oil Company, Bull River mine, Cranbrook	750 (750)	. . (0.7142)	. . (2.4)	— (—)	— (—)	100,904 (206,812)	42,560 (88,692)	On June 10, 1974, closed down for an indefinite period.
Purcell Development Co. Ltd., Mineral King and Paradise mines, Toby Creek	200 (—)	. . (—)	. . (—)	. . (—)	. . (—)	. . (—)	. . (—)	Production of lead and zinc concentrates began October 1974 from treatment of ore from former Mineral King mine and tailings from former Paradise mine.
Reeves MacDonald Mines Limited, Annex mine, Remac	1,000 (1,000)	0.64 (1.06)	. . (. .)	1.18 (1.67)	3.84 (4.49)	195,565 (191,438)	84,221^e (159,510)	Operations being suspended March 31, 1975.
Similkameen Mining Company Limited, Ingerbelle Pit, Princeton	15,000 (15,000)	. . (. .)	0.48 (0.45)	— (—)	— (—)	5,086,000 (5,356,829)	117,650 (130,808)	7,000 tons ore a day mill expansion begun.
Teck Corporation Limited, Beaverdell mine, Beaverdell	120 (120)	9.06 (12.36)	0.003 (0.002)	0.41 (0.62)	0.52 (0.61)	37,184 (37,202)	336,860 (459,883)	Plans salvage work, routine mining and diamond drilling.
Utah Mines Ltd., Island Copper mine, Coal Harbour, Vancouver Island	38,000 (33,000)	. . (. .)	0.47 (0.50)	— (—)	— (—)	11,200,000 (12,071,000)	229,200^e (263,600)	Mill capacity increased from 33,000 to 38,000 tons ore a day.
Wesfrob Mines Limited, Tasu Harbour, Queen Charlotte Islands	5,800 (3,000)	. . (. .)	0.282 (0.408)	. . (. .)	. . (. .)	939,313 (762,978)	80,804 (87,305)	Decision made for mining of the underground orebody.

Table 4. (concl'd)

Company and Location	Mill or Mine Capacity	Grade of Ore Produced: Silver	Copper	Lead	Zinc	Ore Produced	Silver Contained in Concentrates Produced	Remarks
	(tons of ore/day)	(oz/ton)	(%)	(%)	(%)	(tons)	(ounces)	
British Columbia (concl'd)								
Western Mines Limited, Buttle Lake, Vancouver Island	1,100 (1,100)	4.52 (4.60)	1.28 (1.39)	1.48 (1.28)	8.05 (8.29)	297,290 (354,240)	1,212,950 (1,424,437)	High labour turnover, absenteeism and an inadequate labour supply caused reduced production in 1974 compared with that of 1973.
Northwest Territories								
Echo Bay Mines Ltd., Port Radium	150 (150)	104.29 (84.04)	0.99 (1.25)	— (—)	— (—)	20,768 (37,393)	2,120,038 (3,064,000)	
Terra Mining and Exploration Limited, Camsell River area	175 (175)	24.02 (35.4)	0.30 (0.7)	— (—)	— (—)	45,684 (41,116)	1,093,919 (1,393,323)	In 1974 discovered two new veins at depth and continuing development and mining thereof to surface.
Yukon Territory								
Cyprus Anvil Mining Corporation, Faro, (formerly Anvil Mining Corporation Limited)	10,000 (10,000)	. . (. .)	. . (. .)	4.51 (4.88)	5.60 (6.37)	2,925,000 (2,899,145)	2,252,681[2] (2,811,482)	Exploration work continuing.
United Keno Hill Mines Limited, Husky, Elsa, No Cash, Townsite, Dixie and Shamrock mines, Elsa	550 (550)	37.73 (34.62)	. . (. .)	4.22 (4.00)	1.15 (1.00)	93,232 (94,819)	3,238,000 (3,135,000)	Production resumed at Keno mine and developing Shamrock mine.
Whitehorse Copper Mines Ltd., Little Chief mine, Whitehorse	2,000 (2,400)	0.346 (. .)	1.84 (1.83)	— (—)	— (—)	618,000 (700,054)	212,201 (254,000)	Underground ore reserves increased in 1974 due to southward extension located on the 1830 level of Little Chief orebody.

Source: Company reports and technical press.
[1] All statistical data, including mill capacity, represent combined results for Nos. 12 and 6 mines and mills. [2] Figures represent that portion of the silver contained in the concentrates that was actually paid for by the receiving smelters. [3] Grade and production statistics do not include 253,281 and 158,183 tons of copper ore custom milled in separate circuits in 1973 and 1974, respectively. [4] Figures represent silver contained in copper and lead concentrates only. [5] Silver delivered to markets.
^{e} Estimate; — Nil; . . Not available.

Table 5. Prospective[1] silver producing mines in Canada

Company and Location	Year Production Expected	Planned Mill or Mine Capacity	Indicated Ore Reserves	Average Grade of Ore				Remarks
				Silver	Lead	Zinc	Copper	
		(tons ore/day)	(tons)	(oz/ton)	(%)	(%)	(%)	
New Brunswick								
Heath Steele Mines Limited, Little River mine, Newcastle	1976	..	..	..	..	..	..	Ore to be milled at company's existing concentrator which is to be expanded from 3,000 to 4,000 tpd.
Quebec								
Falconbridge Copper Limited, Opemiska Division, Cooke mine, Chapais	..	300	555,000	..	—	—	1.46	The Cooke shaft reached a depth of 1,029 ft by end of 1974.
Orchan Mines Limited, Norita mine, Matagami	1976	900	1,637,000[2]	..	—	7.6	0.7	Shaft sinking has been advanced to a depth of 993 ft, and three level stations have been excavated.
Patino Mines (Quebec) Limited, and subsidiary Lemoine Mines Limited, Bouzan mine, Chibougamau	1975	400	625,000	2.70	—	10.8	4.5	Ore reserves also contain 0.138 ounce gold a ton. Sinking of a shaft to a depth of 1,000 feet began late in 1974.
Ontario								
Falconbridge Nickel Mines Limited, Falconbridge,								
Fraser mine	..	..	..	..	—	—	..	Shaft sinking in progress.
Lockerby mine	1975	..	..	..	—	—	..	Development continuing. One third of maximum production rate expected by end of 1975.
Mattagami Lake Mines Limited, Lyon Lake orebodies, Sturgeon Lake	1977	1,000	3,096,000	3.30	0.60	6.2	1.15	Shaft sinking expected to begin early in 1975.
The International Nickel Company of Canada, Limited, Clarabelle mine, Sudbury	..	..	..	..	..	..	..	Open-pit mining completed in 1974. Mining will be resumed upon development of ore extension.

Table 5. (concl'd)

Company and Location	Year Production Expected	Planned Mill or Mine Capacity	Indicated Ore Reserves	Average Grade of Ore				Remarks
				Silver	Lead	Zinc	Copper	
		(tons ore/day)	(tons)	(oz/ton)	(%)	(%)	(%)	
Manitoba–Saskatchewan								
Hudson Bay Mining and Smelting Co., Limited, Flin Flon district								
Centennial mine	1975	..	1,400,000	..	..	2.6	2.06	Shaft sinking began January 1975.
Westarm mine	..	..	710,000	..	..	0.6	4.63	Shaft sinking expected to begin in April 1975.
British Columbia								
Northair Mines Ltd., Brandywine Falls mine, Alta Lake	1976	300	459,000	3.49^e	2.28^e	3.09^e	0.33^e	Company purchased a 300 tpd concentrator and underground plant.
Zeballos Development Company Ltd., Jeune Landing	1975	200	100,000	..	..	12.5	..	Company purchased a mill in Timmins, Ontario and intends to reinstall it early in 1975.
Northwest Territories								
Nanisivik Mines Ltd., Strathcona Sound, Baffin Island	1977	1,500	7,000,000	1.77	1.4	14.1	..	Feasibility study to be completed early 1974 and construction of mine and concentrator to begin in same year.

[1] Those mines which have announced production plans. [2] Ore reserve figure does not allow for dilution in mining.
[e] Estimated; — Nil; .. Not available.

outlined a reserve of 710,000 tons grading 4.63 per cent copper to the 1,400-foot level. At the end of 1974 the headframe and auxilliary buildings were erected, and shaft sinking was expected to begin in 1975.

British Columbia. Base-metal ores continued to be the main source of British Columbia's mine output of silver. Cominco Ltd., the largest silver producer in the province, derived its output from the lead–zinc–silver ores of its Sullivan mine in southeastern British Columbia, and from purchased ores and concentrates. Byproduct silver output from the Sullivan mine was considerably lower in 1974 than in 1973 because of a four-month suspension of operations caused by a labour strike. As a result of this lengthy closure, production at the Sullivan mine did not reach its full capacity until the end of 1974.

Because of the decline in copper prices, and more particularly because of the adverse affects on B.C. mining companies brought about by the British Columbia government's Mineral Royalties Act (Bill 31), effective October 1, 1974, and British Columbia's parallel Mineral Land Tax Act, Western Mines Limited decided to curtail operations at its Myra Falls mine near Buttle Lake on Vancouver Island. For 1975, the company planned a complete cessation of mine exploration in British Columbia and a reduced level of development work directed towards ore reserves already discovered at its mine at Buttle Lake, B.C. Overall ore reserves at December 31, 1974 were some 1.9 million tons grading 7.5 per cent zinc, 1.1 per cent copper, 1.2 per cent lead, 4.1 ounces silver and 0.08 ounce gold a ton. These reserves were sufficient for six years' operations at the current rate of production, and metal prices and operating costs obtaining at the end of 1974.

Reeves MacDonald Mines Limited continued operations at its Annex zinc–lead–silver property in southern British Columbia. The tonnage of ore produced in 1974 was slightly greater than in 1973 but the grade of ore milled was significantly lower. Byproduct silver output was also substantially lower and it was expected that the mine would suspend operations in the first half of 1975 for economic reasons including the company's unsuccessful attempt to gain tax relief from the British Columbia government's Mineral Royalties Act. However, the single most important factor likely to force closure of the mine was the impending exhaustion of known ore reserves.

Dankoe Mines Ltd. resumed production in April 1974, at a rate of 150 tons of ore a day, at its silver base-metals property about 12 miles south of Keremeos in south-central British Columbia. The mine, equipped with a 450-ton-a-day concentrator, suspended operations in March 1970 because of low silver prices. Late in 1974, Dankoe announced that it had negotiated a contract to custom treat 10,000 tons of ore a month from the nearby Okanagan Falls gold–silver property of Dusty Mac Mines Ltd. Shipments of the Dusty Mac ore were not expected to begin until mid-1975. Dusty Mac's measured ore reserves have been reported to be some 133,000 tons averaging 0.20 ounce of gold and 3.60 ounces of silver a ton.

Northair Mines Ltd. continued underground exploration and development work at its Brandywine Falls silver–gold base-metals property 70 miles north of Vancouver. Partially developed and drill-indicated ore reserves in the three zones were, in mid-1974, calculated to be: Warman zone, 250,000 tons averaging 0.71 ounce gold and 0.85 ounce silver a ton, 0.23 per cent copper, 1.42 per cent lead and 2.35 per cent zinc over a width of 9.3 feet; Manifold zone, 87,000 tons grading 0.27 ounce gold and 14.3 ounces silver a ton, 0.07 per cent copper, 0.28 per cent lead and 0.57 per cent zinc over a width of 5.9 feet; and Discovery zone, 121,800 tons averaging 0.10 ounce of gold and 1.18 ounces of silver a ton, 0.55 per cent copper, 5.43 per cent lead and 6.58 per cent zinc over a width of 17.4 feet. Mining and concentrating operations were expected to begin early in 1976 at a rate of 300 tons of ore a day provided suitable financing arrangements can be made and a pollution control permit obtained from the British Columbia government. Cost of the project has been estimated at $4 million.

Zeballos Development Company Ltd., a wholly-owned subsidiary of Ponderay Exploration Company Ltd., both of Edmonton, Alberta, did development work on the Marble River zinc–silver property of Alice Lake Mines Limited at the north end of Vancouver Island. It was expected the property would be brought into production under a five-year lease from Alice Lake provided this company is granted a production lease from the British Columbia government. A portable mill, incorporating the standard flotation concentrating process, was purchased in Timmins, Ontario and it was expected that the open-pit property would begin production about mid-1975 at a rate of 200 tons of ore daily. Late in 1974 it was reported that proven ore reserves were estimated to be 50,000 tons grading 8.7 per cent zinc and 0.95 ounce of silver a ton and probable reserves 51,000 tons, to a depth of 50 feet.

More diamond drilling and development work was done in 1974 on Equity Mining Capital Limited's Sam Goosly silver–gold–copper–antimony property 40 miles south of Smithers, B.C., and approximately 125 air miles east of Prince Rupert, B.C. The company planned to have a comprehensive feasibility study made to determine the merits of placing the property in production at a rate of 4,500 to 6,000 tons a day. Late in 1974, total tonnage in the Main Deposit and the Southern Tail zones, mineable by open-pit methods, was estimated at 40.3 million tons grading 2.82 ounces of silver and 0.026 ounce of gold a ton, and 0.35 per cent copper. Overburden is relatively light, ranging from 10 to 20 feet and waste to ore shipping ratio would approximate 2 to 1. A production decision will likely be dependent upon a satisfactory resolution of government taxation policies. Equity Mining and Congdon and Carey Company of Denver, Colorado, share equally a 70 per cent working interest in the property, with Kennco Explorations (Western) Limited, a subsidiary of Kennecott Copper Corporation, holding a 30 per cent carried interest. The undertaking is managed by Equity Mining.

Northwest Territories. Silver production in 1974 in the Northwest Territories was significantly lower than in 1973 because of reduced output by Echo Bay Mines Ltd. and Terra Mining and Exploration Limited, which operate silver–copper properties near Port Radium on the east shore of Great Bear Lake. The two properties were again the principal silver producers in the Northwest Territories. In 1974 Terra's new No. 10 and 11 veins were the main development targets with most of the ore production coming from the No. 10 vein. Continuing exploration and development of Terra's (peninsula) property was scheduled for 1975 with $1,000,000 budgeted for opening of the mine. At December 31, 1974 Terra's proven, probable and inferred silver ore reserves totalled some 42,400 tons, averaging 55.1 ounces silver a ton; proven and probable copper ore reserves totalled 27,100 tons, grading 3.1 per cent copper and 2.6 ounces silver a ton.

On June 18, 1974, the Honourable Jean Chretien, then Minister of Indian and Northern Affairs, announced that the federal government would invest $16.7 million towards the development to production of the lead–zinc–silver property of Mineral Resources International Limited at Strathcona Sound on Baffin Island. The property, in which Ecstall Mining Limited has a 35 per cent carried interest, will be operated by a new company named Nanisivik Mines Ltd. Nanisivik is owned 59.5 per cent by Mineral Resources International, 18.0 per cent by the Canadian government and 11.25 per cent by each of Metallgesellschaft A.G. of West Germany and Billiton N.V. of the Netherlands. Construction activities at the mine site began in April 1974, and it was expected that the property would be brought into production late in 1977 at a rate of 1,500 tons of ore a day at an estimated capital cost of $55,000,000. Ore reserves in the main orebody have been estimated at some 7 million tons averaging 14.1 per cent zinc, 1.4 per cent lead and 1.8 ounces of silver a ton.

Further exploration work in 1974 on the zinc–lead–copper–silver prospect which Cominco Ltd. has optioned from Bathurst Norsemines Ltd. resulted in another major discovery, the Boot Lake Zone. Exploration work to the end of 1974 has resulted in the discovery of three ore zones with drill-indicated reserves in the order of 20 million tons. The property is in the Hackett River area, District of Mackenzie, on the Arctic coast about 300 air-miles northeast of Yellowknife, N.W.T.

Yukon Territory. A slight increase in silver production in 1974 in the Yukon Territory resulted from greater output at the silver–lead–zinc property of United Keno Hill Mines Limited. The two principal producers continued to be United Keno and Cyprus Anvil Mining Corporation. At the Keno Hill property, the underground exploration and development programs at both the producing mines and prospective producers continued at high levels in 1974. Also, a considerable amount of local overburden drilling was done. Additions to proven ore reserves were made to all mines except Elsa. Probable reserves increased at the Husky and Dixie mines. At the end of 1974 proven ore reserves totalled 105,600 tons, grading 44.0 ounces silver a ton, 4.9 per cent lead and 1.2 per cent zinc; probable reserves totalled 116,800 tons, grading 40.0 ounces silver a ton, 5.4 per cent lead and 1.3 per cent zinc.

The agreement made in March 1974 between Anvil Mining Corporation Limited and Dynasty Explorations Limited to amalgamate under the name Cyprus Anvil Mining Corporation was held up because of United States tax regulations. The company, nevertheless, began operating under the new name Cyprus Anvil Mining Corporation. Anvil Mining Corporation was a joint-venture company owned 60 per cent by Cyprus Mines Corporation of Los Angeles, California, and 40 per cent by Dynasty Explorations Limited of Vancouver. The expansion program to increase concentrator capacity to 10,000 tons of ore a day, which began in 1973, was expected to be completed in March 1975 at a total cost of almost $5 million. In the first half of 1974 the mining operation of Cyprus Anvil's mine at Faro was rescheduled from a six- to seven-day week basis to compensate for previous shortfalls in the waste stripping production. A 33-day wildcat strike during the second quarter of 1974 resulted in less than planned excavation quantities from the mine. In spite of the strike, ore production in 1974 was slightly higher than in 1973. Ore reserves at December 31, 1974 were estimated at almost 50 million tons, with an average grade of 8.7 per cent combined lead and zinc with about one ounce of silver a ton. At the current mining rate, life expectancy of these estimated reserves is about 14 years.

Extensive surface work, including geophysical surveys and diamond drilling, was done in 1974 in a joint venture by Kerr Addison Mines Limited and Aex Minerals Corporation and resulted in the discovery of the Grum zinc–lead–silver deposit in the Vangorda Creek area near Faro. During 1974, 48 diamond drill holes totalling 57,500 feet were completed in an area 4,500 feet long by 1,600 feet wide. According to press reports, a deposit of several million tons has been indicated. Although it appeared that a portion of the deposit would be amenable to open-pit mining, it was thought that the bulk of the tonnage would have to be mined as an underground operation. It was planned to spend $6,250,000 on a program in 1975 consisting of surface diamond drilling to extend the known mineralization and underground development and diamond drilling to determine continuity and grade. This work combined with engineering investigations will provide the data base for a feasibility study. Kerr Addison holds a 60 per cent interest in the Grum deposit, with the remaining 40 per cent being owned by Aex Minerals.

Bulldozer trenching was continued in 1974 by Dynasty Explorations Limited and its associate, Cima Resources Limited, on the Plata silver–gold–lead property in the Hess Mountains area 110 miles north of Ross River. Dynasty is financing the project and holds an 80 per cent interest in the venture, with Cima having a 20 per cent carried interest. Two significant silver–lead veins were discovered, and four vein zones were prepared for diamond drilling at a later date. Work, in 1973, on the project revealed a principal vein fault over 6,000 feet long that assayed 50 to 60 ounces of silver and 0.02 to 0.20 ounce of gold a ton across widths of three to five feet.

Uses

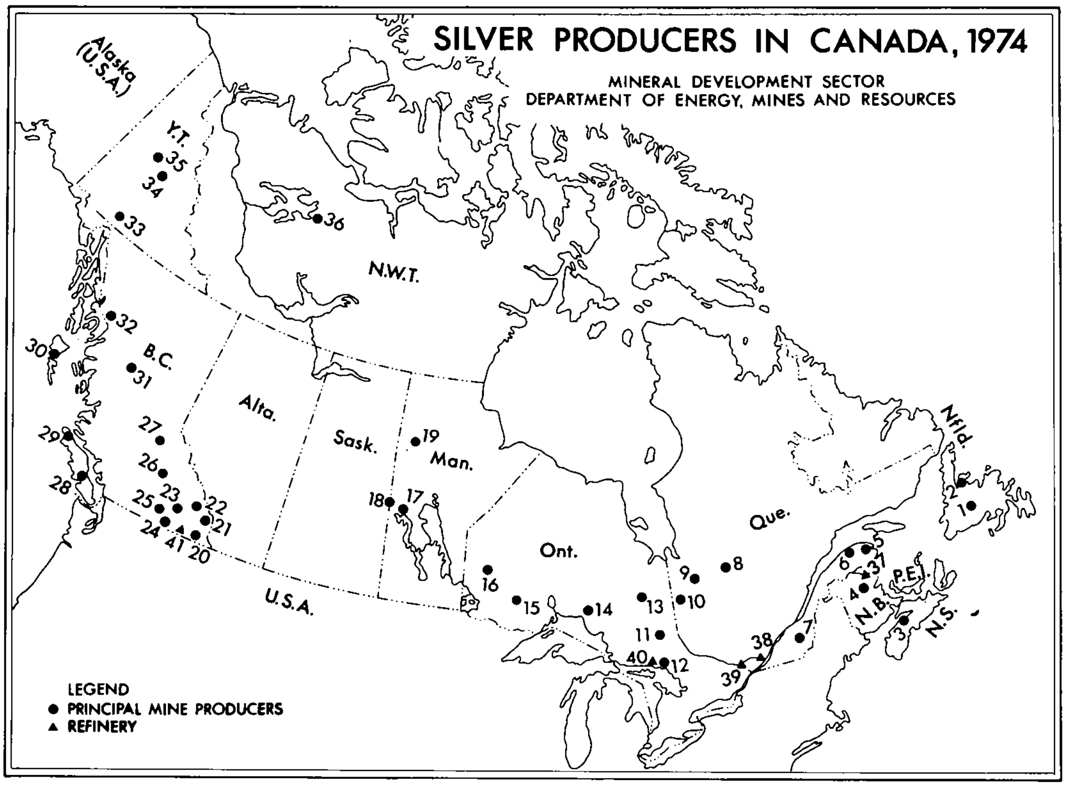
Although the number of industrial applications for silver has increased, significant quantities of the metal are still used in the manufacture of coinage, especially commemorative coins. This is because it strongly resists corrosion, has good alloying properties, an attractive appearance and intrinsic value. The quantity of silver required for coinage increased significantly in 1974 because of the greater amount of silver used by the Royal Canadian Mint in the production of the sterling silver Olympic coins. According to Handy and Harman, noncommunist world consumption of silver for coinage dropped from a high of 381.1 million ounces in 1965 to 21.0 million ounces in 1973 and then increased to 33.0 million ounces in 1974. Silver is used extensively in jewelry, sterling and plated silverware, and as a decorative material, because of the same properties that made it popular in the past as a coinage metal as well as for its high malleability, ductility and ability to take a fine finish. Phillips Petroleum Company recently developed a very promising anti-tarnish compound called Meos which permits treated silver to remain untarnished 20 to 60 times longer than untreated silver. The photographic industry, in which the use of silver is based on the light sensitivity and ease of reduction of certain silver compounds, is the metal's greatest single user. Silver halide is the light-sensitive chemical coating on film that makes photography possible. In 1974, photographic materials accounted for about 27.3* per cent of total industrial consumption of silver in the United States. The only significant development that could bring about a real change in the substantial use and growth of silver in this major outlet would be the discovery of a suitable and economic substitute. In spite of the vast amount of research that has been done in this field for several years, and the repeated rumours and announcements of imminent replacement, a suitable silverless photographic process does not yet appear to be on the horizon. Even if a satisfactory substitute should be found, it could take some years to effect the transition.

Substantial quantities of silver are being used in the electrical and electronics industries because of the good demand for silver contacts, conductors, and other silver-bearing components. These applications include extensive quantities of silver used in the component parts of complex electronics systems to assure maximum conductivity and reliability in guidance systems for spacecraft. In 1973, electrical and electronic products accounted for about 21.0* per cent of total industrial consumption of silver in the United States. Silver is an important constituent of many brazing and soldering alloys because of the low melting point of silver–copper and silver–copper–zinc alloys, their resistance to corrosion, high-tensile strength and ability to join together almost all nonferrous metals and alloys as well as iron and silver. These solders and brazing alloys are widely used in the manufacture of air conditioning and refrigeration equipment, electrical appliances and automotive parts.

Silver–zinc and silver–cadmium batteries are increasingly used in portable equipment where good output, long life and rechargeability are required. These batteries are also used in jet aircraft, missiles, satellites and space capsules where weight and dependability are of prime importance. High-energy silver–zinc batteries played a vital part in the historic Apollo flights to the moon, servicing both the command and lunar excursion modules. Silver–zinc batteries powered TV transmissions from Apollo 17's Lunar Rover. Similar batteries also provide high-intensity light for lanterns and flashlights for plant protection and security officers. A single silver–zinc battery in a nuclear submarine may use as much as 168,000 ounces of silver.

An increase in the use of silver in the battery field could develop as a result of extensive research being done in the use of silver–zinc batteries to power motorcycles and small cars. Corbin-Gentry, Incorporated of Sommerville, Connecticut and Dallas, Texas hopes by 1977 to have a production model on the market of a motorcycle powered by a silver–zinc battery made by Yardney Electric Corp. of Pawcatuck, Connecticut. This motorcycle is expected to have a range of 150 miles and speeds of 50 miles an hour or better. Yardney is the company that attracted considerable attention a few years ago by converting several small cars to electric motors using silver–zinc batteries and produced some impressive performance figures. It has also been reported that electric motorcycles

* Based on figures contained in Table 6.



Principal Mine Producers

(numbers refer to numbers on the map)

1. American Smelting and Refining Company (Buchans Unit)
2. Consolidated Rambler Mines Limited
3. Dresser Minerals, Division of Dresser Industries, Inc.
4. Anaconda Canada Limited (Caribou mine)
   Brunswick Mining and Smelting Corporation Limited (Nos. 12 and 6 mines)
   Heath Steele Mines Limited
   Nigadoo River Mines Limited
5. Gaspe Copper Mines Limited
6. Madeleine Mines Ltd.
7. Clinton Copper Mines Ltd.
   Sullivan Mining Group Ltd., Cupra Division and D'Estrie Mining Company Ltd.
8. Campbell Chibougamau Mines Ltd.
   Falconbridge Copper Limited, Opemiska Division
   Patino Mines (Quebec) Limited
9. Mattagami Lake Mines Limited
   Orchan Mines Limited
10. Falconbridge Copper Limited, Lake Dufault Division
    Manitou-Barvue Mines Limited
    Noranda Mines Limited, Horne Division
    Normetal Mines Limited
11. Agnico-Eagle Mines Limited
    Teck Corporation Limited, Silverfields Division
12. The International Nickel Company of Canada, Limited
    Falconbridge Nickel Mines Limited
13. Ecstall Mining Limited
14. Noranda Mines Limited, Geco Division
    Willroy Mines Limited
15. Mattabi Mines Limited
    Sturgeon Lake Mines Limited
16. Selco Mining Corporation Limited, South Bay Division
17. Hudson Bay Mining and Smelting Co., Limited (Anderson Lake, Chisel Lake, Dickstone, Osborne Lake, and Stall Lake mines)
18. Hudson Bay Mining and Smelting Co., Limited (Centennial, Flin Flon, Ghost Lake, Schist Lake and White Lake mines)

19. Sherritt Gordon Mines, Limited (Fox and Ruttan mines)
20. Reeves MacDonald Mines Limited
21. Cominco Ltd. (Sullivan mine)
22. Kam-Kotia Mines Limited (Silmonac mine)
    Purcell Development Co. Ltd. (Mineral King and Paradise mines)
23. Brenda Mines Ltd.
    Similkameen Mining Company Limited
24. The Granby Mining Company Limited, Phoenix Copper Division
25. Dankoe Mines Ltd.
    Teck Corporation Limited (Beaverdell mine)
26. Bethlehem Copper Corporation
    Lornex Mining Corporation Ltd.
27. Gibraltar Mines Ltd.
28. Western Mines Limited
29. Utah Mines Ltd.
30. Wesfrob Mines Limited
31. The Granby Mining Company Limited (Granisle mine)
32. Granduc Operating Company
33. Whitehorse Copper Mines Ltd.
34. Cyprus Anvil Mining Corporation
35. United Keno Hill Mines Limited
36. Echo Bay Mines Ltd.
    Terra Mining and Exploration Limited

Refineries

(numbers refer to numbers on the map)

37. Brunswick Mining and Smelting Corporation Limited, Smelting Division
38. Canadian Copper Refiners Limited
39. Royal Canadian Mint
40. The International Nickel Company of Canada, Limited
41. Cominco Ltd.

Table 6. United States consumption of silver by end use,[1] 1973-74

	1973	1974
	(ounces)	
Electroplated ware	14,541,844	13,178,917
Sterling ware	29,386,262	22,146,679
Jewelry	5,778,210	5,235,193
Photographic materials	51,979,282	49,578,607
Dental and medical supplies	3,022,217	2,401,180
Mirrors	2,578,946	3,946,665
Brazing alloys and solders	17,736,247	14,514,008
Electrical and electronic products:		
Batteries	4,154,963	4,194,815
Contacts and conductors	40,208,565	31,318,049
Bearings	375,366	416,144
Catalysts	5,988,059	7,293,245
Coins, medallions, and commemorative objects[2]	20,107,896	22,272,396
Miscellaneous[3]	527,831	518,796
Total net industrial consumption	196,385,688	177,014,694
Coinage	920,460	1,016,600
Total consumption	197,306,148	178,031,294

Source: U.S. Bureau of Mines, Mineral Industry Surveys, Gold and Silver in March 1975.
[1] End use as reported by converters of refined silver. [2] Coins, medallions, and commemorative objects formerly included partly in sterling ware and partly in miscellaneous categories. [3] Includes silver-bearing copper, silver-bearing lead anodes and ceramic paints.

powered by silver–zinc batteries have much better hill climbing abilities than similar vehicles fuelled by lead-acid batteries. The silver–zinc battery, now used primarily in aircraft, would, however, have to be leased instead of purchased by the users of such motorcycles and small cars because its purchase price would be prohibitive. Since the sizeable silver content of such batteries is fully recoverable at the end of their useful lives, marketing on a rental basis is thought to be quite feasible.

Silver is used as a catalyst to control the oxidation of methanol to formaldehyde, and ethylene to ethylene oxide, all of which is essential to the production of plastics, antifreeze and polyester products. Silver catalysts are also used in the manufacture of carpets and permanent-press synthetic fabrics. Another growing industrial use is the almost invisible silver threads embedded in the glass of rear windows of automobiles. The threads are connected to the vehicle's battery and serve as heaters to de-ice and de-fog the windows. A low-cost, highly effective silver nitrate cream has been developed for the treatment of severe burns. Silver powder, 99.999 per cent pure, in the form of round beads has applications in powder metallurgy, electronic circuits, and in silver brazing. Meteorological applications involving the use of silver iodide for cloud seeding to produce rain could become a significant outlet for silver as many countries are making efforts to regulate the weather. Other new outlets for the metal are as fungicides and bactericides because of the increasing attention being paid to the ecology and environment. Research is being done on the use of silver in compounds for the improved treatment of swimming-pool water. Tests indicate that the addition of small amounts of silver or silver compounds can significantly reduce the quantities of other chemicals used in swimming pools for purification purposes. Recycling water with minute quantities of silver chloride also helps to eliminate unpleasant odours and tastes in the water and acts as a bactericide. Silver chloride, which has recently become available in the form of a fine-sized free-flowing powder, is used in the treatment of water to remove slime, algae and bacteria. It is also used in industrial and laboratory applications.

A new system called "laser photo" was recently developed. This system will enable an office to transmit, within minutes, a detailed positive print photograph to a branch office a continent away, without requiring wet processing or other intermediate steps. This new application for silver uses a laser as a light source and dry silver paper as the reproductive medium which is processed simply by the application of heat.

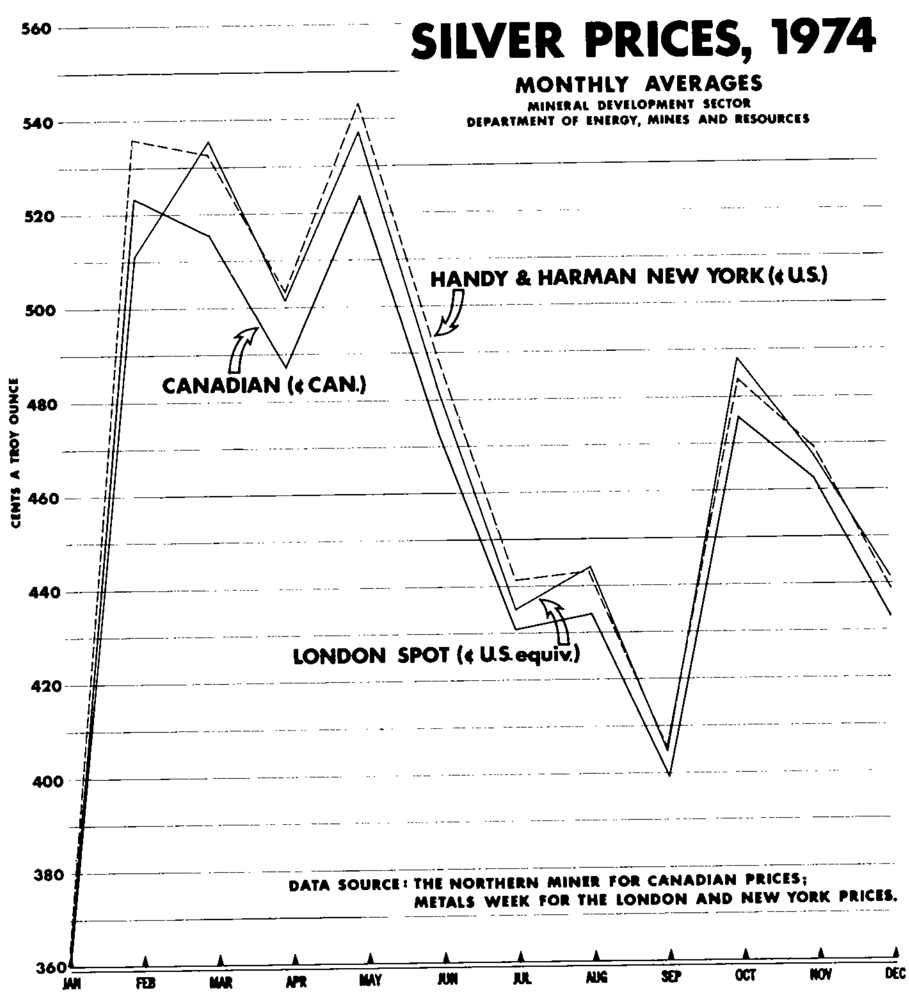
Another potential use for silver is in the conversion of solar energy. Recent experimental work indicates that a central receiver solar energy system using a one-square-mile array of silver-backed mirrors could generate enough thermal energy to supply a population centre of 100,000 people. Such an apparatus could involve the use of more than 32,000 ounces of silver. Some observers believe that the first single plant using such a central receiver system should be in operation in the United States by 1985. They anticipate that by the year 2000 these systems could furnish up to 20 per cent of anticipated United States thermal energy needs — and require a silver supply equivalent to a few years of present world output. In such solar energy systems, silver-backed mirrors catch and reflect the sun's light rays to produce heat; this heat can then generate electricity or be used to create gas fuel. As a gas, it can be stored, or transported by pipeline and, according to some reports, at about half the cost of electric power transmission by overhead voltage lines. Heat produced from these developing solar systems is also thought to be competitive with present fuel oil in costs.

The optical properties of silver are distinctive because of its exceptionally high reflectivity and very low emissivity. Polished silver surfaces have a reflection coefficient of about 80 to 95 per cent depending on the wave length of the sun's light rays. Because of these optical properties, silver is currently considered the best material, perhaps through several system concepts, for heating homes and buildings. Substitutes for silver include super-purity aluminum, and possibly copper; in fact, aluminum has been used on an experimental basis as a collector of sun rays for heating purposes, but the coefficient of reflectivity of both aluminum and copper is lower than that of silver. For the same reason, it is not thought that the platinum group metals will be used for this application. Studies indicate that the solar energy derived from a silver-using process requires about one third less power to produce than a similar process using aluminum. There are now four major United States companies competing in the field of solar energy research and development, namely McDonnell Douglas Aeronautics, Martin Marietta Corp., Rockwell International Corp. and Boeing Aircraft.

Table 7. Annual average silver prices: Canada, United States and United Kingdom, 1965-74

	Canada	United States	United Kingdom	
		Handy & Harman, New York	London Spot	London Spot
	($ Can.)	($ U.S.)	(pence)	($ U.S. Equiv.)[3]
		(per ounce)		
1965	1.399	1.293	111.583	1.300
1966	1.398	1.293	111.815	1.301
1967	1.725	1.550	141.977	1.626
1968	2.311	2.145	219.529	2.189
1969	1.931	1.791	180.774	1.800
1970	1.851	1.771	177.068	1.768
1971	1.571	1.546	63.086[2]	1.542
1972	1.671	1.685	67.403[2]	1.686
1973	2.567	2.558[1]	103.783[2]	2.544
1974	4.595	4.708	199.819[2]	4.675

Sources: Canadian prices are those quoted by *The Northern Miner* (arithmetical average of daily quotations). United States and United Kingdom prices are those quoted by *Metals Week*.
[1] The 60-day general price freeze in effect in the United States from June 13 through August 12, 1973 forced intermittent suspension of Handy and Harman's daily quotation during July and August for a total of 22 days. [2] 1971-74 prices are expressed in new British pence, following British conversion to decimal currency, February 11, 1971, at the rate of 100 pence per pound sterling. Previous rate was 240 pence per pound. [3] Prices have been converted at the yearly average exchange rates quoted by *Metals Week*.



Prices

The New York Handy and Harman silver price displayed a chaotic but rising trend throughout most of 1974. On January 2, the price was $3.345 U.S. an ounce. A low of $3.270 obtained on January 4, and a new record high of $6.700 was reached on February 26; at year-end the price was $4.370. Average for the year was $4.708. The London spot silver price ranged between a low of 141.9 pence an ounce, equivalent to $3.331 (U.S.), on January 2 and a high of 293.0 pence, equivalent to $6.771 (U.S.), on February 26. At year-end the price was 190.4 pence, equivalent to $4.469 (U.S.). Average for the year was 199.8 pence, equivalent to $4.675 U.S. In 1974 the Canadian silver price closely followed its U.S. counterpart with the essential difference being the exchange rate. It fluctuated between a low of $3.253 Can. an ounce on January 4 and a high of $6.526 on February 26 which latter price was an all-time high. At year-end the price was $4.337. Average for the year was $4.595.

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
		(%)	(%)	(%)
32900-1	Ores of metals, nop	free	free	free
35800-1	Anodes of silver	free	free	10
35900-1	Silver in ingots, blocks, bars, drops, sheets or plates, unmanufactured; silver sweepings	free	free	free
35905-1	Scrap silver and metal alloy scrap containing silver (expires October 31, 1975)	free	free	25
36100-1	Silver leaf	12½	20	30
36200-1	Articles consisting wholly or in part of sterling or other silverware, nop; manufactures of silver, nop.	17½	22½	45

United States[1]

Item No.		
420.60	Silver compounds	5%
601.39	Precious metal ores, silver content	free
605.20	Silver bullion, silver dore and silver precipitates	free
605.46	Platinum-plated silver, unwrought or semimanufactured	16%
605.47	Gold-plated silver, unwrought or semimanufactured	25%
605.48	Other unwrought or semimanufactured silver	10.5%
605.65	Rolled silver, unworked or semimanufactured	10.5%
605.70	Precious metal sweepings and other precious metal waste and scrap, silver content	free
644.56	Silver leaf	2.5¢ per 100 leaves

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

[1] Tariff rates applicable to products of Canada imported directly or indirectly into the customs territory of the United States.
nop: Not otherwise provided for.

Sodium Sulphate

A.F. KILLIN

Sodium sulphate (Na_2SO_4), commonly known as 'salt cake', is an industrial chemical used principally in the manufacture of pulp and paper by the 'kraft' process, and in the manufacture of glass and detergents. It can be produced from natural deposits and brines in alkaline lakes in areas with dry climates and little or no drainage, from subsurface deposits and brines, or as a byproduct of chemical processes. Canada's sodium sulphate industry is based on natural brines and deposits in many alkaline lakes in the southern prairies of Saskatchewan and Alberta. Nine plants operated in Canada in 1974. Small quantities of byproduct sodium sulphate are recovered at a viscose-rayon plant and at a pulp and paper mill in Ontario, and at a strontium sulphate-carbonate plant in Nova Scotia.

In the United States, naturally-occurring sodium sulphate is produced in California, Texas and Wyoming, and byproduct salt cake is produced in the eastern states.

Production and developments in Canada

Shipments of sodium sulphate from Canadian producers in 1974 increased 11 per cent over those in 1973 to 604,000 tons. The value of shipments in 1974 at $13,187,000 increased 84 per cent. The sharp increase in value can be attributed to a rise in prices and to increased sales of higher-priced detergent grade sodium sulphate in 1974. The shipment and value figures are preliminary and do not include byproduct production of about 50,000 tons. The Saskatchewan Department of Mineral Resources reports production of sodium sulphate in 1974 at 622,094 tons.

Deposits. Apart from the lakes in Saskatchewan and Alberta, sodium sulphate has also been found associated with magnesium sulphate in British Columbia and with calcium sulphate in New Brunswick. The New Brunswick deposits are deeply buried and occur as glauberite, the anhydrous double sulphate of sodium and calcium.

The sodium sulphate deposits in Saskatchewan and the bordering areas of Alberta have formed in shallow, undrained lakes and ponds where run[off waters carry in dissolved sulphate from the surrounding soils. Through the years, high rates of summer evaporation have concentrated the brine, and cooler fall tempera[tures have caused sodium sulphate to crystallize out as mirabilite ($Na_2SO_4 - 10H_2O$). The cycle has been repeated year after year thereby accumulating thick deposits of hydrous sodium sulphate, commonly known as Glauber's salt. Occasionally, some of the sodium sulphate formed is of the anhydrous variety known as thenardite (Na_2SO_4).

Some lakes have not accumulated thick beds because the crystals of sodium sulphate that are deposited during the fall and winter are redissolved each spring, to reform a brine rich in sodium sulphate. These same lakes commonly contain a high concentration of magnesium sulphate, a mineral that may prove valuable in the future.

Reserves in Saskatchewan have been estimated at 100 million tons of anhydrous sodium sulphate, of which about one half is considered economically recoverable with current technology. Ten deposits in Saskatchewan each contain reserves ranging from 2 million to 9 million tons. One deposit in Alberta contains 3 million tons of Na_2SO_4.

Recovery and processing. For most Saskatchewan producers, weather is as important for the recovery of sodium sulphate as it is for its deposition. A supply of fresh water is also essential.

Sodium sulphate recovery generally begins by pumping concentrated lake brines into reservoirs during the summer. Pumping takes place when the brine is at the highest concentration. To supplement the brining system, one producer uses a floating dredge to excavate crystals from the lake bed and pumps a slurry directly to the processing plant.

The recovery cycle in the reservoir is completed when cool fall weather causes precipitation of hydrous sodium sulphate; excess fluid with impurities is drained or pumped back to the lake. The crystal bed, normally 2 to 4 feet deep, is then excavated by scrapers, shovels or draglines and moved to a stockpile. Stockpiling is done in the winter, and provides sufficient feed to operate a processing plant throughout the year.

Processing consists essentially of the dehydration of the natural crystal (Glauber's salt contains 55.9 per cent H_2O by weight) and drying. Processing equipment includes submerged combustion units, evaporators, classifiers, centrifuges, rotary kiln dryers, screens and crushers. The end product, a powdery white substance, commonly known as salt cake, contains a minimum of 97 per cent Na_2SO_4 and can reach as much as 99.77 per cent. Uniform grain size and free flow are important in material handling and use.

Table 1. Canada, sodium sulphate production and trade, 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Production				
Shipments	543,354	7,165,168	604,000	13,187,000
Imports				
Total crude salt cake and Glauber's salt				
United States	14,179	292,000	14,447	372,000
United Kingdom	2,833	110,000	7,014	157,000
Belgium and Luxembourg	12,793	334,000	3,362	83,000
Total	29,805	736,000	24,823	612,000
Exports				
Crude sodium sulphate				
United States	154,356	3,382,000	254,940	6,948,000
New Zealand	563	30,000	2,358	138,000
Indonesia	—	—	1,399	96,000
Philippines	2,751	87,000	1,238	73,000
Other countries	2	...	999	81,000
Total	157,672	3,499,000	260,934	7,336,000

Source: Statistics Canada.
p Preliminary; — Nil; ... Less than one thousand dollars

The Alberta-based producer uses a solution recovery system rather than seasonal harvesting. The raw Glauber's salt is recovered from the lake bed by solution methods which have proven very successful during both summer and winter. The brine is then subjected to an evaporation and crystallization process to recover the sodium sulphate.

Francana Minerals Ltd. produced detergent grade sodium sulphate at its plant at Grant, Saskatchewan. Dredging and pumping of the raw material from Snakehole and Vincent Lakes will allow a capacity increase from 200 tons a day to 300 tons a day, effective July 1, 1975. The company-owned facility at Hardene (near Alsask), Saskatchewan, which had been dormant since 1969, was reactivated in January 1974 and is producing salt cake for the pulp and paper industry. Saskatchewan Minerals, Sodium Sulphate Division reopened its sodium sulphate plant at Bishopric in 1974. The plant had been shut down since 1972.

By- and Co-product recovery. Courtaulds (Canada) Limited produced about 15,000 tons of byproduct sodium sulphate in 1973 from its Cornwall, Ontario viscose-rayon plant.

Kaiser Strontium Products Limited, a subsidiary of Kaiser Aluminum & Chemical Canada Investment Limited, recovered coproduct salt cake at Point Edward, Nova Scotia. At the plant, strontium sulphate concentrates are reacted with natural sodium carbonate to produce strontium carbonate and sodium sulphate. The designed capacity is 90 tons of strontium carbonate and 100 tons of sodium sulphate a day.

In July 1973, Ontario Paper Company Limited brought on stream a byproduct salt cake unit at its paper mill at Thorold, Ontario with a rated capacity of about 80 tons a day.

Consumption and trade

The pulp and paper industry is still the major consumer of sodium sulphate despite a rise in use in glass and detergents manufacture. The increased demand for kraft paper has strengthened the market and prices rose during the year. The 'kraft' process yields a pulp with a very long fibre that allows manufacture of a strong paper. Consumption of sodium sulphate in the pulp and paper industry in 1974 is estimated in excess of 400,000 tons.

Sodium sulphate is also used in mineral-feed supplements, medicinals and other chemical products, and in base metal smelting.

Canadian exports at 260,934 tons were 65.5 per cent higher than in 1973, whereas imports declined 16.7 per cent to 24,823 tons. Canada's main trading in sodium sulphate is with the United States.

Table 2. Canada, sodium sulphate production, trade and consumption, 1965-74

	Production[1]	Imports[2]	Exports	Consumption
	(short tons)			
1965	345,469	29,347	116,345	275,620
1966	405,314	31,261	101,417	336,346
1967	428,316	27,621	123,833	347,140
1968	459,669	25,018	108,984	391,953
1969	518,299	29,609	120,414	437,055
1970	490,547	29,155	119,888	406,812
1971	481,919	21,299	122,523	401,908
1972	507,275	26,960	131,162	429,080[r]
1973	543,354	29,805	157,672	300,080
1974[p]	604,000	24,823	260,934	. .

Source: Statistics Canada.
[1] Producers' shipments of crude sodium sulphate. [2] Includes Glauber's salt and crude salt cake.
[p] Preliminary; . . Not available; [r] Revised.

Table 4. Canada, available data on sodium sulphate consumption, 1972-74

	1972	1973	1974
	(short tons)		
Pulp and paper	393,909	245,009	
Glass and glass wool	7,844	7,563	
Soaps	12,761	20,372	
Other products[1]	14,566	27,136	
Total	429,080	300,080	. .

Source: Statistics Canada, breakdown by Mineral Development Sector.
[1] Colours, pigments, foundries, feed supplements and other minor uses.
. . Not available.

Table 3. Canada, natural sodium sulphate plants, 1974

	Plant Location	Source Lake	Annual Capacity
			(st)
Alberta			
Alberta Sulphate Limited	Metiskow	Horseshoe	100,000
Saskatchewan			
Francana Minerals Ltd.	Cabri	Snakehole	100,000
Francana Minerals Ltd.	Alsask[1]	Alsask	50,000
Midwest Chemicals Limited	Palo	Whitehorse	120,000
Ormiston Mining and Smelting Co. Ltd.	Ormiston	Horseshoe	100,000
Saskatchewan Minerals	Chaplin	Chaplin	150,000
Saskatchewan Minerals	Bishopric	Frederick	40,000
Saskatchewan Minerals	Fox Valley	Ingebrigt	150,000
Sybouts Sodium Sulphate Co., Ltd.	Gladmar	East Coteau	50,000
Total			860,000

Source: Company reports.
[1] Reactivated in 1974.

Outlook

Although deliveries have been affected by the international business recession, demand in the paper, detergent and glass industries has remained moderately strong, and the outlook is for a stable demand and price situation in the near-term.

Prices

Canadian prices for salt cake increased by $12 to $16 a ton in 1974, although prices at similar operations in the western United States were fairly stable. Producers of byproduct sodium sulphate in the eastern United States increased prices by $10 to $20 a ton.

Canadian prices of sodium sulphate, as quoted by Canadian Chemical Processing Buyers Guide, November 1974.

	(Canadian $ per short ton)
Sodium sulphate (salt cake)	
Bulk, carlots, fob works	30.00
Detergent-grade bulk, fob works	38.00

United States prices according to Chemical Marketing Reporter, December 30, 1974.

	(U.S. $ per short ton)
Salt cake, 100% Na_2SO_4 basis, fob works	30.00 – 31.00
Salt cake, domestic, West, bulk, carlots, fob producing point	18.50
Sodium sulphate, detergent rayon-grade, bags, carlots, works East	43.00 – 53.00

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
21000-1	Natural sodium sulphate	10%	15%	25%

United States

Item No.		
421-42	Crude sodium sulphate (salt cake)	Free
421-44	Anhydrous	40¢ per long ton
421-46	Crystallized (Glauber's salt)	80¢ per long ton

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Stone

D.H. STONEHOUSE

Naturally occurring rock material quarried or mined for industrial use with no change in its chemical state and with its physical character altered only by shaping or by sizing, is commercially termed "stone." Dimension stone is shaped for use as a building block, slab or panel. It may be rough cut, sawn or polished, and its application may depend on its strength, hardness, durability and ornamental qualities. Broken, irregular, screened and sized pieces constitute the crushed stone category. It is used mainly as an aggregate in concrete and asphalt, in highway and railway construction and as heavy riprap for facing wharves and breakwaters.

Stone production in Canada, either as dimension stone or as crushed stone, is used directly or indirectly by the construction industry, except for small amounts used in the manufacture of monuments. Indirect usage includes that portion of the resource that is utilized by the chemical industry (mainly limestone) for the manufacture of lime, cement, iron and steel, all of which are associated with various phases of the construction industry. Activity in both building construction and heavy or engineering construction can be indicative of demands for quarried stone.

The large number of stone-producing operations in Canada precludes describing within this review individual plants or facilities. Many are part-time or seasonal operations, many are operated subsidiary to construction or manufacturing activities by establishments not classified to the stone industry, and some are operated directly by municipal or provincial government departments producing stone for their own direct use. Detailed information can be obtained through the individual provincial departments of mines or equivalent. Most provinces have accumulated data relative to occurrences of stone of all types and in many cases have published such studies. The federal government, through the Geological Survey of Canada, has also gathered and published a great number of Geological papers pertaining to stone occurrences. Works by W.A. Parks[1] and by M.F. Goudge[2] have become classics in the fields of building stones and limestones, respectively.

Dimension stone. Granite, limestone, marble and sandstone are the principal rock types from which building and ornamental stone is fashioned. Construction uses account for over 85 per cent of the consumption of building and ornamental stone produced and sold in Canada; the remainder is used as monumental stone.

Today, in the building sector of the construction industry, granite, limestone and marble are used as facing stone in the form of cut and polished panels, in conjunction with steel and concrete for institutional and commercial buildings. In residential buildings, the use of a limestone or sandstone ashlar, or coursing stone, is becoming increasingly popular. The emphasis has changed from stone used for structural qualities to stone used for its aesthetic qualities. The architect and contractor can design and build for lasting beauty using Canadian building stone.

Crushed stone. Many quarries that produce crushed stone are operated primarily to produce stone for other purposes, e.g., granite for building blocks and monuments, limestone for cement or lime manufacture, or for metallurgical use, marble for monuments and building panels, sandstone for riprap, and cut stone. Quarries removing solid rock by drilling, blasting and crushing are not likely to be operated for small, local needs as are gravel pits and are, therefore, usually operated by large companies associated with the construction industry. Depending on cost and availability, crushed stone competes with gravel and crushed gravel as an aggregate in concrete and asphalt and as railway ballast and road metal. In these applications, it is subject to the same physical and chemical testing procedures as the gravel and sand aggregates.

Other uses for crushed stone include the manufacture of roofing granules from granite and marble, the production of poultry grit from limestone, silica and granite, and the production of rock wool from limestone and sandstone. Pulverized stone is used as follows: granite, limestone and sandstone as asphalt filler; limestone for dusting coal mines; and limestone and marble for agricultural application.

Limestone is also produced for chemical and metallurgical uses in the iron and steel industry, the glass industry, the pulp and paper industry and in sugar manufacture.

Canadian industry

Atlantic provinces. *Limestone.* The many occurrences of limestones in the Atlantic provinces have been systematically catalogued during the past few years.[3,4,5] Deposits of commercial importance are being worked in three of the four provinces. In Newfoundland, limestone is available from small, impure exposures in the eastern portion of the island; from small, high-calcium deposits in the central region; and from large, high-purity, high-calcium occurrences in the west. Other than periodic operation to secure aggregate for highway work, the main exploitation is by North Star Cement Limited at Corner Brook.[6] Lehigh Portland Cement Company, Allentown, Pennsylvania, in association with British Newfoundland Exploration Limited (Brinex), assessed the limestones in the Port au Port district with the objective of establishing a 1-million-ton-a-year portland cement facility in the region. A buoyant export market for portland cement or for clinker would be necessary in order to support a plant of such capability. Early in 1975 Lehigh terminated its agreement with Brinex, and Brinex has continued to investigate the feasibility of an industrial mineral complex based on high calcium limestone.

Table 1. Canada, total production (shipments) of stone, 1972 to 74

	1972		1973		1974*p*	
	(short tons)	($)	(short tons)	($)	(short tons)	($)
By province						
Newfoundland	204,245	531,910	394,311	971,537	400,000	1,100,000
Prince Edward Island	—	—	—	—	—	—
Nova Scotia	1,047,413	2,588,047	812,928	1,732,872	1,000,000	2,000,000
New Brunswick	1,901,171	3,556,927	2,376,076	4,372,401	2,400,000	4,600,000
Quebec	41,383,701	46,467,889	48,155,998	58,459,217	48,100,000	59,200,000
Ontario	31,091,493	41,230,596	35,539,327	52,869,733	38,000,000	55,800,000
Manitoba	609,609	1,255,695	625,282	1,016,676	700,000	1,100,000
Alberta	195,773	808,429	160,644	810,935	200,000	900,000
British Columbia	3,769,119	6,886,662	3,829,421	7,345,183	4,000,000	8,100,000
Canada	80,202,524	103,326,155	91,893,987	127,578,554	94,800,000	132,800,000
By use[1]						
Building stone						
Rough	108,449	2,273,623	55,963	1,495,757		
Dressed	—	—	—	—		
Monumental, ornamental stone						
Rough	30,260	992,050	29,954	1,422,394		
Dressed	—	—	—	—		
Flagstone	48,895[2]	728,386[2]	60,486[2]	524,303[2]		
Curbstone	—	—	—	—		
Paving blocks	—	—	—	—		
Chemical and metallurgical						
Cement plants, foreign	1,310,666	1,434,886	1,422,403	1,702,774		
Lining, open-hearth furnaces	356,525	431,777	392,930	485,922		
Flux in iron and steel furnaces	1,310,826	1,897,958	1,358,325	1,854,543		
Flux in nonferrous smelters	30,086	43,950	23,828	23,426		
Glass factories	189,163	905,113	206,203	839,466		
Lime kilns, foreign	259,005	587,095	273,835	589,346		
Pulp and paper mills	258,318	923,878	295,410	1,049,783		
Sugar refineries	113,772	228,291	69,749	196,024		
Other chemical uses	332,938	898,162	404,427	986,600		

Table 1. (concl'd)

	1972		1973		1974p	
	(short tons)	$	(short tons)	$	(short tons)	$
Pulverized stone						
Whiting (substitute)	8,221	191,169	15,040	299,821		
Asphalt filler	40,313	180,535	58,251	255,068		
Dusting, coal mines	6,713	66,850	8,048	78,548		
Agricultural purposes and fertilizer plants	592,359	2,162,877	809,033	3,038,780		
Other uses	865,420	1,474,626	851,991	1,734,450		
Crushed stone						
For manufacture of artificial stone	259,479	469,715	52,999	326,300		
Roofing granules	181,026	3,689,128	180,510	3,540,810		
Poultry grit	25,943	224,038	31,863	321,163		
Stucco dash	23,114	575,908	27,693	722,650		
Terrazzo chips	14,663	209,310	13,494	288,949		
Rock wool	—	—	—	—		
Rubble and riprap	1,724,206	1,917,995	2,332,343	3,276,594		
Concrete aggregate	11,203,880	14,131,954	14,665,956	19,351,261		
Asphalt aggregate	6,746,132	7,976,734	5,209,403	7,159,219		
Road metal	27,649,781	31,099,040	37,579,035	48,291,629		
Railroad ballast	3,348,176	3,556,276	3,962,834	5,082,203		
Other uses	23,164,195	24,054,831	21,882,182	23,754,820		
Total	80,202,524	103,326,155	92,274,188	128,692,603		

Source: Statistics Canada.
[1] Breakdown by use, 1972, by Statistics Section, Mineral Development Sector. [2] Includes flagstone, curbstone, paving blocks, etc.
p Preliminary; — Nil.

In Nova Scotia, limestones occur in the central and eastern parts of the province in thin, tilted lenses typical of deposits in Atlantic Canada and in contrast to deposits of much greater thickness and areal extent in central Canada.

Mosher Limestone Company Limited quarries a dolomitic limestone at Upper Musquodoboit, Nova Scotia. Pulverized material is sold for agricultural use throughout the Atlantic provinces. Sydney Steel Corporation (Sysco) produces a high-calcium, fossiliferous limestone at Irish Cove, Nova Scotia, and a high-purity dolomite at Frenchvale, Nova Scotia, for use in the Sydney steel plant. Studies to determine the viability of a lime manufacturing plant in the Sydney area have been made in connection with incorporation of a basic oxygen process at the Sysco plant. Calpo Limited continues to supply sized, high calcium limestone from an area near Antigonish Harbour to Scott Paper Limited at Abercrombie and Canada Cement Lafarge Ltd. obtains limestone for portland cement manufacture on site at its Brookfield location.[6]

In New Brunswick, limestone is quarried at three locations — Brookville, Elm Tree and Havelock — for use as a crushed stone, as an aggregate, or for agricultural application. Havelock Processing Ltd. has expanded its plant to offer a range of products including washed, crushed and sized aggregates for asphalt and concrete application and finely pulverized filler material. Havelock Lime Works Limited produces high calcium lime at Havelock[7] and Canada Cement Lafarge Ltd. uses limestone at its Havelock plantsite in the production of portland cement.[6]

Granite. Occurrences of granites in the Atlantic region have been described by Carr.[8] Current operations in Nova Scotia are at Nictaux, Shelburne and Erinville. A grey granite is produced from three operations near Nictaux and from one quarry at Shelburne for use mainly in the monument industry. A black granite from Shelburne and a diorite from Erinville are used similiarly. Quartzitic rock referred to as "bluestone" is quarried at Lake Echo, north of Dartmouth, for use as facing stone. Crushed quartzite for use as an aggregate is produced at a number of locations in Halifax County. At Folly Lake in Colchester County a diorite rock is quarried mainly for use as railway ballast.

Granites are quarried intermittently from a number of deposits within New Brunswick to obtain stone of required colour and texture for specific application. A red, fine- to medium-grained granite is quarried near St. Stephen, and fine-grained, pink, grey and blue-grey granites are available in the Hampstead (Spoon Island) district. In the Bathurst area, a brown-to-grey, coarse-grained granite is quarried upon demand, as is a salmon-coloured, medium-grained granite near Antinouri Lake, and a black, ferromagnesian rock in the Bocabec River area. Red granite is available in the St. George district. Granite for use as a crushed stone is produced near Fredericton and near Moncton.

Sandstone. A medium-grained, buff sandstone is quarried at Wallace, Nova Scotia, for use as heavy riprap and for dimension stone applications. Recently, considerable tonnages were used in the reconstruction of the fortress at Louisbourg. Small deposits in many parts of the province are quarried periodically for local use.

In New Brunswick, a red, fine- to medium-grained sandstone has been quarried in Sackville for use in construction of buildings on the Mount Allison University campus. Deposits are exploited from time to time throughout Kent and Westmorland counties for local projects and for highway work.

Quebec. *Limestone.* Limestone occurs in the St. Lawrence and Ottawa river valleys and in the Eastern Townships. Other major deposits in the province are located in the Lac Saint-Jean – Saguenay River area and in the Gaspé region. The limestones range geologically from Precambrian to carboniferous, and vary widely in purity, colour, texture and chemical composition.[2]

Of over 90 limestone producers in Quebec, about 50 are classed as stone quarries with non-cement, non-lime associations. These are located near major market areas such as Montreal, Quebec, Sherbrooke, Ottawa-Hull and Trois-Rivières and supply crushed stone to the construction industry, mainly for use in concrete and asphalt and as highway subgrade.

The pulp and paper industry, the metallurgical industry and the agricultural industry use substantial quantities of limestone. At Kilmar, in western Quebec, Dresser Industries Canada, Ltd., formerly Canadian Refractories Limited, mines a magnesite – dolomite ore from which it produces refractory-grade magnesia and magnesia products.

Portland cement is produced by five companies in Quebec with a combined annual capacity of about 5.2 million tons, from a total of seven plants, in 1974.[6] Four companies produce lime at four locations within the province.[7]

Limestone blocks and other shapes are produced for the construction trade in the Montreal region and at various locations throughout the province, as the need arises. Marble has been produced in the Stukely and Philipsburg areas.

Table 2. Canada, production (shipments) of limestone, 1972-73

	1972		1973	
	(short tons)	($)	(short tons)	($)
By province				
Newfoundland	27,953	39,236	181,881	103,223
Nova Scotia	242,454	965,898	230,278	638,694
New Brunswick	410,477	1,121,056	575,446	1,733,956
Quebec	35,540,638	36,139,497	40,481,174	45,781,950
Ontario	30,797,143	36,793,037	33,938,185	46,229,334
Manitoba	601,296	960,079	625,282	1,016,676
Alberta	195,385	797,030	151,216	803,960
British Columbia	2,936,774	4,881,731	2,474,910	4,009,168
Canada	70,752,120	81,697,564	78,658,372	100,316,961
By use[1]				
Building stone				
Rough	50,433	285,894	12,539	168,045
Dressed	—	—	—	—
Monumental and ornamental				
Rough	607	13,469	1,152	43,512
Dressed	—	—	—	—
Flagstone	4,667[2]	82,863	—	—
Curbstone	—	—	—	—
Paving blocks	—	—	—	—
Chemical and metallurgical				
Cement plants, foreign	1,310,666	1,434,886	1,362,067	1,568,828
Lining, open-hearth furnaces	356,520	431,727	392,930	485,922

Table 2 (concl'd)

	1972		1973	
	(short tons)	($)	(short tons)	($)
Flux, iron and steel furnaces	1,310,826	1,897,958	1,358,325	1,854,543
Flux, nonferrous smelters	30,086	43,950	23,828	23,426
Glass factories	189,163	905,113	206,203	839,466
Lime kilns, foreign	259,005	587,095	273,835	589,346
Pulp and paper mills	248,051	872,991	284,744	983,050
Sugar refineries	113,772	228,291	69,749	196,024
Other chemical uses	332,803	897,757	374,037	896,037
Pulverized stone				
Whiting substitute	8,221	191,169	14,240	283,897
Asphalt filler	30,710	156,467	51,265	235,109
Dusting coal mines	6,713	66,850	8,048	78,548
Agricultural purposes and fertilizer plants	534,614	1,987,255	785,833	2,962,503
Other uses	865,420	1,474,626	850,133	1,712,277
Crushed stone				
For artificial stone	225,930	292,203	4,235	72,794
Roofing granules	12,435	39,290	25,200	69,434
Poultry grit	19,314	148,007	23,616	180,355
Stucco dash	21,167	560,755	3,071	61,995
Terrazzo chips	—	—	—	—
Rock wool	—	—	—	—
Rubble and riprap	1,665,985	1,818,688	728,706	1,066,080
Concrete aggregate	9,274,410	10,416,842	13,321,982	16,112,325
Asphalt aggregate	5,517,913	5,994,299	4,012,124	4,978,535
Road metal	24,246,029	26,627,789	34,739,335	44,181,407
Railroad ballast	2,596,688	2,367,514	2,671,820	2,327,185
Other uses	21,519,972	21,873,816	17,059,153	18,346,318
Total	70,752,120	81,697,564	78,658,372	100,316,961

Source: Statistics Canada.
[1] Breakdown by use, 1973, by Statistics Section, Mineral Development Sector. [2] Includes flagstone, curbstone and paving blocks.
— Nil.

Granite. Nearly 60 per cent of Canada's granite production comes from Quebec from long-established operations in two general regions — one north of the St. Lawrence and Ottawa rivers, including the Lac Saint-Jean area, and one south of the St. Lawrence River. Precambian rocks contain granites of various colours, compositions and textures. Of 57 granite producers listed by the Quebec Bureau of Statistics in 1973, only about ten were operating stone dressing plants, the rest were supplying crushed stone mainly for road building.[9,10] Many areas underlain by granite are too remote from transportation and markets to be economically attractive.

Sandstone. There are far fewer sandstone producing operations in Quebec than there are producers of limestones and granites. Less than ten are listed with the Department of Natural Resources, and only half of these are producing flagstone and facing stone, the rest are in the crushed stone business.

Ontario. *Limestone.* Although limestones in Ontario range from Precambrian through Devonian, the major production comes from Ordovician, Silurian and Devonian deposits.[11,12] Of particular importance are the limestones and dolomites from the following geological sequences: the Black River and Trenton formations, extending from the lower end of Georgian Bay across southern Ontario to Kingston; the Guelph–Lockport Formation, extending from Niagara Falls to the Bruce Peninsula and forming the Niagara Escarpment; and the Middle Devonian limestones extending from Fort Erie through London and Woodstock to Lake Huron. Production of building stone, fluxstone and crushed aggregate from the limestones of these areas normally account for over 90 per cent of total stone production in Ontario.

Marble is widely distributed over southeastern Ontario and, according to the Ontario Ministry of Natural Resources reports, underlies as much as 100 square miles.[13]

Legislation now in effect in Ontario controls the development, operation and rehabilitation of existing pits and quarries, designates areas in which such operations may be started and provides for regulated sequential land use. The necessity for an advance assessment of the total impact of all developments affecting land use is recognized in the total legislative package, complications arise, however, because of the number of government levels implementing and administrating the legislation.

During 1974 portland cement was produced by four companies at a total of six locations in Ontario,[6] while eight companies operated a total of ten lime-producing facilities in the province.[7]

Granite. Granites occur in northern, northwestern and southeastern Ontario.[14] Few deposits have been exploited for the production of building stone because the major consuming centres are in southern and southwestern Ontario where ample, good-quality limestones and sandstones are readily available for building. The areas most active in granite building stone production have been the Vermilion Bay area near Kenora, the River Valley area near North Bay, and the Lyndhurst–Gananoque area in southeastern

Table 3. Canada, production (shipments) of marble, 1972-73

	1972		1973	
	(short tons)	($)	(short tons)	($)
By province				
Quebec	307,871	730,287	256,858	854,726
Ontario	9,299	165,366	9,662	252,474
Total, Canada	317,170	895,653	266,520	1,107,200
By use[1]				
Building stone				
Rough	—	—	—	—
Dressed	—	—	—	—
Chemical process stone				
Pulp and paper mills	10,267	50,887	10,666	66,733
Other uses	135	405	30,188	90,563
Pulverized stone				
Whiting	—	—	800	15,924
Agricultural purposes and fertilizer plants	57,170	172,602	23,200	76,277
Other uses	—	—	1,858	22,173
Crushed stone				
For manufacture of artificial stone	33,549	177,512	48,764	253,506
Roofing granules	1,000	10,359	2,490	24,892
Poultry grit	172	1,301	480	4,801
Stucco dash	1,947	15,153	1,297	17,257
Terrazzo chips	14,663	209,310	13,494	288,949
Rubble and riprap	1,923	11,543	1,810	23,840
Concrete aggregate	—	—	—	—
Railroad ballast	—	—	103,557	188,077
Road metal	118,000	146,500	—	—
Other uses	78,344	100,081	27,916	34,208
Total	317,170	895,653	266,520	1,107,200

Source: Statistics Canada.
[1] Breakdown by use, 1973 by Statistics Section, Mineral Development Sector.
— Nil.

Ontario. Rough building blocks were quarried from a gneissic rock near Parry Sound, while at Havelock a massive red-granite rock was quarried.

Sandstone. Sandstone quarried near Toronto, Ottawa and Kingston has been used widely in Ontario as building stone.[15] Production is currently from the Limehouse–Georgetown–Inglewood district where Medina sandstone is quarried and from the Kingston area where Potsdam sandstone is quarried. Medina sandstones vary from grey, through buff and brown to red; and some are mottled. They are fine to medium grained. The Potsdam stone is medium grained; the colour ranges from grey-white through salmon-red to purple, and it also can be mottled. Current uses are as rough building stone, mill blocks from which sawn pieces are obtained, ashlar, flagstone and as a source of silica for ferrosilicon and glass.

Table 4. Canada, production (shipments) of granite, 1972-73

	1972		1973	
	(short tons)	($)	(short tons)	($)
By province				
Newfoundland	16,490	82,450	36,230	234,614
Nova Scotia	804,959	1,622,149	400	11,900
New Brunswick	1,478,684	2,372,481	1,866,250	3,415,700
Quebec	2,205,787	5,437,984	3,431,441	7,333,608
Ontario	263,891	3,955,643	1,574,389	5,994,901
Manitoba	8,313	295,616	—	—
British Columbia	562,904	999,012	1,255,358	2,808,582
Total, Canada	5,341,028	14,765,335	8,164,068	19,799,305
By use[1]				
Building stone				
Rough	33,102	1,470,450	17,671	704,529
Dressed	—	—	—	—
Monumental and ornamental				
Rough	29,653	978,581	28,802	1,378,882
Dressed	—	—	—	—
Flagstone	32,686[2]	476,557	9,849	127,298
Curbstone	—	—	—	—
Lining open-hearth furnaces	5	50	—	—
Chemical uses				
Pulp and paper mills	—	—	—	—
Pulverized stone				
Asphalt filler	9,603	24,068	6,986	19,959
Other pulverized uses	—	—	—	—
Crushed stone				
For artificial stone				
Roofing granules	158,922	3,617,373	147,955	3,431,892
Poultry grit	3,732	57,699	6,539	128,221
Stucco dash	—	—	23,325	643,398
Rubble and riprap	46,801	72,961	1,589,214	2,174,588
Concrete aggregate	1,648,502	2,663,134	821,112	1,703,061
Asphalt aggregate	895,473	1,387,129	815,771	1,466,770
Road metal	921,173	1,744,675	1,960,596	2,843,398
Railroad ballast	325,619	543,427	1,012,013	2,286,231
Other uses	1,235,757	1,729,231	1,724,235	2,891,078
Total	5,341,028	14,765,335	8,164,068	19,779,305

Source: Statistics Canada.
[1] Breakdown by uses, 1973, by Statistics Section, Mineral Development Sector. [2] Includes flagstone, curbstone and paving blocks.
— Nil.

Western provinces. *Limestone.* From east to west through the southern half of Manitoba, rocks of the following geological ages are represented — Precambrian, Ordovician, Silurian, Devonian and Cretaceous. Limestones of commercial importance occur in the three middle classifications and range from magnesian limestone through dolomite to high-calcium limestones.[2,16] Although building stone does not account for a large percentage of total limestone produced, the best known of the Manitoba limestones is Tyndall Stone, a mottled dolomitic limestone often referred to as "tapestry" stone. It is widely accepted as an attractive building stone, and is quarried at Garson, Manitoba, about 30 miles northeast of Winnipeg.

Limestone from Moosehorn, 100 miles northwest of Winnipeg, and from Mafeking, 25 miles east of the Saskatchewan border and 100 miles south of The Pas, is transported to Manitoba and Saskatchewan centres for use in metallurgical, chemical, agricultural and construction industries. Limestone from Steep Rock and from Lily Bay is used by cement manufacturers in Winnipeg, and limestone from Faulkner is now being used by the lime plant at Spearhill. The possibility of utilizing marl, an unconsolidated calcareous material, from deposits in the Sturgeon Lake region of Saskatchewan in the pulp and paper, cement and lime industries has been investigated. Marl from a deposit 40 miles north of Edmonton is being used as raw material in cement manufacture.[6,7]

Table 5. Canada, production (shipments) of sandstone, 1972-73

	1972		1973	
	(short tons)	($)	(short tons)	($)
By province				
Newfoundland	159,802	410,224	176,200	633,700
Nova Scotia	—	—	582,250	1,082,278
New Brunswick	12,010	63,390	314,581	336,794
Quebec	3,096,396	4,008,665	1,685,139	3,251,487
Ontario	21,160	316,550	17,091	393,024
Alberta	388	11,399	56	975
British Columbia	212,550	384,820	—	—
Total, Canada	3,502,306	5,195,048	2,775,317	5,698,258
By use[1]				
Building stone				
Rough	24,914	517,279	25,753	623,183
Dressed	—	—	—	—
Flagstone	11,542[2]	168,966	50,637[2]	397,005
Curbstone	—	—	—	—
Paving blocks	—	—	—	—
Pulverized stone	—	—	—	—
Asphalt filler	—	—	—	—
Agricultural purposes and fertilizer plants	575	3,020	—	—
Crushed stone				
For artificial stone	—	—	—	—
Roofing granules	8,669	22,106	4,865	14,592
Poultry grit	2,725	17,031	1,228	7,786
Terrazzo chips	—	—	—	—
Rubble and riprap	9,497	14,803	3,241	6,086
Concrete aggregate	224,077	430,879	484,045	1,142,388
Asphalt aggregate	332,746	595,306	381,508	713,914
Road metal	2,352,866	2,572,463	879,104	1,266,824
Railroad ballast	425,869	645,335	175,444	280,710
Other uses	108,826	207,860	769,492	1,245,770
Total	3,502,306	5,195,048	2,775,317	5,698,258

Source: Statistics Canada. [1] Breakdown by use, 1973, by Statistics Section, Mineral Development Sector. [2] Includes flagstone, curbstone and paving blocks.
— Nil.

Table 6. Canada, production (shipments) of shale, 1972-73

	1972		1973	
	(short tons)	($)	(short tons)	($)
By province				
Quebec	233,009	151,456	2,301,386	1,237,446
Alberta	—	—	9,372	6,000
British Columbia	56,891	621,099	99,153	527,433
Canada	289,900	772,555	2,409,911	1,770,879
By use[1]				
Chemical and metallurgical				
Cement plants, foreign	—	—	60,336	133,946
Pulverized stone				
Other uses	—	—	—	—
Crushed stone				
Rubble and riprap	—	—	9,372	6,000
Concrete aggregate	56,891	621,099	38,817	393,487
Road metal	11,713	7,613	—	—
Railroad ballast	—	—	—	—
Other uses	221,296	143,843	2,301,386	1,237,446
Total	289,900	772,555	2,409,911	1,770,879

Source: Statistics Canada.
[1] Breakdown by use, 1973 by Statistics Section, Mineral Development Sector.
— Nil.

The eastern ranges of the Rocky Mountains contain limestone spanning the geological ages from Cambrian to Triassic, with major deposits in the Devonian and Carboniferous systems in which a wide variety of types occur.[17] In southwestern Alberta, high-calcium limestone is mined at Exshaw, Kananaskis and Crowsnest, chiefly for the production of cement and lime, for metallurgical and chemical uses and for use as a crushed stone. Similar uses are made of limestone quarried at Cadomin, near Jasper.[6,7]

In British Columbia, large volumes of limestone are mined each year for cement and lime manufacture, for use by the pulp and paper industry and for various construction applications.[6,7] A large amount is exported to northwestern United States for cement and lime manufacture. Four companies mined limestone on Texada Island, with the entire output being moved by barge to Vancouver and to the State of Washington. Deposits on Aristazabal Island have recently been developed for the export market. Other operations at

Table 7. Canada, production (shipments) of stone by types, 1964-73

	Granite		Limestone		Marble		Sandstone	
	(short tons)	($)	(short tons)	($)	(short tons)	($)	(short tons)	($)
1964	7,310,629	16,854,742	57,019,890	63,140,728	95,455	891,617	4,433,555	5,264,849
1965	7,829,220	16,569,762	62,178,833	69,974,005	78,440	1,049,264	4,172,981	5,328,404
1966	19,598,325	25,423,394	69,760,441	77,431,007	157,789	1,190,592	5,202,281	5,949,172
1967	19,876,638	29,016,622	57,155,517	66,062,095	191,286	1,093,024	6,350,611	7,103,735
1968	16,654,735	23,310,531	54,538,796	65,619,953	165,007	637,845	4,267,391	5,136,658
1969	5,399,812	15,832,160	59,610,356	67,219,003	85,848	390,599	2,275,996	4,203,388
1970	4,837,239	15,231,891	57,896,297	67,563,790	61,835	350,903	2,328,957	4,133,708
1971	4,748,801	13,316,799	65,023,606	75,838,878	176,431	561,124	3,305,782	5,895,309
1972	5,341,028	14,765,335	70,752,120	81,697,564	317,170	895,653	3,502,306	5,195,048
1973	8,164,068	19,799,305	78,658,372	100,316,961	266,520	1,107,200	2,775,317	5,698,258

Table 7 (concl'd)

	Shale		Slate		Total	
	(short tons)	($)	(short tons)	($)	(short tons)	($)
1964	743,564	621,197	191,265	109,550	69,794,358	86,882,683
1965	2,338,460	1,837,492	160,171	88,094	76,758,105	94,847,021
1966	1,103,218	974,544	—	—	95,822,054	110,968,709
1967	433,256	612,796	—	—	84,007,308	103,888,272
1968	313,838	953,088	—	—	75,939,767	95,658,075
1969	105,000	541,112	—	—	67,477,012	88,186,262
1970	198,512	695,458	—	—	65,322,840	87,975,750
1971	260,222	924,963	—	—	73,514,842	96,537,073
1972	289,900	772,555	—	—	80,202,524	103,326,155
1973	2,409,911	1,770,879	—	—	92,274,188	128,692,603

Source: Statistics Canada.
— Nil.

Table 8. Canada, stone exports and imports, 1972-74

	1972		1973		1974[p]	
	(short tons)	($)	(short tons)	($)	(short tons)	($)
Exports						
Building stone, rough	15,900	761,000	16,436	929,000	12,723	774,000
Crushed limestone, limestone refuse	1,710,260	2,463,000	1,690,755	2,426,000	1,343,907	2,254,000
Stone crude, nes	673,785	1,010,000	382,860	1,010,000	514,859	1,502,000
Natural stone, basic products	..	2,532,000	..	1,946,000	..	1,332,000
Total	2,399,945	6,766,000	2,090,051	6,311,000	1,871,489	5,862,000
Imports						
Building stone, rough	10,983	456,000	10,912	528,000	14,625	749,000
Crushed limestone, limestone refuse	1,813,287	3,034,000	2,341,659	3,741,000	2,783,546	5,161,000
Crushed stone including stone refuse, nes	67,955	1,825,000	60,458	1,984,000	100,523	2,796,000
Stone crude, nes	956	59,000	1,519	153,000	1,975	133,000
Granite, rough	12,705	637,000	19,951	1,127,000	14,420	958,000
Marble, rough	3,292	373,000	5,464	680,000	9,979	1,363,000
Shaped or dressed granite	..	826,000	..	345,000	..	1,721,000
Shaped or dressed marble	..	989,000	..	964,000	..	1,241,000
Natural stone basic products	..	252,000	..	410,000	..	646,000
Total	1,909,178	8,451,000	2,439,963	9,932,000	2,925,068	14,768,000

Source: Statistics Canada.
[p] Preliminary; .. Not available; nes Not elsewhere specified.

Terrace, Clinton, Westwold, Popkum, Dahl Lake, Doeye River and Cobble Hill produced stone for construction and filler use, and for cement manufacture.[18] Periodically, interest is revived in the possible use of travertine from a British Columbia source.

Granite. In Manitoba, at Lac du Bonnet northeast of Winnipeg, a durable, red granite is quarried for building and monumental use. Grey granite located east of Winnipeg, near the Ontario border, is a potential source of building stone.

In British Columbia a light-grey to blue-grey, even-grained granodiorite of medium texture is available from Nelson Island. An andesite has been quarried at Haddington Island, off the northeast coast of Vancouver Island, for use as a building stone.

Sandstone. Sandstone for building and ornamental uses, quarried near Banff, Alberta, is hard, fine-grained, medium-grey and is referred to as "Rundal Stone".

The environment

There is justifiable concern for the future development, operation and rehabilitation of pits and quarries in all locations, especially in and near areas of urban development. Although an open-pit mining operation close to residential areas is seldom desirable, nonrenewable mineral resources must be fully and wisely utilized. Where urban sprawl has been unexpectedly rapid, conflicts for land use can materialize and potential sources of raw mineral materials for the construction industry can be overrun. Master plans are required to co-ordinate all phases of development so that mineral exploitation is part of the urban growth pattern.

Rehabilitation of stone quarries for subsequent land use is generally more difficult and more costly than rehabilitation of gravel pits. They provide the same disruptions to the natural environment and to urban development and are included in continuing studies to plan efficient land use.

Markets, outlook and trade

Limestones are widely distributed in Canada and generally are available in sufficient quantity and with such chemical or physical specifications that long transportation hauls are unnecessary. Limestone products are low-priced commodities and only rarely, when a market exists for a high-quality, specialized product such as white portland cement or a high-purity extender, are they beneficiated or moved long distances. Provided the specifications are met, the nearest source is usually considered, regardless of provincial or national boundaries.

Table 9. Value of construction in Canada, 1973-75

	1973	1974	1975[1]	Change 1974-1975
	(millions of dollars)			(%)
Building construction				
Residential	7,165.3	8,329.9	8,262.0	−0.8
Industrial	1,148.6	1,420.7	1,536.4	8.1
Commercial	2,211.5	2,843.9	3,228.5	13.5
Institutional	1,200.0	1,373.6	1,654.8	20.5
Other building	679.7	921.1	1,129.5	22.6
Total	12,405.1	14,889.2	15,811.2	6.2
Engineering construction				
Marine	147.7	198.3	211.4	6.6
Highways, aerodromes	1,825.8	2,108.2	2,382.9	13.0
Waterworks, sewage systems	791.1	1,031.5	1,221.4	18.4
Dams, irrigation	85.6	107.2	133.2	24.3
Electric power	1,520.4	1,841.1	2,463.5	33.8
Railway, telephones	806.0	1,025.0	1,301.5	27.0
Gas and oil facilities	1,499.5	1,685.4	1,897.6	12.6
Other engineering	1,092.6	1,329.4	1,826.4	37.4
Total	7,768.7	9,326.1	11,437.9	22.6
Total construction	20,173.8	24,215.3	27,249.1	12.5

Source: Statistics Canada.
[1] Intentions.

Table 10. Canada, value of construction work performed by principal type of construction, by industry, 1972-75

Industry	1972			1973			1974			1975[1]		
	Building	Engineering	Total	Building	Engineering	Total	Building	Engineering	Total	Building	Engineering	Total
	(millions of dollars)											
Agriculture & fishing	265	143	408	312	169	481	418	226	644	490	264	754
Forestry	8	64	72	15	88	103	25	112	137	25	133	158
Mining, quarrying, oil wells	174	1,099	1,273	220	1,249	1,469	251	1,460	1,711	281	1,692	1,973
Construction	60	1	61	70	1	71	84	1	85	94	1	95
Manufacturing	688	392	1,080	844	419	1,263	1,114	587	1,701	1,204	912	2,116
Utilities	235	2,551	2,786	281	2,890	3,171	391	3,385	3,776	531	4,313	4,844
Trade	265	10	275	355	9	364	429	11	440	429	14	443
Finance, insurance real estate	755	77	832	1,059	102	1,161	1,308	99	1,407	1,425	103	1,528
Commercial services	259	1	260	333	2	335	463	4	467	536	2	538
Housing	5,871	—	5,871	7,165	—	7,165	8,330	—	8,330	8,262	—	8,262
Institutional services	1,112	12	1,124	1,040	9	1,049	1,200	11	1,211	1,411	11	1,422
Government departments	635	2,612	3,247	710	2,830	3,540	875	3,430	4,305	1,121	3,992	5,113
Total	10,327	6,962	17,289	12,404	7,768	20,172	14,888	9,326	24,214	15,809	11,437	27,246

Source: Statistics Canada.
[1] Intentions — Nil.

Over 70 per cent of Canada's annual production of limestone is used as crushed stone. This includes about 50 per cent used as road metal (broken, screened stone for macadam roads), about 20 per cent used as concrete aggregate and about 2 per cent used as railroad ballast.

Some major uses in the chemical field are: neutralization of acid waste liquors; extraction of aluminum oxide from bauxite; manufacture of soda ash, calcium carbide, calcium nitrate and carbon dioxide; in pharmaceuticals; as a disinfectant; in the manufacture of dyes, rayons, paper, sugar and glass; and in the treatment of water. Dolomitic limestone is used in the production of magnesium chloride and other magnesium compounds.

Limestone is used in the metallurgical industries as a fluxing material, where it combines with impurities in ore to form a fluid slag that can be separated from molten metal. Calcium limestones are used in open-hearth steel manufacture, whereas both calcium limestones and dolomitic limestones are used as a flux in the production of pig iron in blast furnaces.

Limestone is used extensively as a filler or an extender and, where quality permits, as whiting. In such applications both physical and chemical properties are important. Specifications vary widely but, in general, a uniform, white material passing 325 mesh would meet the physical requirements. Whiting is used in ceramic bodies, plastics, floor coverings, insecticides, paper, wood putty, rubber, paints and as a filler in many other commodities. In paint manufacture, the material may be used as a pigment extender.

Agricultural limestone is used to control soil acidity and to add calcium and magnesium to the soil. Limestone and lime are used as soil stabilizers, particularly on highway construction projects.

Dolomite is the source of magnesium metal produced at Haley, Ontario; the company also uses a high-calcium lime from southeastern Ontario in the production of calcium metal. Dead-burned dolomitic limestone, for use as a refractory, is produced at Dundas, Ontario, by Steetley of Canada (Holdings) Limited.

Limestone from deposits in coastal areas of British Columbia is mined, crushed, loaded on barges of up to 20,000 tons capacity, and transported as much as 400 miles to consuming centres along the west coast in both Canada and the United States. One Canadian company, Domtar Chemicals Limited, manufactures lime at Tacoma, Washington, using limestone from Texada Island.

Crushed stone will continue to compete with sand and gravel for major markets where the latter are scarce. Through vertical integration, large operations based on construction materials can, by mergers and acquisitions, obtain captive markets for their products in operating construction firms. Construction firms can also integrate backwards into the resource field.

The possibility of substitutes for aggregates is not likely to occur soon in Canada although in countries where such resources are scarce other materials such as compressed garbage are being used. The use of lime or cement to stabilize soils could reduce the amount of aggregate fill required on some highway or railway projects.

Traditional markets for building stone have been lost to competitive building materials such as steel and concrete. Modern design and construction methods favour the flexibility offered by the use of steel and precast or cast-in-place concrete. For aesthetic qualities not available elsewhere, rough or polished stone is used in many modern structures. Monumental stone continues to be in demand.

The present structure of the building stone industry in Canada is unlikely to change very soon. Recent efforts have been made on behalf of the industry to illustrate to contractors and architects the availability of a wide range of Canadian building stones and their adaptability in modern building design.

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Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
		(%)	(%)	(%)
29635-1	Limestone, not further processed than crushed or screened	free	free	25
30500-1	Flagstone, sandstone and all building stone, not hammered, sawn or chiselled	free	free	20
30505-1	Marble, rough, not hammered or chiselled	10	10	20
30510-1	Granite, rough, not hammered or chiselled	free	free	20
30515-1	Marble, sawn or sand rubbed, not polished	free	10	35
	GATT		5	
30520-1	Granite, sawn	free	7½	35
30525-1	Paving blocks of stone	free	7½	35
30530-1	Flagstone and building stone, other than marble or granite, sawn on not more than two sides	free	7½	35
30605-1	Building stone, other than marble or granite, sawn on more than two sides but now sawn on more than four sides	5	7½	10
30610-1	Building stone, other than marble or granite planed, turned, cut or further manufactured than sawn on four sides	7½	12½	15
30615-1	Marble, not further manufactured than sawn, when imported by manufacturers of tombstones to be used exclusively in the manufacture of such articles, in their own factories	free	15	20
	GATT		free	
30700-1	Marble, nop	17½	17½	40
30705-1	Manufacturers of marble, nop	17½	17½	40
30710-1	Granite, nop	17½	17½	40
30715-1	Manufacturers of granite, nop	17½	17½	40
30800-1	Manufacturers of stone, nop	17½	17½	35
30900-1	Roofing slate, per square (100 square feet)	free	free	75¢
30905-1	Granules, whether or not coloured or coated, for use in manufacture of roofing, including shingles and siding	free	free	25

Tariffs (concl'd)

United States

Item No.		On and after January 1 1970	1971	1972
513.61	Granite, not manufactured, and not suitable for use as monumental, paving or building stone	free	free	free
514.11	Limestone, crude, not suitable for use as monumental, paving or building stone, per short ton	14¢	12¢	10¢
		(%)	(%)	(%)
513.21	Marble chips and crushed	7	6	5
514.91	Quartzite, whether or not manufactured	free	free	free
515.11	Roofing slate	17	15	12.5
515.14	Other slate	7	6	5
515.41	Stone, other, not manufactured and not suitable for use as monumental, paving or building stone	free	free	free

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Note: Varying tariffs are in effect on the more fabricated stone categories.
nop Not otherwise provided for.

Sulphur

G.H.K. PEARSE

Sulphur, one of the most important and versatile industrial raw materials, is widely distributed throughout the world in both elemental and combined states. It has been used by man since antiquity and today all industries use sulphur in some form, principally as a processing and manufacturing reagent. More than half of the world's sulphur output is in elemental form, nearly all obtained from native sulphur deposits and sour natural gas. The remainder is recovered from pyrite and smelter stack gases principally as sulphuric acid, in which form 87 per cent of all sulphur is consumed. Fertilizer manufacture accounts for about half of all sulphur consumed, followed by chemicals, pigments and pulp and paper as the next largest consuming sectors.

World sulphur production in all forms increased 5.8 per cent to 51.6 million metric tons, and consumption rose 8.5 per cent to 48.4 metric tons in 1974 largely as a result of sustained vigour in the world fertilizer industry. Canada's total elemental sulphur sales in 1974 were 24 per cent greater than in 1973 at 5.08 million tons.* Sulphur stockpiles on the prairies were 13.5 million tons at year-end.

Strong demand, beginning in late 1972, continued throughout 1974 and prices rose to record levels.

The Canadian sulphur industry

Canadian sulphur is obtained from three sources: elemental sulphur derived from sour natural gas and petroleum; sulphur recovered from smelter gases in the form of sulphuric acid; and sulphur contained in pyrite concentrates used in sulphuric acid manufacture. Minor tonnages of elemental sulphur are recovered as a byproduct of electrolytic refining of nickel sulphide matte, and a small quantity of liquid sulphur dioxide is produced from pyrites and smelter gases. In 1974, eighty-nine per cent of Canadian sulphur shipments were in elemental form, nearly all from sour natural gas in western Canada.

Canadian elemental sulphur production from sour natural gas was lower in 1974 than in the previous year, the first decline since 1951. Despite this, Canada remains the world's largest exporter of elemental sulphur.

Hydrocarbon sources

Hydrocarbons contain sulphur in some form in at least minute amounts. Where the sulphur content is unacceptably high, as it is in many gas reservoirs in western Canada, it must be removed. Sulphur produced from hydrogen sulphide (H_2S), the dominant sulphur compound occurring in sour natural gas, is presently the most important source in Canada. Because of the need to strip highly corrosive and toxic hydrogen sulphide from gas prior to marketing, the elemental sulphur produced is an involuntary by-product of natural gas operations.

Sulphur recovery in Canada from Athabasca oil sands and crude oil is comparatively minor at present and from coal is virtually nil. However, with ever increasing energy requirements, and with stringent air pollution regulations coming into force, these vast sources of sulphur will, in the future, contribute substantially to world supply.

Sour natural gas. Although the H_2S content of sour gas fields ranges as high as 91 per cent by weight of the total raw gas in place, most of the producing fields contain from 1 to 20 per cent H_2S. The modified Claus process in one of its variants is used to recover sulphur from the sour natural gas. Briefly, the method is as follows: H_2S is extracted by absorption into a solution

*The long or gross ton (2,240 pounds) is used throughout unless otherwise stated.

Table 1. Canada, sulphur production and trade, 1973-74

	1973		1974P	
	(long tons)	($)	(long tons)	($)
Production				
Pyrite and pyrrhotite[1]				
Gross weight	22,932	. .	43,750	. .
Sulphur content	11,466	173,021	21,875	376,000
Sulphur in smelter gases	675,496	10,069,746	711,607	12,676,000
Elemental sulphur	4,101,656	23,816,072	4,690,179	66,242,000
Total sulphur content	4,788,618	34,058,839	5,423,661	79,294,000
Imports				
Sulphur crude or refined				
United States	35,143	971,000	30,850	1,241,000
France	51	7,000	43	5,000
Total	35,194	978,000	30,893	1,246,000
Exports				
Sulphur in ores (pyrite)				
United States	. .	659,000	. .	648,000
Total	. .	659,000	. .	648,000
Sulphuric acid and oleum (contained sulphur)				
United States	39,455	3,513,000	80,168	3,847,000
Other	10	4,000	8	2,000
Total	39,465	3,517,000	80,176	3,849,000
Sulphur crude or refined, nes				
United States	937,844	8,427,000	1,163,420	20,319,000
Australia	479,321	7,499,000	422,856	11,975,000
Taiwan	214,344	3,164,000	402,259	10,782,000
New Zealand	178,161	2,642,000	262,503	5,838,000
Italy	253,270	3,198,000	329,350	5,739,000
South Africa	160,454	2,375,000	257,069	5,489,000
Belgium and Luxembourg	223,561	3,832,000	195,067	4,965,000
South Korea	121,549	1,729,000	156,762	3,884,000
Netherlands	104,712	1,485,000	199,344	3,573,000
Chile	18,805	267,000	63,771	2,170,000
United Kingdom	—	—	122,780	1,604,000
Brazil	156,613	1,478,000	110,545	1,571,000
U.A.R.	—	—	39,449	1,550,000
Mozambique	9,000	126,000	73,188	1,546,000
Other	579,669	8,126,000	385,943	9,363,000
Total	3,437,303	44,348,000	4,184,306	90,368,000

Source: Statistics Canada. Department of Energy, Mines and Resources.
[1] Producers' shipments of byproduct pyrite and pyrrhotite from the processing of metallic sulphide ores.
[2] Sulphur in liquid SO_2 and H_2SO_4 recovered from the smelting of metallic sulphides and from the roasting of zinc-sulphide concentrates.
[3] Producers' shipments of elemental sulphur produced from natural gas; also included are quantities of sulphur produced in the refining of domestic crude oil and from the treatment of nickel-sulphide matte.
p Preliminary; – Nil; . . Not available; nes Not elsewhere specified.

of one of the following: diethanolamine, monoethanolamine, hot potassium carbonate, or sulfinol. The solution is then heated in a stripper tower where H_2S is evolved. The H_2S passes into a furnace where a controlled air flow results in partial oxidation of H_2S to permit the following reactions:

$$2H_2S + 3O_2 \rightarrow 2H_2O + 2SO_2$$
$$2H_2S + SO_2 \rightarrow 2H_2O + 3S$$

Gas from this furnace enters a condenser-converter series and a portion of liquid sulphur is removed from the vapour in each unit. Overflow gases then pass through another reaction furnace and the process is repeated until 95 per cent or more of the original sulphur has been removed. The tail gases are incinerated and released to the atmosphere. Liquid sulphur is fed into an underground storage pit for pumping to outside storage blocks where the liquid cools and solidifies. Alternatively, the liquid is fed into a slating plant where it is quenched in water on a special belt subsequently breaking up into "slates." Slated sulphur is claimed to be superior to bulk because it is dust-free and easier to handle. All offshore shipments are now in slated form.

Canada's first sour natural gas sulphur recovery plant came on stream in Alberta in 1951, and sulphur output in 1952 was 8,000 tons. In 1974, 45 plants were operating, including one in Saskatchewan and two in British Columbia with a combined daily capacity of 26,176 tons, up slightly from the previous year as a result of expansions to seven existing plants. During the year, Texaco Exploration Canada Ltd.'s 15-ton-a-day Bonnie Glen plant was built and the 13-ton-a-day Black Diamond plant of Sun Oil Company Limited was closed down because of exhaustion of gas reserves. Production of elemental sulphur in Alberta as reported by the Alberta Energy Resources Conservation Board was 6,776,992 tons, a decrease of 3 per cent from that of 1973. Production in 1974 in British Columbia was 58,412 tons and in Saskatchewan 2,875 tons. Total Canadian production for 1974 was 7,066,718 tons of elemental sulphur derived from sour gas.

Alberta sulphur sales were 4,866,387 tons in 1974, up 22 per cent from 1973. Value of sales trebled to $67,744,000 in 1974 reflecting the continued upward swing in prices which began in 1973, reversing a four-year decline. Alberta inventories stood at 13,520,038 tons at year-end. In 1974, British Columbia and Saskatchewan elemental sulphur sales were 52,921 tons and 3,415 tons, and inventories were 119,256 tons and 7,750 tons, respectively.

Canadian elemental sulphur productive capacity, having doubled between 1968 and 1972, reached a plateau and, for the first time, output declined marginally in 1974. No significant sour gas find has been made in recent years and, with a lag of three to four years between discovery and plant start up, a major increment in sulphur capacity cannot be expected before the late 1970s. Additional capacity scheduled for 1975 includes Sun Oil Company Limited's 82-ton-a-day Rosevear plant scheduled for completion in December and expansion to Shell Canada Limited's Waterton plant (3,016 to 3,040 tons a day), Hudson's Bay Oil and Gas Company Limited's Kaybob I and II (2,090 to 2,140 tons a day), Texasgulf Inc.'s Windfall (1,940 to 1,990 tons a day), Petrogas Processing Ltd.'s Balzac (1,840 to 1,890 tons a day) and Amoco Canada Petroleum Company Ltd's Crossfield East (1,710 to 1,765 tons a day).

The above expansions are in response to more stringent pollution abatement guidelines laid down in November 1971 by the Alberta government. The guidelines include: mandatory stack cleanup facilities and recovery efficiencies between 97 and 99 per cent, depending on acid gas quality, for plants rating over 1,000 tons a day; minimal stack cleanup or equipment with efficiency between 94 and 98 per cent for plants rated between 400 and 1,000 tons a day; at least a three-stage Claus unit or equivalent with efficiency between 92 and 96 per cent for 100- to 400-ton plants, and a two-stage Claus unit with recovery efficiency between 90 and 94 per cent for smaller plants. All plants must comply with this requirement by December 31, 1975.

Prior to 1974, all sulphur destined for offshore markets was railed to loading terminals at Vancouver, some 650 miles from processing plants. During the year, substantially higher sulphur prices permitted shipping via Churchill, Manitoba, Thunder Bay, Ontario and Quebec City, Quebec. Approximately 100,000 tons were moved through these alternate ports. These ports will increase in importance in the future if sulphur prices remain high and if problems of rail transport to the west coast remain unsolved. Other bottlenecks related to Vancouver harbour storage capacity and slating capacity were removed by appropriate expansions to facilities during the year.

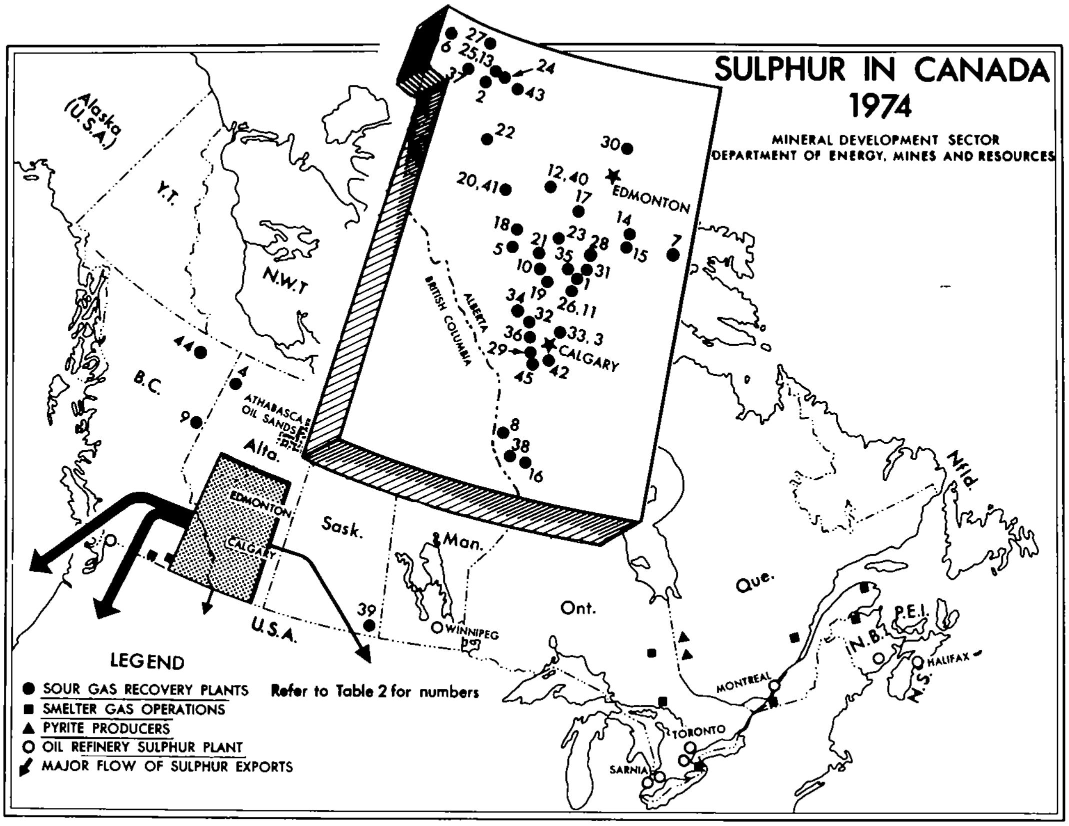
Athabasca oil sands. The Athabasca oil sands constitute a vast deposit of relatively unconsolidated sandstone impregnated with bitumen, covering some 30,000 square miles of northeastern Alberta. The estimated 300 billion barrels of recoverable oil in the formation contain about 2 billion tons of sulphur.

In late 1967, Great Canadian Oil Sands Limited (GCOS) completed the first commercial oil-sand extraction plant at a cost of $240 million. The ancillary sulphur recovery plant is designed to produce 300 tons of sulphur daily. Sulphur production has increased from 47,000 tons in 1970 to 95,013 tons in 1974, reflecting improvements in the plant in recent years. Shipments from GCOS began in October 1974, and by year-end 30,000 tons had been shipped to Quebec City for offshore markets. Stockpiled sulphur at the plant site had reached 375,022 tons as of December 31st, 1974. Another project, that of Syncrude Canada Ltd., commenced construction during the year and is expected to be completed in 1978. It is designed to produce 125,000 b/d of synthetic crude oil and

Table 2. Canada, sour gas sulphur extraction plants, 1974

Operating Company	Source Field or Plant Location	H_2S in Raw Gas	Daily Capacity
	(Alberta, except where noted)	(%)	(long tons)
1. Amerada Hess Corporation	Olds	11	383
2. Amoco Canada Petroleum	Bigstone Creek	19	376
3. Amoco Canada Petroleum	East Crossfield	34	1,710
4. Aquitaine Company of Canada	Rainbow Lake	4	137
5. Aquitaine Company of Canada	Ram River	9-35	4,100
6. Atlantic Richfield	Gold Creek		42
7. Canadian Industrial Gas*	Kessler		
8. Saratoga Processing Company	Savannah Creek (Coleman)	13	377
9. Canadian Occidental	Taylor Flats, B.C.	3	325
10. Canadian Superior Oil	Harmattan-Elkton	53	482
11. Canadian Superior Oil	Lonepine Creek	12	151
12. CanDel Oil	Minnehik-Buck Lake		32
13. Chevron Standard	Kaybob South	19	3,050
14. Chevron Standard	Nevis	7	258
15. Gulf Oil Canada[1]	Nevis	3-7	290
16. Gulf Oil Canada	Pincher Creek	10	196
17. Gulf Oil Canada	Rimbey	1-3	327
18. Gulf Oil Canada	Strachan	10	995
19. Home Oil	Carstairs	1	58
20. Hudson's Bay Oil and Gas	Brazeau River	1	89
21. Hudson's Bay Oil and Gas	Caroline	1	20
22. Hudson's Bay Oil and Gas	Edson	2	285
23. Hudson's Bay Oil and Gas	Hespero (Sylvan Lake)	1	15
24. Hudson's Bay Oil and Gas	Kaybob South (1)	17	1,070
25. Hudson's Bay Oil and Gas	Kaybob South (2)	17	1,020
26. Hudson's Bay Oil and Gas	Lonepine Creek	10	279
27. Hudson's Bay Oil and Gas[1]	Sturgeon Lake South	10	96
28. Imperial Oil	Joffre		27
29. Imperial Oil	Quirk Creek		286
30. Imperial Oil	Redwater	3	26
31. Mobil Oil Canada	Wimborne	14	331
32. Petrofina Canada	Wildcat Hills	4	174
33. Petrogas Processing	Crossfield (Balzac)	31	1,840
34. Shell Canada	Burnt Timber Creek	8-5	187
35. Shell Canada	Innisfail	14	158
36. Shell Canada	Jumping Pound	3-5	500
37. Shell Canada	Simonette River	15	209
38. Shell Canada	Waterton	18-25	3,016
39. Steelman Gas	Steelman, Sask.	1	7
40. Texaco Exploration[2]	Bonnie Glen		15
41. Tenneco Oil & Minerals	Nordegg		41
42. Texasgulf Inc.	Okotoks	33	452
43. Texasgulf Inc.	Windfall	16	1,940
44. Westcoast Transmission	Fort Nelson, B.C.		250
45. Western Decalta	Turner Valley	4	24
Total daily rated capacity — December 31, 1974.			25,646

[1] Plants increased capacity in 1974.[2] New plant in 1974. *Plant closed during 1974.



products. Petrofina Canada Ltd. may have a plant on stream by 1982, and development of the tar sands by 1985 is expected to result in a synthetic crude production of 400,000 barrels a day. This would yield about 700,000 tons of sulphur a year. Annual output by 2000, assuming a new plant every two years after 1985, could reach 3 million tons of sulphur.

Oil refineries. Some crude oils contain as much as 5 per cent sulphur, either as hydrogen sulphide or in other compounds. Domestic crudes generally contain less than 1 per cent sulphur. The sulphur may either be removed in the form of H_2S or treated to form nondeleterious disulphides. Recovery techniques employed during oil refining are similar to those used in the removal of sulphur from sour gas.

In Canada, sulphur is recovered from imported crudes at oil refineries in Nova Scotia, New Brunswick, Newfoundland and Quebec and from domestic crudes at oil refineries near Toronto, Sarnia, Winnipeg, Edmonton and Vancouver. Total sulphur output from refineries in 1973 was 150,000 tons including 60,000 tons from Montreal refineries alone. This recovery represents only 20 per cent of total sulphur contained in the crude.

Coal and oil shales. Coke oven gases generally contain some hydrogen sulphide, the quantity dependent upon the sulphur content of the coal being carbonized. Ordinarily, the H_2S is removed in "iron oxide boxes", but it can also be recovered and converted to elemental sulphur.

In response to the demand for increasing amounts of clean fuel, numerous research projects were initiated over the last few years with the aim of developing high quality, pollution-free gas from coal. Escalation of the energy crisis, particularly in the United States and Europe, brought about by Middle East oil supply cutbacks near the end of 1973, has given further impetus to gasification projects and oil shale studies. Annual sulphur recovery from these sources, largely in the United States, could reach 2 million tons during the 1980s and 10 million tons by the end of this century. Although coal in western Canada is low in sulphur (less than 0.5%), coal from the Maritimes is notably sulphurous. With more stringent pollution regulations coming into force, coal gasification may become the only way in which this energy source can be utilized in the future.

Table 3. Proposed new plants and expansions for 1975

Operating Company	Location	Proposed Daily Rated Capacity
Amoco Canada Petroleum[1]	Crossfield E.	..
Petrogas Processing[1]	Crossfield E. (Balzac)	..
Hudson's Bay Oil and Gas[1]	Kaybob I and II	..
Hudson's Bay Oil and Gas[2]	Zama	73
Shell Canada[1]	Waterton	3,100
Texasgulf Inc.[1]	Windfall	..
Westcoast Transmission[2]	Fort Nelson (2)	450
Anticipated daily rated capacity end of 1975		26,413

[1] Expansions. [2] New plants.
.. Not available.

Metallic sulphide sources

In Canada, the use of metallic sulphides for their sulphur content dates back to 1866. Early operations consisted essentially of roasting pyrite for the direct manufacture of sulphuric acid. In the 1920s the use of base-metal smelter gases for the manufacture of byproduct H_2SO_4 began near Sudbury, Ontario, and at Trail, British Columbia. Virtually all Canada's sulphur production was from metallic sulphides prior to 1951 when the first sour gas sulphur recovery plant was built. In 1974, metallic sulphides provided 733,482 tons of contained sulphur and accounted for 9.5 per cent of Canada's total sulphur production.

Smelter gases. Effluent gas from smelting of sulphide ores contains from 1 to 12 per cent sulphur dioxide (SO_2). Recovery of SO_2 includes processes for cleaning, purifying, cooling and concentrating. Concentrated SO_2 is then used directly for the manufacture of H_2SO_4 via the contact-acid process. Occasionally, the SO_2 is compressed to liquid sulphur dioxide and in some cases is used for the manufacture of oleum (fuming sulphuric acid, $H_2S_2O_7$). Production in 1974 was 711,607 tons of contained sulphur, an increase of 5 per cent from 1973. Proposed increments to smelter capacity and increased sulphur recovery efficiency presages a rapid growth in sulphuric acid output over the next few years.

The largest sulphuric acid plant complex in Canada is that of Canadian Industries Limited (CIL) at Copper Cliff, Ontario. The company operates three acid plants that have a combined daily capacity of 2,680 tons of H_2SO_4 based on SO_2 gas from International Nickel Company of Canada, Limited's (Inco) iron ore recovery plant. In addition, CIL has a liquid sulphur dioxide plant at Inco's nearby Copper Cliff smelter. Much of the acid produced at Copper Cliff is shipped by unit-train about 475 miles to CIL's fertilizer works near Sarnia, Ontario. The company owns a sulphuric acid depot at Niagara Falls, Ontario, which consists of a 60,000 short-ton storage tank and equipment for unloading unit-trains and loading tank-cars and trucks. Acid from Copper Cliff is shipped directly to the facility via 56-car unit-trains.

Subsidiaries of Noranda Mines Limited produce smelter acid at three localities, namely Gaspé Copper Mines, Limited's 315,000-ton-a-year plant at Murdochville, Quebec, Belledune Acid Limited's 125,000-ton-a-year plant at Belledune, New Brunswick and Canadian Electrolytic Zinc Limited's zinc concentrate roasting facility at Valleyfield, Quebec recently doubled in capacity to 250,000 tons a year. A proposed copper smelter and associated 100,000-ton-a-year sulphuric acid installation to be built at Noranda, Quebec has been shelved for the time being.

Cominco Ltd.'s sulphuric acid capacity at Trail, British Columbia, based on its lead-zinc smelter, will be increased 30 per cent in 1975 to 490,000 tons a year with the replacement of the two older units with a single plant. Acid capacity at the company's Kimberley plant is 300,000 tons a year. Much of the acid produced is utilized by Cominco in the manufacture of fertilizers.

Allied Chemical Canada, Ltd. produces sulphuric acid from the roasting of zinc concentrates supplied under agreement with Canadian Electrolytic Zinc, whereby Allied retains the acid for its own use and delivers the zinc calcine to Canadian Electrolytic Zinc's nearby refinery.

Ecstall Mining Limited's, Timmins, Ontario zinc plant has a sulphuric acid capacity of 200,000 tons a year. A two stage expansion plan will raise acid output to 400,000 tons by 1978 and to 560,000 tons by 1979. This development will be coupled with a phosphate fertilizer works.

Falconbridge Nickel Mines Limited has announced plans for the replacement of its blast furnaces with electric melting equipment and installation of fluid bed roasters. Acid capacity will be 325,000 tons a year upon completion in 1977.

Shipments of acid and oleum to the United States in 1974 were 80,168 tons contained sulphur, double that of 1973. Small amounts were shipped elsewhere, mainly to the West Indies.

Pyrite and pyrrhotite. Pyrite and pyrrhotite concentrates produced as a byproduct of base metal mining operations are sometimes marketed for their sulphur content. The distinction between the category of sulphur in pyrite and pyrrhotite and that in smelter gases used in this review is based upon this concept. For example, although most of the acid production at Copper Cliff, Ontario is dependent upon the roasting of iron sulphides, the sulphur production is reported as smelter gases. In other instances, however, the iron sulphide concentrates are sold and shipped for roasting elsewhere and are reported as pyrite and pyrrhotite production.

Noranda Mines Limited and Normetal Mines Limited have, over the years, shipped pyrite to acid plants, principally in the northern eastern United States. Recent conversion to elemental sulphur feed resulted in a drastic reduction in pyrite usage. Noranda discontinued pyrite sales in 1973. Other companies are stockpiling pyrite concentrates pending development of future markets for this material. In 1974, Canada's pyrite and pyrrhotite shipments amounted to 43,750 tons of concentrates (21,875 tons contained sulphur) valued at $376,000.

Canadian consumption and trade

In 1974, Canadian consumption of sulphur in all forms, as reported by consumers, amounted to 1.61 million tons of which 910,000 tons was elemental sulphur.

Canada is the world's largest supplier of elemental sulphur to world markets. Exports in 1974 reached 4.2 million tons, an increase of 24 per cent over the previous year.

Because of its highly competitive nature, involuntary byproduct sulphur from western Canada has, over the years, penetrated much of the United States market. From the outset this country has been the principal destination for Canadian sulphur and presently accounts for about 30 per cent of Canadian exports. Canada's sales increased to all-time highs in offshore market areas, reflecting strong world-wide demand for sulphur. Shipments to Europe, which had increased 82 per cent in 1973 increased a further 44 per cent in 1974 to 950,000 tons, largely as a result of the United Kingdom's return as a buyer and major increases in Dutch and Italian purchases. Asian sales declined marginally, the People's Republic of China's virtual withdrawal from the market having been offset by a near doubling of purchases by Taiwan. Australasian sales rose 4 per cent, Latin American 15 per cent and African 82 per cent. Major sulphur consuming countries that have increased their purchases of Canadian sulphur by 50 per cent or more in 1974 include Netherlands, Republic of South Africa, Taiwan and New Zealand. The United Arab Republic and Morocco became customers for the first time in 1974, and Kenya, Mozambique and Tunisia are establishing themselves as significant importers.

Table 4. Canada, principal sulphur operations based on metallic sulphides, 1974

Operating Company	Plant Location	Raw Material	Annual Capacity 100% H_2SO_4	Annual Capacity Approx. S. equiv.
			(long tons)	
Smelter gases				
Belledune Acid	Belledune, N.B.	SO_2 lead-zinc	125,000	42,000
Allied Chemical	Valleyfield, Que.	SO_2 zinc conc.	120,000	40,000
Canadian Electrolytic Zinc	Valleyfield, Que.	SO_2 zinc conc.	125,000	42,000
Canadian Industries[1]	Copper Cliff, Ont.	SO_2 pyrrhotite	900,000	300,000
Cominco	Trail, B.C.	SO_2 lead-zinc	435,000	145,000
Ecstall Mining Limited	Timmins, Ont.	SO_2 zinc conc.	205,000	70,000
Gaspé Copper Mines	Murdochville, Que.	SO_2 copper	315,000	105,000
			Product	
Pyrite and pyrrhotite				
Noranda Mines	Noranda, Que.	Sulphide ore	Pyrite concentrate	
Normetal Mines Limited	Normetal, Que.	Sulphide ore	Pyrite concentrate	

[1] Includes sulphur content in liquid SO_2 production.

Table 5. Canada, sulphur production and trade, 1965-1974

	Production				Imports	Exports	
	Pyrites[1]	In Smelter Gases	Elemental Sulphur	Total	Elemental Sulphur	Pyrites	Elemental Sulphur
				(long tons)		($)[2]	
1965	166,918	397,080	1,846,662	2,410,660	144,813	978,828	1,337,367
1966	144,901	446,702	1,822,676	2,414,279	129,871	981,000	1,249,113
1967	162,826	528,568	2,231,290	2,922,685	111,404	1,067,000	1,583,533
1968	139,136	594,935	2,304,090	3,038,161	67,688	1,056,000	1,884,821
1969	152,858	603,702	2,654,746	3,411,306	40,630	1,105,000	2,005,480
1970	156,707	630,206	3,167,931	3,954,844	47,725	1,226,000	2,668,072
1971	138,421	552,185	2,811,677	3,502,283	27,484[r]	1,074,000	2,364,190[r]
1972	61,204	606,110	3,246,099	3,913,413	25,091	501,000	2,542,896
1973	11,466	675,496	4,101,656	4,788,618	35,194	659,000	3,437,303
1974[p]	21,875	711,607	4,690,179	5,423,661	30,893	648,000	4,184,306

Source: Statistics Canada.
[1] See footnotes for Table 1. [2] Dollar value of pyrite exports quantities not available.
[p] Preliminary. [r] Revised.

Table 6. Canadian export markets, 1974

Country or Area	Exports	Per cent of Total
	(millions of long tons)	
United States	1.16	27.8
Europe	.83	19.9
Australia	.42	10.0
Taiwan	.40	9.6
New Zealand	.26	6.2
South Africa	.26	6.2
South Korea	.16	3.8
Brazil	.11	2.6
Others	.58	13.9
Total	4.18	100.0

Source: Mineral Development Sector.

World review

Although world sulphur production in 1974 exceeded demand for the seventh consecutive year, consumption increased 8.5 per cent. The surge in demand — significantly above the historical growth rate — is largely a result of continued vigour in the fertilizer industry. Elemental sulphur exports by major suppliers increased 22.5 per cent in 1974 to nearly 12.5 million tons following a 16.3 per cent increase in the previous year. This growth was aided by stagnation in the pyrite trade.

Tight supply conditions prevailed during the year despite considerable improvement in Canadian supply capability which permitted a 22 per cent increase in exports. Similarly, major shipment increases were achieved by Poland, Mexico and United States; only France, among the major suppliers, registered a decline in exports.

Table 7. Canada sulphur consumption, 1965-74

	From Pyrites and Smelter Gases[e]	Elemental Sulphur[1]	Total
		(long tons)	
1965	438,166	659,978	1,098,000
1966	461,478	725,053	1,187,000
1967	590,185	752,963	1,343,149
1968	669,763	741,155	1,410,919
1969	680,438	688,211	1,368,649
1970	682,992	751,543	1,434,535
1971	562,645[r]	718,443	1,281,088
1972	600,093[r]	846,955	1,447,048
1973	643,290[r]	892,594	1,535,884
1974	695,782	910,000[e]	1,605,782

Source: Statistics Canada.
[1] As reported by consumers.
[e] Estimated by Mineral Development Sector.
[r] Revised.

Consumption of sulphur in the western world amounted to 35.4 million tons. Western world production in all forms was 36.7 million tons. Polish sales to western markets amounted to 1.9 million tons virtually unchanged from that of 1973 and shipments to the People's Republic of China from Canada, Mexico and the Persian Gulf totalled 40,000 tons in 1974, less than 10 per cent of 1973 shipments. A similar tonnage was shipped to other communist countries. Additions to western stockpiles were 2.0 million tons, of which 1.89 million tons was vatted in Canada and the remainder accounted for by United States and Iraq.

The world's largest producer of sulphur in all forms is the United States, with the majority of production derived from Frasch mines located in the Gulf Coast area. These deposits, when first developed in the early 1900s made large tonnages of low-cost sulphur available to world markets and established the United States as the world's foremost supplier of elemental sulphur. In 1974 Frasch production increased 4 per cent to 7.90 million tons and recovered elemental sulphur principally from sour natural gas, increased 7 per cent to 2.58 million tons. Shipments of elemental sulphur advanced 5 per cent over that of 1973 and stocks rose marginally to 3.96 million tons. Exports increased 46 per cent to 2.58 million tons, imports almost doubled to 2.15 million tons and domestic consumption of elemental sulphur grew 7 per cent to 9.97 million tons in 1974. All plants were operating close to full capacity during the year.

Table 8. Canada, consumption of elemental sulphur by industry

	1972	1973
	(long tons)	
Chemicals	227,340	232,621
Pulp and paper	324,182	300,088
Rubber products	3,553	3,154
Fertilizers	247,189	326,642
Foundry	7,640	9,004
Other industries[1]	37,051	21,085
Total	846,955	892,594

Source: Statistics Canada. Breakdown by Mineral Development Sector.
[1] Includes production of titanium pigments, pharmaceuticals and medicinals, starch, soaps and detergents, explosives, food processing, sugar refining and other minor uses.

Mexican elemental sulphur production increased over 40 per cent in 1974 to 2.3 million tons, principally as a result of intensive development of the Jaltipan dome deposits by Azufrera Panamericana SA (APSA). Domestic shipments which have tripled in six years in response to growth in the fertilizer industry reached an estimated 500,000 tons in 1974. Under the influence of a vigorous marketing program initiated by APSA, exports increased a remarkable 240 per cent in 1974 to 1.75 million tons.

Table 9. Canada, sulphuric acid production, trade and apparent consumption, 1965-74

	Production	Imports	Exports	Apparent Consumption
	(short tons — 100% acid)			
1965	2,165,000	3,075	57,113	2,110,962
1966	2,500,000	6,948	54,948	2,452,000
1967	2,749,279	3,626	84,280	2,668,625
1968	2,852,027	2,606	125,971	2,728,662
1969	2,396,535	60,746	103,386	2,353,895
1970	2,728,298	10,966	142,559	2,596,705
1971	2,933,000	4,952	101,094	2,836,858
1972	3,030,182	70,112	104,227	2,996,067
1973	3,265,772r	72,451	135,210	3,203,013r
1974p	2,896,834	137,502	274,693	2,759,643

Source: Statistics Canada.
r Revised; p Preliminary.

Production of elemental sulphur from sour natural gas from the Lacq field in France in 1974 was virtually unchanged at 1.8 million tons. Exports decreased by 10 per cent to 0.9 million ton in 1974 and domestic deliveries rose by a similar amount to 0.9 million ton. Elemental sulphur output from sour gas in northern West Germany is rising rapidly after several years plagued by technical problems. This source, providing 350 thousand tons in 1974, is expected to produce over 500 thousand tons in 1975.

Polish shipments increased sharply during the latter half of 1974 after technical problems at the Machow open-pit mine were solved and improved performance was achieved from two Frasch-type operations. However, exports to western markets increased only marginally to about 2 million tons as strong domestic and eastern Europe demand absorbed the remaining 2 million tons produced. New mine developments now in hand will increase supply capabilities substantially over the next few years.

Iraq became a significant producer of elemental sulphur in 1973 with output largely from the Mishraq dome rising to 573,000 tons. Capacity is reported to have reached 1 million tons a year but no expansion to output is expected until improved rail transport capability to the Persian Gulf port of Umm Qasr, 450 miles to the south, is completed in 1976. During the year, shipment by truck to Lebanon for Mediterranean customers was begun and a large fleet of trucks is on order with Mercedes in Germany.

Table 10. Canada, available data on consumption of sulphuric acid by industry, 1972

	(short tons – 100% acid)
Iron and steel mills	18,720
Other iron and steel	12,129
Electrical products	5,834
Leather tanneries	3,249
Pulp and paper mills	139,546
Processing of uranium ore	91,640
Manufacture of mixed fertilizers[1]	23,014
Manufacture of plastics and synthetic resins	17,829
Manufacture of soaps and cleaning compounds	21,587
Other chemical industries	9,984
Manufacture of industrial chemicals[2]	2,028,462
Petroleum refining	33,587
Mining[3]	50,000e
Nonferrous smelting and refining	163,431
Miscellaneous[4]	13,318
Total	2,632,330

Source: Statistics Canada.
[1] Includes consumption for production of super-phosphate in this industry. [2] Includes consumption of "own make" or captive acid by firms, classified to these industries. [3] Includes metal mines, nonmetal mines, mineral fuels and structural materials. [4] Includes synthetic textiles, explosives and ammunition and other petroleum and coal products, mineral wool, starch and glucose, vegetable oils, sugar refining and textile drying and finishing.
e Estimated.

Table 11. World production of sulphur in all forms, 1973

	Elemental	Other[1]	Total
	(thousands of metric tons)		
United States	10,182	1,380	11,562
Canada	7,303	699	8,002
U.S.S.R.	2,295	5,474	7,769
Poland	3,500	265	3,765
Japan	680	2,087	2,767
France	1,823	169	1,992
Mexico	1,619	44	1,663
Spain	3	1,176	1,179
West Germany	333	762	1,095
Italy	76	707	783
Iran	595	—	595
Finland	123	385	508
Sweden	5	415	420
Norway	4	385	389
East Germany	110	270	380
South Africa	25	280	305
Others	1,325	4,287	5,612
Total	30,001	18,785	48,786

Source: British Sulphur Corporation Limited, November/December 1974.
[1] Sulphur in other forms includes sulphur contained in pyrites and contained sulphur recovered from metallurgical waste gases mostly in the form of sulphuric acid.
— Nil.

Outlook

The near-term outlook for sulphur is made uncertain by the current world-wide economic slowdown. Slackening demand, largely attributable to the nonfertilizer use sector, appears likely to be offset by attendant cutbacks in base metal associated sulphuric acid supply. In the early months of 1975, such cutbacks are expected to average as much as 20 per cent for the year representing a reduction in total sulphur availability of almost 2 million tons from that of 1974. At the same time, increases in supply from other sources are limited. Availability of elemental sulphur from Canada and Iraq is constrained by transportation bottlenecks although use of alternate ports in Canada offers modest relief. United States and Mexican Frasch producers are at full capacity and France's elemental sulphur output reached a plateau several years ago. Of the major producers, only Poland appears to be capable of increasing output significantly in 1975. Canada is expected to boost sales in 1975 to 5.4 million tons. Demand for fertilizers has moderated somewhat from early 1974 but remains fairly strong, especially in North America, Eastern Europe and the Soviet Union. In balance for 1975, sulphur supplies appear to be adequate. However, a modest rise in demand occasioned by, for example, the return of the People's Republic of China as an importer could result in a tightening in several markets.

For the longer-term, fertilizer requirements, under the stimulus of world food shortages and the expansion of modern agricultural practice in Asia, Africa and Latin America, should sustain annual sulphur consumption growth in the 5 to 6 per cent range over the next several years.

Although Canada is the world's largest exporter of sulphur with a 34 per cent share of total trade, its impact on world sulphur markets is expected to decline. Production of elemental sulphur from sour natural gas peaked in 1973 at just over 7 million long tons and registered a 2 per cent decline in 1974. Several of the major plants are recycling operations, i.e., sulphur is stripped from the gas and the gas returned to the reservoir. Output from these plants is now tapering off and, considering the reservoir life of the others, a reduction to about one half of the current output from existing plants is expected by 1985. Replacement of part of this capacity through new discoveries remains a possibility but, given the fact that no significant sour gas finds have been made in the last few years and, considering a lag time of three or four years, between discovery and production, no major increment in output is likely before the end of the decade. Sulphur recovery from the Athabasca oil sands depends on the rate of exploitation of this source of oil. Current estimates in the order of 300,000 b/d by 1985 are less than earlier projections by two thirds. Sulphur from metallic sulphides, produced largely in the form of sulphuric acid, could double by 1985. However, it is unlikely that new sour gas discoveries and growth in output of metallurgical and oil sands sulphur will be adequate to offset the decline in Canadian production before the late 1980s.

United States Frasch producers improved sales moderately in 1974 over the previous year, itself a record year. In spite of this showing and the favourable outlook for sulphur, two constraints are making themselves felt. Costs have virtually doubled recently as a result of price increases for essential natural gas. At best, producers will have to face the problem of continued escalating costs of production and fuel supply cuts remain a distinct possibility. Notwithstanding the success of the Duval Corporation's mine in west Texas, which has been stepped up to 2.4 million tons a year, and Texasgulf Inc.'s 500,000 ton operation scheduled for 1976, output from United States sulphur deposits appears to have little scope for growth. These developments and the likely reactivation of Freeport Mineral Company's offshore Caminada dome, appear to do little more than offset declining production from the large older deposits.

Although pollution abatement sulphur will become more important, its impact is proving to be less dramatic than earlier predictions suggested, for several reasons, namely for sulphur removal from electric utility stack gases, the largest source of pollution-sulphur, economic and technologic considerations weigh in favour of a scrubbing process which will result in an inert waste product to be discarded; a number of smelters are located in areas lacking adequate markets for sulphuric acid which will likely result in a similar disposal of surplus acid; and in light of energy supply considerations, attention has been focussed on conservation which will moderate growth in fossil fuel consumption, the major source of sulphur emissions.

Under the influence of these factors, and coupled with demand pressures for fertilizers from the agricultural sector generated by world food shortages, sulphur inventories should peak in the next two or three years and supply and consumption will tend toward a balance, perhaps reaching that point before the end of the present decade.

Prices

A firming trend in prices, evident in the latter months of 1972, manifested itself in 1973 and continued through 1974, reaching $30 a ton fob Alberta plant. Overseas prices similarly advanced as surging fertilizer requirements tightened sulphur availability. Major expansions to phosphoric acid capacity are in hand and others are planned for completion over the next three or four years. Despite the possibility of a phosphate fertilizer overcapacity situation developing by 1980, increased demand pressures and further price increases are likely over the medium term.

Canadian sulphur prices quoted in *Canadian Chemical Processing*, November 1974.

	($)
Sulphur, elemental, fob works	
contract, carload, per long ton	25.00
Sulphuric acid, fob plants, east,	
66° Be, tanks, per short ton	
December	37.00

United States prices in U.S. currency, quoted in *Engineering and Mining Journal*, December 1974

	($)
Sulphur elemental	
U.S. producers, term contracts	
fob vessel at Gulf ports,	
La. and Tex., per long ton (nominal)	
Bright	47
Dark	46
Export prices, fob Gulf ports	
Bright	55
Dark	44
Mexican export fob vessel	
per long ton	
Bright	26
Dark	25

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
92503-1	Sulphur of all kinds, other than sublimed sulphur, precipitated sulphur and colloidal sulphur	free	free	free
92802-1	Sulphur, sublimed or precipitated, colloidal sulphur	free	free	free
92807-1	Sulphur dioxide	free	free	free
92808-1	Sulphuric acid, oleum	10%	15%	25%
92813-4	Sulphur trioxide	free	free	free

United States

Item No.			Item No.		(%)
418.90	Pyrites	free	422.94	Sulphur dioxide	
415.45	Sulphur, elemental	free		On and after Jan. 1, 1970	8.5
416.35	Sulphuric acid	free		On and after Jan. 1, 1971	7
				On and after Jan. 1, 1972	6

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Talc, Soapstone and Pyrophyllite

G.H.K. PEARSE

Talc is a hydrous magnesium silicate $H_2Mg_3(SiO_3)_4$ formed by the alteration of rocks rich in magnesia (most commonly ultrabasic igneous rocks and sedimentary dolomite) within which it occurs as veinlets, tabular bodies, or irregular lenses. It is a soft flaky mineral with a greasy feel or "slip"; it is readily ground to a fine white or nearly white powder, has a high fusion point, low thermal and electrical conductivity and is relatively chemically inert. Most of the uses of talc depend on individual physical properties or combinations of these properties.

Talc is produced in various grades which are usually classified by end use, namely cosmetic, ceramic, pharmaceutical and paint. A special high-quality block talc used in making ceramic insulators and other worked shapes is designated steatite grade.

Soapstone is an impure talcose rock generally occurring in massive, compact deposits from which blocks can be sawn. Soapstone has been used since early times in many parts of the world for carving ornaments, pipes, cookware, lamps and other utensils. The art of carving has survived among the Eskimos up to the present era. Present uses include metalworkers' crayons, refractory bricks, and blocks for sculpturing.

Pyrophyllite is a hydrous aluminum silicate $H_2Al_2(SiO_3)_4$ formed by hydrothermal alteration of acid igneous rocks, predominantly lavas which are andesitic to rhyolitic in composition. It resembles talc in physical properties and for this reason finds uses similar to talc — notably in ceramic bodies and as a filler in paints, rubber and other commodities.

In Canada, talc is produced in two provinces, Quebec and Ontario. Pyrophyllite is produced only in Newfoundland. The value of talc and soapstone shipments increased from $1,291,303 in 1973 to $1,590,000 in 1974. The value of pyrophyllite production increased from $1,778,091 in 1973 to $2,207,000 in 1974.

Production and developments in Canada

Talc, soapstone. The earliest recorded production in Canada was in 1871–72 when 300 tons of cut soapstone valued at $1,800 were shipped from a deposit in L 24, R 6 in Bolton Township, southern Quebec, by Slack and Whitney. In 1896 a deposit in Huntingdon Township, in the Madoc district in Ontario was opened up, and over the next few years numerous deposits in this area were discovered and mined intermittently.

Several deposits in southern British Columbia and one in southwestern Alberta were discovered prior to 1920 and some of these were worked in a small way. At present, talc is mined by three companies — two in Quebec and one in Ontario.

Baker Talc Limited produces talc and soapstone from an underground mine in South Bolton, Quebec, 60 miles southeast of Montreal. Ore from the mine is trucked 10 miles south to the company's mill facilities at Highwater. In former years, Baker Talc produced a relatively low-grade, low-cost product suitable for use primarily as a dry-wall joint filler, asphalt filler and dusting compounds for asphalt roofing. Tests conducted in 1967–68, employing a Jones High Intensity Wet Magnetic Separator, demonstrated that the company's talc could be upgraded for use in the paint, cosmetic and paper industries and this process was added to the mill circuit in 1969. This project was supported by the federal Department of Industry, Trade and Commerce. Subsequently, a modified flotation process replaced the magnetic separator which resulted in improved output.

Current output of high-grade product, destined largely for paper mills, is around 5,000 tons a year. Expansions begun in 1973 were completed during 1974, however the economic downturn caused sales to decline during the latter half of the year, and total output fell about 10 per cent below the 1973 level. Minor shipments have also been made for use as a filler in plastics and paints and, from time to time, the company markets soapstone blocks as an artistic medium to schools and shops.

Broughton Soapstone & Quarry Company, Limited, quarries talc and soapstone from two deposits near Broughton Station in the Eastern Townships of Quebec, where the same geological conditions are evident as in the South Bolton area. Several low-priced grades of ground talc are produced, and soapstone is sawn to produce metalworkers' crayons and various sizes of blocks for sculpturing and plates for etching. Much of the Eskimo artists' soapstone requirements are supplied by this company.

Canada Talc Industries Limited produces talc from underground workings at Madoc, Ontario. The deposits at Madoc are extensive and were formed by the alteration of dolomitic marble. Tremolite and dolomite impurities in the deposit limit the use of some ground products. A high-quality product suitable as a filler material in the paint industry is produced.

Numerous deposits of talc and soapstone occur in other parts of Canada. A soapstone deposit on Pipestone Lake in Saskatchewan was worked by Indians for the manufacture of pipes and various utensils. Reserves are reported to be considerable. In the Northwest Territories, a few occurrences of soapstone are known from which Eskimos obtained material for carving. Showings of minor importance occur at several localities in Nova Scotia and Newfoundland.

Table 1. Talc, soapstone and pyrophyllite production, trade and consumption, 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Production (shipments)				
Talc and soapstone				
Quebec[1]	..	740,504	..	870,000
Ontario[2]	..	550,799	..	720,000
Total	..	1,291,303	..	1,590,000
Pyrophyllite				
Newfoundland	..	486,788	..	617,000
Total production	81,495	1,778,091	93,000	2,207,000
Imports (Talc)				
United States	32,828	1,944,000	39,625	2,507,000
Italy	6	1,000	281	41,000
Other countries	199	25,000	51	4,000
Total	33,033	1,970,000	39,957	2,552,000
		1972		1973p
Consumption[3] (ground talc available data)				
Ceramic products		6,764		7,326
Paints and wall joint sealers		8,096		9,731
Roofing		7,074		9,373
Paper and paper products		4,363		5,247
Rubber		2,171		2,359
Insecticides		602		316
Toilet preparations		782		519
Cleaning compounds		889		529
Pharmaceutical preparations		214		185
Linoleum and tile		1,368r		978
Other products[4]		3,930		5,724
Total		36,253		42,287

Source: Statistics Canada.
[1] Ground talc, soapstone, blocks and crayons. [2] Ground talc. [3] Breakdown by Mineral Development Sector. [4] Chemicals, foundries, gypsum products and other miscellaneous uses.
p Preliminary; .. Not available; r Revised.

Pyrophyllite. Newfoundland Minerals Limited, a subsidiary of American Olean Tile Company, Inc. produces pyrophyllite from an open-pit mine near Manuels, 12 miles southwest of St. John's, Newfoundland. Ore is crushed, sized and hand-cobbed at the mine site prior to trucking a short distance to tidewater. Continuous chemical analyses and physical tests are run on all material delivered from the mine to the loading dock. Blended ore is shipped in bulk to the parent company's operation at Lansdale, Pennsylvania, where it is used in the manufacture of ceramic tile. Annual production varies between 30,000 and 40,000 tons. The pyrophyllite deposit at Manuels appears to be a hydrothermal alteration of sheared rhyolite. Altered zones are associated for the most part with extensive fracturing near intrusive granite contacts. Reserves are extensive.

Other known pyrophyllite deposits in Canada include an extensive area of impure pyrophyllite near Stroud's Pond in the southern part of Burin Peninsula, Newfoundland; a deposit near Ashcroft, British Columbia; and three deposits in the Kyuquot Sound area, 200 miles northwest of Victoria, British Columbia. The Vancouver Island deposits were worked on a limited scale in the early part of this century.

Trade and markets

Most talc and soapstone produced in Canada is consumed domestically while all pyrophyllite produced is exported. Imported talc, most of it from the United States, is high-quality, high-value material suitable for use in the paint, ceramics, paper and cosmetic industries. Production of these superior grades of talc in Canada began in 1970 with the new beneficiation techniques incorporated into Baker Talc's mill and, in 1971, a product acceptable to the pulp and paper industry was marketed. It is anticipated that imported high-quality talc will soon be displaced to some extent in other industries by this domestic product. Imports in 1974 amounted to 39,957 tons valued at $2,552,000; up nearly 7,000 tons from 1973. Of this, 39,625 tons were imported from the United States and the remainder predominantly from Italy. Average value of imports in 1974 was $64 a ton, while domestic production sells in the range of $10–75 a ton, depending upon quality.

Table 2. Production and trade, 1965-74

	Production[1]			
	Talc and Soapstone	Pyrophyllite[2]	Total[3]	Imports Talc
	(short tons)			
1965	22,703	30,134	52,837	27,858
1966	29,596	40,548	70,144	24,918
1967	..	..	60,665	26,487
1968	..	..	80,589	28,244
1969	..	..	75,850	34,910
1970	..	..	72,055	33,068
1971	..	..	65,562	33,752
1972	..	..	80,946	40,505
1973	..	..	81,495	33,033
1974^p	..	..	93,000	39,957

Source: Statistics Canada.
[1] Producers' shipments; [2] Producers' shipments of pyrophyllite, all exported; [3] From 1967, breakdown of producers' shipments not available for publication.
^{p} Preliminary; .. Not available.

Table 3. World production of talc, soapstone, and pyrophyllite, 1972-74

	1972	1973^p	1974^e
	(short tons)		
Japan	1,661,114	1,723,550	1,700,000
United States	1,107,404	1,246,534	1,250,000
U.S.S.R.	430,000	440,000	500,000
France	250,548	285,363	300,000
South Korea	259,867	348,257	..
India	209,189	228,344	..
Finland	99,568	120,928	150,000
Italy	163,607	161,539	150,000
People's Republic of China	165,000	165,000	..
Brazil	143,000	143,000	..
North Korea	110,000	120,000	..
Austria	91,725	101,638	..
Canada	80,946	81,495	..
Norway	85,000	85,000	..
Romania	63,000	66,000	..
Australia	61,891	62,000	..
Other countries	258,891	259,028	1,700,000
Total	5,240,750	5,637,676	5,750,000

Sources: U.S. Bureau of Mines, *Minerals Yearbook*, Preprint 1973. U.S. Bureau of Mines, Commodity Data Summaries, January 1975, Statistics Canada.
^{p} Preliminary. ^{e} Estimated. .. Not available.

Uses

Talc is used mostly in a fine-ground state although soapstone is used in massive or block form. There are many industrial applications for ground talc, but major consumption is limited to less than a dozen industries.

Talc is used as a filler material in the manufacture of high-quality paper where it aids in dehydration of the pulp, improves sizing characteristics, reduces the tendency of papers to yellow and assures a well-bonded surface to promote ease of printing. For use in the paper industry, talc must be free of chemically active compounds such as carbonates, iron minerals and manganese; have a high reflectance; possess high retention characteristics in the pulp; and be free of abrasive impurities. Micronized material provides a high-gloss finish on coated papers.

The ceramic industry utilizes very finely ground talc to increase the translucence and toughness of the finished product and aid in promoting crack-free glazing. For use in ceramics, talc must be low in iron, manganese and other impurities which would discolour the fired product.

High-quality talc is used as an extender pigment in paints. Specifications for a talc pigment, as established in ASTM Designation D605-69, relate to the chemical composition, colour, particle size, oil absorption and consistency of, and dispersion in, a talc-vehicle system. A low content of carbonates, a nearly white colour, a fine particle size with controlled particle size distribution and a specific oil absorption are important. However, because of the variety of paints, precise specifications for talc pigments are generally based on agreement between consumer and supplier. Paint characteristics influenced by the use of talc as an extender are gloss, adhesion, flow, hardness and hiding power.

Talc is well known for its use in pharmaceutical preparations and cosmetics. It is the major ingredient in face, baby and body powders. Finely ground, high-purity material is used as a filler in tablets and as an additive in medical pastes, creams and soaps. Material used for these purposes should be free of deleterious chemical compounds, abrasive impurities and fibrous minerals such as tremolite and asbestos, which are believed to be injurious to health when inhaled or ingested.

Lower-grade talc is used as a dusting agent for asphalt roofing and gypsum board; as a filler in dry-wall sealing compounds; as a filler material in floor tiles; in asphalt pipeline enamels; in auto-body patching compounds; as a carrier for insecticides; and as a filler or dusting compound in the manufacture of rubber products.

Other applications for talc include use in cleaning compounds, polishes, electrical cable coating, plastic products, foundry facings, adhesives, linoleum, textiles, and in the food industry.

Particle-size specifications for most uses require the talc to be minus 325 mesh. The paint industry demands from 99.8 to 100 per cent minus 325 mesh. For rubber, ceramics, insecticides and pipeline enamels, 95 per cent minus 325 mesh is usual. In the wall-tile industry 90 per cent minus 325 mesh is generally required. For roofing grades the specification is about minus 80 mesh with a maximum of 30 to 40 per cent minus 200 mesh.

Soapstone has now only very limited use as a refractory brick or block but, because of its softness and resistance to heat, it is still used by metalworkers as marking crayons. The ease with which it can be carved makes it an excellent artistic medium.

Pyrophyllite can be ground and used in much the same way as talc, but at present, the use of the Canadian material is confined to ceramic tile. It must be minus 325 mesh and contain a minimum of quartz and sericite, which are common impurities.

World review

Deposits of talc are widely distributed throughout the world, but have been commercially developed only in the more industrialized countries. Because talc is of relatively low unit value, only a very small proportion of world production is traded internationally. The majority of international trade takes place within Europe, in the Far East between Japan, the People's Republic of China and Korea, and in North America between Canada and the United States. However, talc of exceptional purity is able to withstand the cost of transportation over much greater distances. For example, high-grade French, Italian, Indian and Chinese talcs are shipped throughout the world.

Prices

United States talc prices according to Oil, Paint and Drug Reporter, December 31, 1974.

	($ per ton)
Canadian	
Ground, bags, carlot, fob mines	20 – 35.00
Vermont	
Domestic, ordinary, off-colour, ground, bags, carlot, fob works	22.25
California	
Domestic, ordinary off-colour, bags, carlot, fob works	34 – 39.50
New York	
Domestic fibrous ground bags	35.50

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
		(%)	(%)	(%)
71100-3	Talc or soapstone	10	15	10
71100-8	Micronized talc	free	5	free
29655-1	Pyrophyllite (expires 30-6-84)	free	free	25
29645-1	Talc for use in manufacturing of ceramic tile (expires 30-6-84)	free	free	25
29646-1	Talc for use in manufacture of pottery (expires 30-6-84)	free	free	25

United States

Talc, steatite, soapstone

Item No.		
523.31	Crude and not ground	0.02¢ per lb
523.33	Ground, washed, powdered, or pulverized	6%
523.35	Cut or sawed, or in blanks, crayons, cubes, disks, or other forms	0.2¢ per lb
523.37	All other, not provided for	12%

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975) TC Publication 706.

Tin

G.S. BARRY

Tin is one of the few metals that Canada imports in large quantities. Domestic production is small and exported in the form of concentrates to the U.S.A. and offshore smelters, mainly in the United Kingdom and Mexico. Mine production is not sufficient to support a domestic smelter.

Canadian production in 1974 of tin in concentrates and lead tin alloy was 475 tons*, valued at $1,222,000.

Canadian industrial requirements of tin are met mainly by imports that totalled 5,556 tons in 1974, valued at $42,370,000.

Canada also imports small quantities of tinplates (less than 1 per cent of domestic production), mainly from the United States. Tin metal scrap and tinplate scrap is mainly exported to the United States, as facilities for secondary metal processing in Canada are very limited. Tin-bearing secondary solders are recovered in a few plants, for example, Federated Genco Limited at its Scarborough plant, Toronto. These are mainly melted away from products such as car radiators and pipes, and are re-constituted as solders. Statistics on the amounts recovered, however, are not available.

M & T Products of Canada Limited, Hamilton, Ontario recovers a secondary tin product by de-tinning industrial and municipal scrap. The product is potassium stannate, used mainly in electroplating applications. An equivalent of 120 to 140 tons of tin is thus recovered annually.

Traditionally, Malaysia was the main supplier of Canadian requirements of tin (e.g. 64 per cent in 1973) but this pattern changed in 1974, with the United States becoming the main supplier of 62 per cent of Canadian imports. Besides the switch of USA– Malaysia roles, Brazil became a new supplier, (9 per cent – 1974); the United Kingdom also shipped larger amounts than in the previous three years, whereas the People's Republic of China fell much below levels established in the previous two years. Increased imports from the United States are temporary phenomena and are directly linked to larger stockpile disposals and lower price levels on the North American market, that throughout much of 1974 tended to lag behind escalating world prices.

Until the end of 1973, Cominco Ltd. was the only mine producer of tin, recovering cassiterite (SnO_2) as a byproduct from milling lead – zinc ores at Kimberly, British Columbia. This company's annual output is between 100 and 150 tons, and prospects for any increases are nil. Mining is moving away from moderatly tin-bearing, base metal sulphides, and it is possible that production now will be lower than historically.

Besides the concentrates at Kimberly, Cominco recovers a lead – tin alloy from the treatment of lead bullion dross in the indium circuit of its Trail smelter. The company also produces, from purchased commercial-grade metal, small quantities of Tadanac brand high-purity tin (99.9999 per cent) and special research grade (99.999 per cent).

An important new producer is Ecstall Mining Limited, a subsidiary of Texasgulf Inc. The company completed construction of a tin-circuit at its base metal concentrator at Timmins in the spring of 1974. This $5.5 million installation was designed to recover approximately 1,600,000 pounds of tin annually, but recoveries during 1974 were below expectation and production targets were not reached. During the year the company concentrated mainly in achieving grade levels to an originally-established target of about 54 per cent tin. This higher grade level was almost achieved by year end, but at the expense of overall recovery. Consideration was lately given to the production of low grade concentrates, with consequent recovery improvement.

Fine-grained cassiterite is a mineralogical component of sulphide ores of several Canadian mines but cannot be economically recovered, except at the Sullivan mine of Cominco and the Kidd Creek mine of Ecstall, mentioned above. Ore grades at these mines are between 0.15 and 0.25 per cent SnO_2. Tin is present in small quantities in the zinc – lead ore-bodies of Brunswick Mining and Smelting Corporation Limited, New Brunswick and in the South Bay mine, Ontario, of Selco Mining Corporation Limited.

Brunswick Tin Mines Limited, a subsidiary of the Sullivan Mining Group Ltd., continued exploration and metallurgical testing on its multimineral deposit in southwestern New Brunswick. Reserves for the Fire Tower Zone reported in 1973 are 29.5 million

* Metric tons (2,205 pounds) are used throughout.

tons, with an average grade of 1.20 per cent tungsten, 0.09 per cent molybdenum, 0.08 per cent bismuth, 0.04 per cent tin, 0.07 per cent copper, 0.35 per cent zinc, 0.08 per cent lead, 4 per cent fluorspar and about one ounce of indium per ton. In addition, diamond drilling completed in 1973 on the North Zone, a little more than half a mile north of the Fire Tower deposit, indicated over 1,000,000 tons grading approximately 0.5 per cent tin, with higher grade in deeper holes. Additional work on the property, and metallurgical testing during 1974, allowed the company to remain optimistic about mining prospects of this property. A decision could be made during 1975; however, it is quite likely that if a production decision is reached initial mining will mainly concentrate in the bismuth and tungsten-rich zones, and tin may not even be a by-product at this stage of operations.

The principal use of tin in Canada, accounting for over 50 per cent of the total consumption, is in the production of tinplate. There are two producers: Dominion Foundries and Steel, Limited (Dofasco) and The Steel Company of Canada, Limited (Stelco), both at Hamilton, Ontario. Canadian output of tinplate is all electrolytic; hot-dip production ceased in 1966. It is estimated that in 1972 approximately 2,504 tons of tin were used to produce 483,700 tons of tinplate; in 1973, approximately 2,819 tons to produce 552,606 tons, and in 1974 approximately 2,975 tons to produce 585,300 tons, which indicates that further economies were made by the application of thinner coatings of tin.

Dofasco and Stelco each operate three electrolytic tinplate lines. Stelco's third line, with a capacity of 175,000 tons of tinplate a year, was commissioned in November 1971. It can be converted to produce steel with other types of coatings, notably chrome-coated steel. Dofasco's third line is also dual purpose, and was commissioned in March 1972. It doubled the company's tinplate manufacturing capacity.

The second largest use for tin is in the manufacture of solders. Between 1,800 and 2,000 tons of tin

Table 1. Canada, tin production, imports and consumption 1973-74

	1973		1974p	
	(metric tons)	($)	(metric tons)	($)
Production				
Tin content of tin concentrates and lead-tin alloys	132	569,890	475	1,222,000
Imports				
Blocks, pigs, bars				
United States	1,020	4,805,000	3,459	26,697,000
Malaysia	3,483	14,972,000	818	5,876,000
Brazil	20	98,000	528	4,140,000
United Kingdom	22	124,000	212	1,696,000
People's Republic of China	500	2,081,000	190	1,261,000
Netherlands	285	1,149,000	111	975,000
Australia	73	338,000	108	913,000
Switzerland	–	–	50	432,000
Other countries	62	252,000	80	380,000
Total	5,465	23,819,000	5,556	42,370,000
Tinplate				
United States	2,187	599,000	3,486	1,395,000
United Kingdom	159	84,000	174	136,000
Japan	–	–	22	11,000
Total	2,346	683,000	3,682	1,542,000
Tin, fabricated materials, nes				
United States	121	349,000	111	571,000
West Germany	–	–	5	52,000
United Kingdom	4	9,000	8	16,000
Austria	–	–	5	14,000
Total	125	358,000	129	653,000

Table 1 (concl'd)

	1973		1974^p	
	(metric tons)	($)	(metric tons)	($)
Exports				
Tin in ores, concentrates and scrap				
United States	171	15,000	205	929,000
United Kingdom	103	234,000	165	315,000
Mexico	47	90,000	113	305,000
Other countries	–	–	103	186,000
Total	321	339,000	586	1,735,000
Tinplate scrap				
United States	7,052	253,000	7,437	663,000
Spain	–	–	802	100,000
United Kingdom	–	–	125	48,000
Other countries	–	–	229	88,000
Total	7,052	253,000	8,593	899,000
Consumption				
Tinplate and tinning	2,897		3,189	
Solder	1,818		1,735	
Babbit	187		238	
Bronze	214		185	
Other uses (including collapsible containers, foil, etc.)	119		78	
Total	5,235		5,425	

Source: Statistics Canada.
^{p} Preliminary; — Nil; nes Not elsewhere specified.

are used annually for this product. Important Canadian users of unmanufactured tin for this application are The Canada Metal Company, Limited, Federated Genco Limited, Kester Solder Company of Canada Limited, Toronto Refiners and Smelters Limited, Tonolli Company of Canada Ltd., Metals & Alloys Company Limited, and Cramco Alloy Sales Limited. Bronze, a copper – zinc – tin alloy, is also produced in Canada, chiefly by The Noranda Copper Mills Limited and Anaconda Canada Limited.

World developments

More than 75 per cent of the world tin mine output is derived from alluvial deposits by dredging and hydraulic mining methods. Leading countries in this field are Malaysia, Thailand, Indonesia and Nigeria. Lode mines account for most of the tin output of Bolivia, Australia, Britain and South Africa. Some 12 other countries of the western world produce small amounts. Countries of the communist and Socialist Blocs, notably The People's Republic of China and the U.S.S.R. are also important producers. Statistics from these states are not available but their total production is estimated in the range of 36,000 tons per year.

Total non-communist world output of tin-in-concentrates in 1974 was estimated by the International Tin Council at 182,000 tons. The addition of about 36,000 tons for the Eastern Block would indicate an overall world production of approximately 218,000 tons. The writer surmises that final mine production statistics may be slightly lower at about 215,000 tons.

Concentrating processes for alluvial and most lode tin are chiefly based on relatively simple gravity separation methods that produce concentrates ranging from 50 to 76 per cent tin. Typical concentrates as delivered, for example, to Indonesia's Mentok smelter in 1974 graded 65 to 72 per cent tin. Lode mining companies in Australia, South Africa and Britain have recently installed flotation cells in their beneficiating plants to complement gravity separation and improve the recovery of other metals, as well as some very fine tin. Another trend now being implemented is split production of a high grade concentrate and a low grade concentrate. By producing some low grade concentrates of approximately 30 per cent tin, an overall improvement in recovery is achieved that may

Table 2. Canada, tin metal production, exports, imports and consumption, 1964-74

Year	Production[1]	Exports[2]	Imports[3]	Consumption[4] Recorded	Consumption[4] Unrecorded
		(metric tons)			
1964	160	334	4,927	4,899	
1965	171	219	5,073	4,910	
1966	322	342	4,322	5,052	
1967	198	331	4,621	4,889	
1968	163	119	4,369	4,319	
1969	131	313^e	5,024	4,349	450
1970	120	272^e	5,111	4,554	500
1971	144	296^e	5,104	4,056	800
1972	160	379^e	5,906	4,760	700
1973	132	127^e	5,465	5,235	100
1974^p	475	550^e	5,556	5,425	50

Source: Statistics Canada.
[1] Tin content of tin concentrates shipped, plus tin content of lead-tin alloys produced. [2] Tin in ores and concentrates and tin scrap, and after 1969 also re-exported primary tin. [3] Tin metal. [4] Consumption — officially unrecorded, includes consumer stock changes.
^{p} Preliminary; ^{e} Estimated.

compensate for the substantially higher smelting charges which must be incurred.

Malaysia, the largest world tin producer, had a production of tin-in-concentrates of 68,122 tons in 1974, compared to 72,260 tons produced in 1973. This is the third consecutive annual decrease in production from a peak of 76,830 tons achieved in 1972. The record Malaysian production was 79,400 tons in 1941. At the end of 1974 Malaysia recorded production from 1,025 mining units, which included 56 dredges and 932 gravel pump operations. Dredges account for 32 per cent of production and gravel pumps for 54 per cent. The labour force was 44,050, an increase from 41,744 in 1973. Thus more people were employed to produce less tin from more mining operations as the average of ore mined decreased. Declining ore reserves to replace deposits now being worked out, combined with cost escalation and high taxation, do not augur well for the immediate future. Government officials like to point solely to a direct relationship between the lack of incentives for investment and the price of tin, which may be an oversimplification of the problems involved. In the long term, Malaysia is still predicting it will maintain a dominant role as tin supplier, pointing to two new potential sources: offshore mining, and deep-seated alluvial deposits. The latter would require the construction of a new generation of deep dredges. One promising new area is in the Kuala Langat forest reserve, mooted to become in the future Malaysia's second Kinta Valley. The State government is considering partnership ventures with an objective of building three large dredges each costing some 20 million Malaysian dollars. The objective is to have the first dredge operational by mid-1976. The presence of offshore deposits was established off the west coast of Malaysia, particularly in the States of Perak and off the Malacca coast. Detailed exploratory drilling programs were instituted in 1974 and it is expected that significant offshore mining will become a reality in the early 1980s. Malaysia has two tin smelters that jointly produced 84,394 tons of tin in 1974 from domestic and imported ores, compared to 82,468 tons in 1973. Syarikat Eastern Smelting has a 45,000 tpy smelter in Penang and the Straits Trading Co. Ltd. has one of 45,000 tpy at Butterworth.

Bolivia is the largest producer of tin from lode mines. A small proportion of annual output is derived from dredging operations. For 1974, Bolivia's mine production is estimated at 29,553 tons, of which 21,849 tons were exported for smelting, mainly to Europe and the United States. In addition, the country's Vinto smelter commissioned in January 1971 by Empressa Nacionale de Fundiciones (ENAF), produced 7,042 tons, operating near its initial rated capacity of 7,500 tpy. An agreement with the West German government for the financing of the next stage of the Vinto smelter has been reached. Klockner-Humbolt Deutz Ag of Germany, the designer of the first stage, will first make a "small extension" of some 4,000 tons to be completed before the end of 1975 at a cost originally estimated at U.S. $5.5 million. The third stage

Table 3. Price ranges in tin agreements

Period of operation	Floor Price	Sector Lower	Sector Middle	Sector Upper	Ceiling Price
			(£/long ton)		
1 July 1956–22 Mar. 1957	640	640–720	720–800	800–880	880
22 Mar. 1957–12 Jan. 1962	730	730–780	780–830	830–880	880
12 Jan. 1962– 4 Dec. 1963	790	790–850	850–910	910–965	965
4 Dec. 1963–12 Nov. 1964	850	850–900	900–950	950–1000	1000
12 Nov. 1964– 6 July 1966	1000	1000–1050	1050–1150	1150–1200	1200
6 July 1966–22 Nov. 1967	1100	1100–1200	1200–1300	1300–1400	1400
22 Nov. 1967–16 Jan. 1968	1283	1283–1400	1400–1516	1516–1633	1633
16 Jan. 1968– 2 Jan. 1970	1280	1280–1400	1400–1515	1515–1630	1630
			(£/metric ton)		
2 Jan. 1970–21 Oct. 1970	1260	1260–1380	1380–1490	1490–1605	1605
21 Oct. 1970–4 July 1972	1350	1350–1460	1460–1540	1540–1650	1650
			(M$/picul)		
4 July 1972–21 Sept. 1973	583	583–633	633–668	668–718	718
21 Sept. 1973–30 May 1974	635	635–675	675–720	720–760	760
30 May 1974–31 Jan. 1975	850	850–940	940–1010	1010–1050	1050
31 Jan 1975–	900	900–980	980–1040	1040–1100	1100

In the light of changes in exchange rates occasioned by the "floating" of the £ Sterling, the price range has been expressed in terms of the ex-works price of tin on the Penang market in Malaysian dollars per picul since 4 July 1972.

final expansion to a total annual capacity of 20,000 tons will be completed in early 1977 at an estimated cost of U.S. $19.8 million. Bolivia, as well as Malaysia, is also experiencing major problems in recovery and beneficiation. Concentrates produced grade 20 to 60 per cent, with recoveries that range from less than 50 per cent to 72 per cent. Most of the low-grade concentrates are now smelted by Copper Pass & Son at the North Ferriby plant in Britain, Metallgesellschaft Berzelius smelter in West Germany, and the Texas City smelter in the United States. Beside the Vinto smelter expansion, Bolivia's main priority in the mineral field, therefore, is the upgrading of low grade ores and concentrates. The U.S.S.R. originally proposed the installation of volatilization plants of Soviet design and was reported to have granted a $6.4 million 10 – year credit for a plant at Potosi, to be completed in 1976. The mill heads at Potosi apparently grade 0.80 per cent tin. It will be upgraded in a preconcentrator plant to 3–3.5 per cent, will then go to the volatilization plant which will upgrade it to 50 per cent, and the product will be sent to the Vinto plant for smelting. The main advantage is an expected increase in recovery from 50–60 per cent to more than 90 per cent. Future volatilization plants will also process low-grade tailings, upgrading this material to about 50 per cent tin, which is suitable for smelting. It was subsequently reported in December 1974 that ENAF has accepted a joint presentation prepared by Klockner-Humbolt Deutz, with the co-operation of a Danish firm and Machino Export of the U.S.S.R., for the construction of the low-grade smelting plant to be started in early 1976 and completed in 1977 at a cost of $15 million.

Table 4. Estimated world[1] production of tin-in-concentrates, 1964,1973-74

	1964	1973	1974
		(metric tons)	
Malaysia	60,967	72,260	68,122
Bolivia	24,587	28,568	29,553
Indonesia	16,607	22,492	25,023
Thailand	15,847	20,921	20,339
Australia	3,700	10,632	9,960
Nigeria	8,861	5,828	5,455
Republic of Zaire	6,596	5,442	4,750
Total, including countries not listed	149,562	185,300	182,000

Source: International Tin Council, Statistical Bulletin.
[1] Excludes countries with centrally planned economies, except Czechoslovakia, Poland and Hungary; The People's Republic of China and U.S.S.R. are large tin producers.

The annual capacity would be 10,000 tons. Bolivia continues to be successful in outlining additional reserves in most of its mining districts. It was reported in 1974 that one of the richest new lodes was found in the large Caracoles mine which will allow for a 30 per cent increase in the mining rate.

Table 5. Estimated world[1] production of primary tin metal, 1964, 1973-74

	1964	1973	1974
	(metric tons)		
Malaysia	72,496	82,468	84,394
Thailand	–	22,927	19,827
Indonesia	1,385	14,632	15,065
United Kingdom	17,119	20,404	12,085
Bolivia	3,669	7,038	7,042
Australia	3,069	6,904	6,714
Spain	1,802	4,257	6,160
U.S.A.	3,963	4,600	6,000
Nigeria	8,888	5,983	5,574
Brazil	1,158	4,433	4,848
Belgium	5,546	3,669	3,418
Republic of South Africa	1,034	1,800	2,000
West Germany	1,197	1,038	1,384
Total, including countries not listed	143,263	184,800	178,900

Source: International Tin Council, Statistical Bulletin.
[1] Excludes countries with centrally planned economies, except Czechoslovakia, Poland and Hungary.
— Nil.

Indonesia pursued an aggressive program of expansion of the tin industry, with mine output increasing for the year 1974 by 11.2 per cent to 25,023 tons, and metal output increasing from 14,632 tons in 1973 to 15,065 tons in 1974. The country has an objective to reach a mine output of 27,000 to 29,000 tons by 1980 and to have 80 to 100 per cent of it smelted domestically. The Indonesia State Tin Enterprise, P.N. Timah, continued the expansion of the Peltim smelter with a target for completion in 1975, at which time the total theoretical capacity will be 33,000 tons. The Peltim smelter was commissioned in 1967 with a designed capacity of 25,000 tons per year, but achieved operational capacity of only 15,000 tons by 1973. Difficulties still persist with the three rotary furnaces, which, along with other problems, are spaced too closely for effective operation. On a long term basis they are not expected to produce much more than 12,000 to 15,000 tons annually. With the addition of three stationary furnaces, each with a capacity of 6,000 tons, it is expected that the Peltim smelter will have an operational capacity of some 33,000 tons per year. Trial runs at the new section will start in the second half of 1975. Tin from the smelter is shipped from the new Mentok Harbour, completed in 1973 to accomodate vessels up to the 19,000 dwt class.

Almost all the Indonesian tin output comes from dredging and hydraulic mining on and off Bangka Island (70.6 per cent), Bilitung Island (21.6 per cent) and Singkeg Island (7.1 per cent). While inshore reserves are substantial, they are being depleted and mining, for instance on Singkep, is expected to end in the next few years. Indonesia's offshore prospects, however, are excellent and a growing proportion of output will be derived from a number of offshore dredges now operating with the "flag-ship" dredge Bangka I (in operation since 1966) and future large dredges now being planned. A decision was made to begin construction in 1975 (completion mid-1977) of Bangka II, a super dredge which will have an effective capacity in excess of 7 million cubic yards per year, more than the current largest-known ocean-going dredge, Thailand's Temco II of 5 million cubic yards capacity. A decision was also made to proceed with construction by 1976 of a third super dredge, Bilitung I, to be completed by 1978. The Broken Hill Proprietary Company Limited, through its subsidiary Broken Hill Indonesia, is completing a 3-1/2 year program leading to a decision regarding production at the once important lode mine of Kelapa Kampit on the Bilitung Island. A decision has been made to start with a pilot plant of 25,000 tpy which would be expanded to 200,000 tpy if warranted. At the Fourth World Conference on Tin in Kuala Lumpur in October 1975 total tin reserves for Indonesia were estimated at: proven, 700,000 tons; indicated and inferred, 200,000 tons; conditional resources, 350,000 tons and hypothetical resources, 300,000 tons.

Thailand. Thailand's tin mining production decreased for the third consecutive year to 20,339 tons in 1974. This decline is expected to continue. Dredging operations account for approximately 33 per cent, and gravel pumps and hydraulic mining methods, 47 per cent of output. Thailand also recorded output from several small lode mines. Thailand's land-based reserves are declining. A 1973 government report placed total reserves at 1,000,000 tons of tin content, which is slightly higher than Thailand's total production between 1907 and 1973.

Australia. Australia is the fifth largest producer of tin in the non-communist world and production in 1974 was estimated at 10,035 tons, including 72 tons contained in other concentrates. The underground operations of Aberfoyle, Cleveland and Renison mines in Tasmania, and the Ardlethan mine in New South Wales, accounted for about 70 per cent of the total production. The balance of tin in concentrates produced in 1974 came from sluicing and dredging operations in Western Australia, New South Wales and Queensland. Expansion plans, particularly at Renison mine, will raise the total output of the underground mines to about 10,000 tons by 1976. Production of tin metal at the smelter of Associated Tin Smelters Pty. Alexandria, Queensland, the only smelter in Australia, was 6,714 tons slightly below its capacity of 7,000 tons a year. Australia exports its surplus tin concentrates for smelting, mainly to Malaysia and the United Kingdom.

Nigeria. Tin output in the Federal Republic of Nigeria, now all from alluvial deposits, declined to 5,455 tons in 1974 from 5,828 tons in 1973. As a result, tin metal production at the Makeri smelter at Jos, which treats only domestic concentrates, declined to 5,574 tons, well below the 13,500 ton a year designed capacity. High operating costs were partially offset by the reduction in the royalties payable and increased tin prices. In December all government employees were granted a minimum pay increase of 30 per cent, and this resulted in the tin workers also demanding higher wages.

Higher labour costs in 1975 will accelerate the trend towards increased mechanization in the tin industry. The merger of Bisichi-Jantar (Nigeria) in 1974 was undertaken to lower operational costs and improve efficiency. Investigations of the sub-basalt tin deposits in Benue-Plateau States continued in 1974. Exploratory work also continued at the Liruie tin lode deposit located within Kano State, about 60 miles north of Jos.

Zaire. Production of tin in the Republic of Zaire has declined steadily since 1969. Production of tin-in-concentrates in 1974 was 4,750 tons compared with 5,442 tons in 1973.

Brazil. The Brazilian government has approved a program to develop the nonferrous metal industry to make the country self-sufficient by 1983, the projected rate of tin production being 21,000 tons. Brazil's consumption of tin in 1974 was estimated at 2,680 tons. The country's production for 1974 was 3,814 tons, up from 3,742 tons in 1973. Brazil has two tin smelters which operate partly on imported ores. The 1974 metal production was estimated at 4,848 tons. The tin deposits in the western state of Rondonia are the major source of Brazilian tin production, but the opencast operations in the Nova Roma district in the State of Goias, about 140 miles north of Brazilia, contribute appreciable amounts to Brazil's tin production.

Burma. Burma, currently producing about 600 tons of tin a year, compared with 6,000 tons annually prior to the second World War has begun a planned program of mineral exploration with foreign assistance. The country has received $6.5 million in aid from the United Nations Development Program for the period 1974–78 for a variety of projects, including a geological survey, and onshore and offshore exploration of tin and tungsten deposits.

In April 1974, the West German government agreed to advance an additional loan of $800,000 for the expansion and modernization of the Heinda tin mines in the Northern Shar state. West Germany is also assisting in feasibility studies at the tin and tungsten mines at Hermingyi, South Burma. The U.S.S.R. is cooperating in the development of the Mawchi tin –tungsten lode mine.

The People's Republic of China. China is a significant world producer and exporter of tin. Production has been estimated at 20,000 tons annually. Output is primarily from the lode deposits in the Kuchui district in Yunnan and the placer deposits of the Fuhochung area in Kwangsi. In 1974 China exported about 9,000 tons of tin.

Table 6. Estimated world[1] tin position, 1972-74

	1972	1973	1974
	(metric tons)		
Ore supply			
Production of tin-in-concentrates	195,400	185,300	182,000
Stocks at year's end	9,108	10,289	8,171
Primary metal supply			
Smelter production of tin metal	190,700	184,800	178,900
Net sales to centrally planned countries	..	..	..
Government stockpile sales	367	20,269	23,508
Buffer stock, net bought	5,842	—	—
net sold	—	11,478	859
Commercial stocks at year's end	40,300	37,300	33,500
Primary metal consumption	191,500	212,900	199,200

Source: International Tin Council, Statistical Bulletin.
[1] Excludes countries with centrally planned economies except Czechoslovakia, Poland and Hungary.
.. Not available; — Nil.

Laos. Tin production in Laos in 1974 was estimated at 612 tons, down significantly from the 748 tons produced in 1973. The country has the potential to support an increased tin output but at present production is coming from two open-cast operations. Laos has a communications problem, with no railways and only about half of its roads suitable for all-weather use.

The Republic of South Africa. Production of tin in South Africa in 1974 was 1,490 tons, down from the 2,628 tons produced in 1973. Rooiberg Minerals Development Co., Ltd., the largest producer in South Africa, plans to increase production by expanding output at one of its mines and bringing new mines into production by 1977. South West Africa produced an estimated 700 tons in 1974. Over half of the combined output of the two countries is smelted at Zaaiplaats smelter, near Potgietersrust, and the remainder is exported in concentrates, mainly to Britain.

United Kingdom. The treatment of lower grade ore, power cuts and labour shortage were largely responsible for tin production in the United Kingdom decreasing from 3,573 tons in 1973 to 3,239 tons in 1974. The country produces about 20 per cent of its yearly requirements of tin. The decline in economic activity and escalating costs has led to a marked decline in exploration activity in the Cornwall district. Work continued on bringing the Mount Wellington mine of Cornwall Tin and Mining Corporation into production at a planned rate of 600 tons a day by early 1976 to recover about 1,600 tons to tin metal a year. Geevor Tin Mines Ltd. is to sink a sub-inclined shaft below the deepest level of Geevor mine to develop the Geevor and Levant lodes seaward and in depth, and to facilitate the exploration of unexplored ground beneath the ocean. All tin mine operators in the Cornwall district are faced with sharp increases in operating costs.

United States. Lost River Mining Corporation Limited signed a long term agreement in February 1974 with the Bering Straits Native Corporation of Alaska with respect to land and development rights pertaining to the company's fluorite–tin–tungsten property on the Seward Peninsula. The Bering Straits group has expressed an interest in participating in the financing of the estimated $78 million project and in the mine construction contracts. The agreement also covers environmental protection, native hire and management training, and an option to acquire equity interest in any futures mines. Commencement of construction of this project is dependent on obtaining satisfactory financial arrangements.

The International Tin Agreement

Tin is the only metal for which there is formal cooperation between producer and consumer interests and among governments to rationalize problems of supply and demand and attenuate, to a certain extent, exces-

Table 7. World[1] tin position, 1972-74 (and estimated 1975-76)

	1972	1973	1974	1975^e	1976^e
	(thousands of metric tons)				
Ore supply					
Production of tin-in-concentrates	195.3	185.3	182.1	169.0	180.0
Stocks at year's end	9.1	10.3	8.2	ne	ne
Primary metal supply					
Smelter production of tin metal	190.0	184.7	179.1	166.5	177.0
Net supplies (+) from Sino-Soviet Bloc	0.0	(–)1.9	(+)2.7	(+)11.3	(+)4.5
US Government stockpile sales	0.4	17.6	23.5	ne	ne
Buffer stock sales (+) purchases (–)	(–)5.8	(+)11.5	(–)0.9	ne	ne
Primary metal consumption (I.T.C.)	191.1	212.1	197.9	170.0	190.0
Balance (Metal)	(–)6.5	(+)0.2	(+)6.5	ne	ne
Recorded commercial stocks:					
at year's end	40.3[2]	37.3	33.5	ne	ne
Net addition to market (+)	(+)5.9	(+)3.0	(+)3.8	ne	ne
Apparent change in all stocks (not statistically recorded)	(–)0.6	(+)3.2	(+)10.3	ne	ne

Source: International Tin Council, Statistical Bulletin.
[1] Excludes countries with centrally planned economies except Czechoslovakia, Poland and Hungary. [2] Recorded commercial stocks at year's end of 1971 were 46,200 tons.
ne not estimated.

Note: The World Bureau of Metal Statistics reports slightly different primary consumption as follows: 1972– 187.2; 1973– 205.8; 1974– 193.7

sive price variations. The large mine producers of tin are developing countries with little consumption, and the largest consumers are the major industrial countries. A common interest in market stability in the post-war period led first to a study group and then to the First International Tin Agreement in 1956 under the auspices of the United Nations. The International Tin Council was formed to implement this Agreement.

The First International Tin Agreement was in force from July 1, 1956 to June 30, 1961 and the Second from July 1, 1961 to June 30, 1966. The third and fourth international tin agreements came in force respectively, on July 1, 1966 and on July 1, 1971. The current agreement will expire on June 30, 1976. Negotiations leading to the implementation of the next five-year international agreement will be held in Geneva in May 1975.

The main objective of The International Tin Council is the consideration of short-term problems of supply and demand and pricing. Decisions that affect supply and price, however, are made with regard to long-term trends. Consumer and producer members have an equal number of votes in the governing body, The International Tin Council. Canada is a signatory to the Agreement and, in proportion to its consumption, has 41 out of the total of 1,000 votes allocated to consumers. The 22 consumer members and seven producer members accounted for 63 per cent of recorded world consumption in 1974. The total does not include U.S.S.R. consumption, as its data is not available, even though the U.S.S.R. is a member country. The United States is the main nonmember country among Western consuming countries. Its consumption in 1974 was 53,647 tons.

Producer members are Australia, Boliva, Indonesia, Malaysia, Nigeria, Thailand and The Republic of Zaire. Counted together, producer and consumer members of the Council account for 92.6 per cent of the noncommunist production of tin in concentrate, of which the seven producer members account for 89.6 per cent.

Members of The International Tin Council established a buffer stock which at the beginning of the FourthAgreement had direct financial resources equivalent to about 20,000 tons of tin, but due to continuous increases in the tin price these resources were only equivalent to about 12,500 tons at the end of 1974. In addition, however, to the above, the Council has the authority to borrow on the commercial markets using tin held by the buffer stock as a collateral.

The operation of the stock to which until recently only producer members contributed, is vested in a manager appointed by the Tin Council, and responsible to the Executive Chairman of the Council. The ranges of permissible prices are set by the Tin Council and within this framework the manager of the buffer stock may use discretionary judgment to buy or sell tin metal, but not concentrates, on major markets to modify price fluctuations and ease supply problems.

Council may impose export controls to curtail metal supply if tin in the buffer stock exceeds 10,000 tons and other conditions appear to warrant such action. Financial resources of the buffer stock, until recently wholly the responsibility of the producer members, were significantly bolstered by voluntary contributions from the Netherlands since 1971 and France since 1973 in proportion to their consumption and votes on the Council.

The buffer stock manager operates within price ranges designated as the lower, middle, and upper sector as shown in the accompanying tabulations. Under the first three agreements, the buffer stock manager was directed to buy only in the lowermost sector and sell only in the uppermost sector with no action in the middle sector except under special instruction which was rarely granted. Under the Fourth Agreement, however, the buffer stock operations are more effective since under a much more flexible system the manager was given authority to both buy and sell in the lower and upper sectors as long as he remains a net buyer in the lower sector and a net seller in the upper sector. The manager was also given permission to operate temporarily in the middle sector under special provisions.

Export controls were invoked on a number of occasions. The last control period was from January 19, 1973 to September 30, 1973. Export quotas for the producer members of the International Tin Council are set in proportion to historical export statistics for selected preceding quarters. The export controls are established on a quarterly basis. Once a maximum permissible level is set for a given quarter it cannot be lowered, but controls can be lifted at any time. Controls can be tightened in each successive quarter if market deterioration warrants this action. For each occasion, special full sessions of the International Tin Council must be held. External borrowing is also approved at full sessions of the Council.

On November 14, 1973 the buffer stock manager's operations were restricted by the ITC but the council authorized him to sell tin on the London Metal exchange or any other established market in such quantities as in his opinion would be effective against the market price rising steeply, or would influence the price to fall below the ceiling. The buffer stock manager also had authority to operate in the middle sector of the price range. At the 13th session of the ITC on May 29–30, 1974 the council agreed that restrictions on buffer stock operations should not be renewed and it also withdrew the authorization for the buffer stock manager to operate in its middle sector of the price range. The buffer stock declined from 1,001 tons at the end of 1973 to 142 tons at the end of 1974.

General Service Administration Stockpile

An important stockpile of tin in the world is that held by the United States in its stockpile of Strategic and Critical Materials. This stockpile held about 348,500 long tons of tin in 1962, before disposals of tin, deemed to be in excess of strategic requirements, began. By July 1, 1968, when commercial U.S. stockpile sales were suspended, these stocks were down to 257,524 long tons. Tin sales continued under the program of the United States Agency of International Development (AID) until June of 1973 when commercial sales were resumed.

The stockpile objective was raised on March 28, 1969 from 200,000 to 232,000 long tons. The original tin stockpile authorization was not repealed in 1969 when congress raised the objective to 232,000 long tons, and in August, 1974 the General Service Administration (GSA) officially announced that the extra 32,000 long tons would be available for disposal, increasing the total to 49,897 long tons. Following a general policy decision to reduce drastically U.S. stockpile objectives in all commodities, the strategic reserves objective for tin was reduced to 40,500 long tons on April 16, 1973. The release of the remaining surplus of about 160,000 long tons has to wait for Congressional approval, which ran into major delays. The tin stockpile objective may be revised upwards.

Sales of tin by the GSA from the stockpile in 1973 and 1974 were 19,949 and 23,469 long tons, respectively. Stockpile tin inventory on December 31, 1974 was 207,458 long tons, and authorized disposals at that time were 6,832 tons.

Uses

Tin metal is unequalled as a protective, nontoxic hygienic coating on steel. The manufacture of tinplate represents the largest market for tin. Approximately 85 per cent of tinplate is used by the can-making industry. Available world data indicate that 86,500 tons of tin were used in 1974 for the production of 14.7 million tons of tinplate, compared to 81,800 tons used to produce 13.8 million tons in 1973. The tin coating on steel varies with the product mix of tinplate plants, from 0.25 pounds per base box (5.6 g/m^2) for electrolytic tinplate, up to 1.25 pounds (28 g/m^2) for the hot-dip process. Tinplate is sold by the base box (31,360 square inches).

Tin International reports in its January 1974 issue that at the end of 1973, 110 electrolytic tinning lines were in operation in the world, which include all 27 important producing countries other than the U.S.S.R. and the People's Republic of China. Total finishing capacity is some 21 million tons, of which almost 98 per cent is now electrolytic. Four new electrolytic tinplate producers began commercial operations during 1974.

The technology of can-making is changing, with better and more economic uses being made of coiled tinplate. Other developments include the use of double-reduced tinplate and of jet soldering techniques for can side-seams. A tin coat also imparts an inherent lubricity to tinplate, an important characteristic for the recently introduced deep-drawn and wall-ironed can-making process (D&I). Seamless cans could compete in the beer and beverage can market in which chrome-plated steel (TFS) or aluminum have already acquired a strong foothold, increasingly replacing glass containers. Crown Cork & Seal Corporation in the United States was the first to achieve commercial production of one-piece D&I tinplate cans in 1971; in 1972 American Can Company brought into production a similar line at Edison. In Britain, The Metal Box Company started commercial production of D&I cans in 1973. There is currently no substitute for tinplate in most container applications involving food processing and the expansion of this market will continue, particularly in less developed countries. Despite yearly increases in absolute quantities of containers, the utilization of tin in tinplate has remained static in the past few years mainly because of more economical, thinner application of tin coatings. In the United States the tinplate industry, for example utilized 5.176 kg. of tin per ton of tinplate in 1971, 4,849 kg. in 1972 and 4.504 kg. in 1973. In 1974 the utilization was up slightly to 4.612 kg. per ton of tinplate. This can be compared with the utilization of 5.954 kg. per ton of tinplate for the world average in 1974. While most processed food products are now packed in cans manufactured from electrolytic tinplate, demand for hot-dipped (H.D.) tinplate material for canning highly corrosive foods such as fish remains strong in some countries. In the developed countries, H.D. tinplate is being increasingly replaced by electrolytic, particularly by differential tinplate, which carries a heavier coating on one face than on the other.

After tinplate, solders are the second largest tonnage users of tin; estimated at 24 per cent in the U.S.A., 31 per cent in Japan and 12.5 per cent in West Germany in 1974.

The common solder used, in side seams of tin cans for example, consists of 60 to 70 per cent tin. For soldering galvanized metal (e.g. in the automotive industry) solders with a 50 to 60 per cent tin are commonly used since they possess the best "wetting" characteristics.

Uses for tin solder (60–63 per cent Sn) in the electronic industry are growing rapidly; tin remains unchallenged as the means for interconnecting components, giving utmost reliability. New applications are the mass production of "tailor-made" preforms based on discs and washers punched from foil and the use of a tin – lead powder and flux mixture that fuses when heat is applied. Tin and tin-rich coatings are also widely used to ensure highest solderability.

Soft solders are used to join side seams of cans (2–3 per cent Sn) and as lead-rich body-filling solders (2 per cent Sn) in the automotive industry. Automobile radiator cores are another important application. This market could run into some stiff competition with the announcement by some large European radiator manufacturers that they have solved the problems of mass-producing aluminum radiators. Use of solders in plumbing is important but is not increasing in proportion to gains in the construction industry because of the increased use of PVC (polyvinyl chloride) plastics. In 1974, the average ratio of tin to lead used in solders by the US industry was 1 to 3.5.

The alloy applications of tin have a long tradition. Babbit (usually 50 to 91 per cent tin) and white metal alloys (e.g., 10 to 15 per cent tin and 4 to 12 per cent antimony) are used in bearings and so are aluminum–tin alloys, which have a higher fatigue strength. Newer bearing materials include chromium- and beryllium-inoculated, tin-base alloys offering markedly improved mechanical properties. Copper–tin alloys such as bronze and gunmetal (up to 12 per cent Sn) have an average tin content of about 6 per cent and account for about 7 per cent of the world primary tin consumption; or for about 12,000 tons of primary tin, plus some 28,000 tons of secondary tin. The gunmetals contain copper, tin and zinc and sometimes lead to improved machinability. Bells are still being cast in "bell metal" (77 per cent copper – 23 per cent tin). For example, on January 18, 1975 the eight-ton Liberty Bell was cast by a renowned Dutch firm. It will be shipped to Philadelphia's Independence Hall for United States bicentennial celebrations and then transferred permanently to Washington.

Continuous casting of standard shapes has reduced fabrication cost and caused renewed interest in bronze as an engineering material. A heat-treatable tin–bronze has now been developed, giving added strength.

Titanium–tin alloys bearing 2 to 11 per cent tin are used increasingly in the aerospace industry, especially in supersonic jets. For example, the British–French Concorde aircraft utilize these alloys. Terneplate, an alloy of 80–88 per cent lead and 20–12 per cent tin, has a three-century tradition as a most durable roofing material. It shows signs of revival in the United States. Other applications for terneplate are in automotive oil filters and some fixtures, and in critical body parts, for example the undersides of electric golf carts. A possible future use with large tonnage potential would be as a replacement of copper in radiator cores. A new product introduced by Hoesch in West Germany in 1973 is Galvo-Terne. It is a cold-rolled sheet, electrolytically coated with an 88 per cent lead–12 per cent tin alloy, offering attractions for corrosion-resistant car parts (gasoline tanks). It is resistant to a number of chemicals, suggesting potential uses in chemical plant applications.

Pewter is again becoming popular; for instance, pewter plate and beaker castings commemorated the 1972 Munich Olympics. Modern methods of making pewterware from rolled sheet have recently been introduced. Pewter is pure tin that has been hardened by the addition of copper and antimony; representative compositions range from 91 per cent tin, 2 per cent copper and 7 per cent antimony to 95 per cent tin, 1 per cent copper, and 4 per cent antimony. Lately, the Association of British Pewter Craftsmen drew up plans for guaranteeing a minimum of 90 per cent tin in British pewter articles. Some pewters are lead-free, but many pewters favour the addition of up to 0.5 per cent lead. Total world consumption of tin for the manufacture of pewter is now estimated to approach 5,000 tons a year.

Fusible alloys of tin, bismuth, lead, cadmium and, sometimes, indium are used in safety devices such as heat fuses. Diecasting alloys of tin, antimony and copper have applications in the production of jewellery.

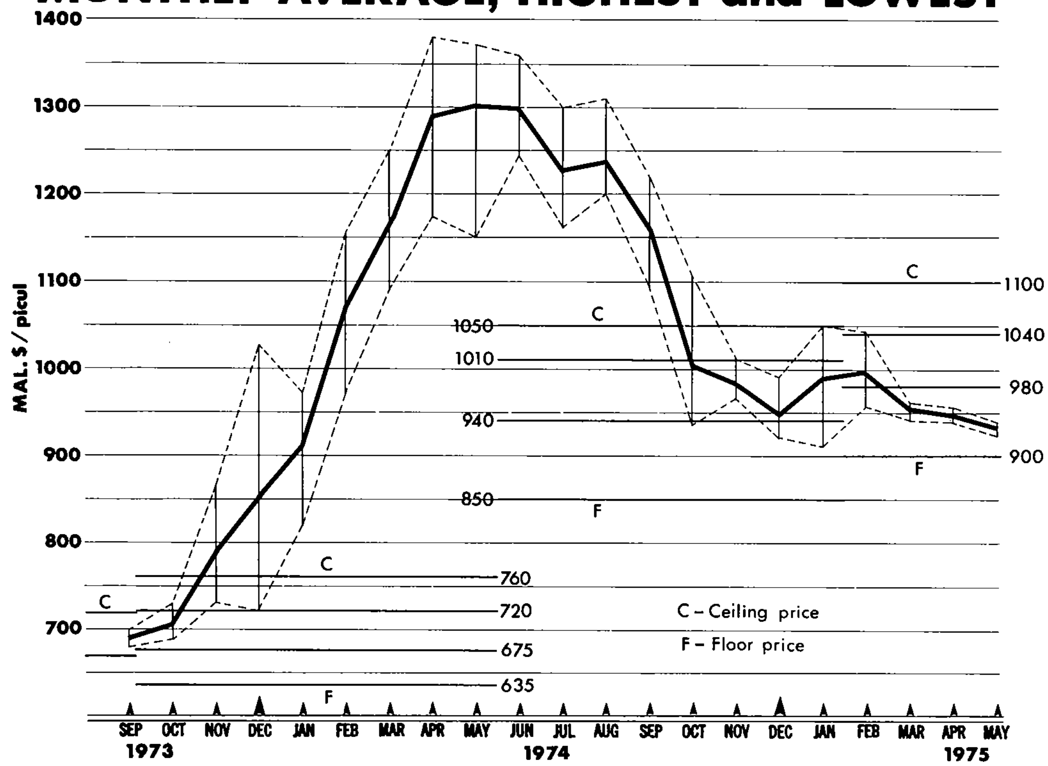
Tin is widely used as a minor alloying agent in other metals; for example, alloy AP (antipollution) bronze is a corrosion-resistant, copper–tin–aluminum alloy for condenser tubes in power stations operating in polluted waters. Tin accounts for 5.5 to 9.0 per cent of this alloy. Tin is a constituent in superconductive alloys such as intermetallic Nb_3Sn. Tin is also used in special protective coatings, particularly as a tin–nickel alloy electroplate which has excellent corrosion resistance, high hardness and the power of retaining an oil film.

Lead–calcium–tin alloys are now being introduced in battery manufacturing, a market long served almost exclusively by antimonial lead. The tin content in this alloy is slightly below one per cent.

A relatively new application is the use of small quantities of tin (approximately 0.1 per cent) in cast iron for engine blocks crankshaft and rear-axle assemblies. Adding tin assures a uniformily hard, wear-resistant and thermally stable perlitic structure in the castings. Current consumption for this usage is estimated at 1,000 tons a year. Tin has also an application in powder metallurgy, primarily for sintered bronze bearings (sealed, self-lubricating). A new application is powder-sintered, bronze-teflon bearings. Tin plus copper is replacing other metallic additions to iron powders to improve the quality of conventional sintered iron alloys, but only a substantial reduction in the price of tin powder could lead to a large market expansion for such products. Some encouragement of this field is provided by recent experiments in West Germany on the use of water-atomized powder produced directly from tinplate scrap.

Pure tin is used in collapsible tubes, especially for pharmaceutical products. Tin is used in conjunction with the manufacture of glass, through the "float process", in which a continuous ribbon of glass floats along the surface of a bath of molten pure tin. The process was introduced by Pilkington Brothers (U.K.) in 1959 and has now completely superceded the plate

TIN PRICE PENANG EX-WORKS: MONTHLY AVERAGE, HIGHEST and LOWEST



Source : International Tin Council

Monthly tin prices in 1974

	London Metal Exchange			New York			Penang		
	Highest	Lowest	Average	Highest	Lowest	Average	Highest	Lowest	Average
	Cash – £ per metric ton			Prompt – ¢ per lb.			Ex-works – M$ per picul		
Jan.	3,085.0	2,642.5	2,930.1	313.5	280.0	298.1	970.6	820.0	910.8
Feb.	3,522.5	3,142.5	3,308.3	383.0	321.8	351.5	1,155.8	975.9	1,072.1
Mar.	3,725.0	3,392.5	3,528.0	406.8	366.5	389.4	1,249.5	1,091.8	1,165.2
Apr.	3,997.5	3,632.5	3,847.1	467.0	408.5	440.8	1,380.0	1,175.0	1,290.6
May	4,040.0	3,545.0	3,855.0	470.0	427.0	456.9	1,370.1	1,150.0	1,302.8
June	3,952.5	3,617.5	3,774.6	473.3	448.0	462.8	1,360.0	1,244.3	1,300.6
July	3,810.0	3,275.0	3,562.6	449.3	412.5	426.6	1,300.0	1,161.0	1,229.4
Aug.	4,012.5	3,547.5	3,739.4	432.0	414.3	422.9	1,310.0	1,200.0	1,238.2
Sept.	4,195.0	3,725.0	3,951.4	434.0	404.5	415.9	1,221.1	1,095.1	1,162.0
Oct.	3,872.5	2,925.0	3,180.5	396.8	347.8	365.3	1,106.4	935.0	1,002.6
Nov.	3,300.0	3,105.0	3,182.0	384.0	365.0	371.0	1,011.0	966.0	983.2
Dec.	3,185.0	3,002.5	3,078.9	366.0	340.8	351.9	990.1	920.0	947.9

Source: Tin International.

process for making high-quality flat glass.

Tin is also marketed as tin oxide for polishing applications; a newer use of tin oxide is in the manufacture of conductive glass and glass resistors.

Tin is used widely in organotin compounds and inorganic tin compounds. Chemicals, however, account for consumption of 5,000 – 10,000 tons, much of which comes from secondary tin. Growth potential from this modest base is excellent. The main uses of organotins are as: dioctyltin stabilizers for PVC; triphenyltin fungicides in agriculture; and tributyltin in industrial biocides and disinfectants. Inorganic compounds stannous chloride and stannous sulphate, as well as sodium stannate and potassium stannate, are used as electrolytes in the tin-plating process. The chloride also stabilizes the colour and perfume of soap. Stannic oxide is an opacifier in enamels. Stannic chloride is a basic chemical in the manufacture of the organotin compounds. Under development is the use of organotin chemicals as biocidal compounds to combat tropical diseases; for example, schistosomiasis (blood flukes) by eliminating the main carrier, the water snail.

Tin chemicals are used as highly efficient catalysts in polyurethane foam technology and in the construction industry, and as catalysts in silicone elastomers, also known as semiplastic sealants; a rapidly expanding application. Organotins have outstanding stabilizing properties for the production of PVC compounds and roofing materials, as well as in the packaging industry.

The high-purity tin produced in Canada by Cominco, 59 grade (5-9's) (99.999 per cent) and 69 grade (6-9's) (99.99 per cent) is used mostly in metallic form in the electronics industry. Some is used to produce semiconductors such as a tin–lead telluride for advanced solid-state radiation detection devices. Tin is reclaimed by M.&T. Products of Canada Limited in the form of potassium stannate and is used directly in electroplating.

Outlook

General economic conditions in early 1975 point in the direction of low consumption of all nonferrous metals. In the past, tin was able to sustain such periods with relatively higher price stability than other metals. Export controls, however, may have to be invoked. Table 7 indicates a rather pessimistic outlook for 1975 but tin should be well on the path to recovery in 1976. An added factor of concern are sales from the People's Republic of China that give signs of increasing. China is not a member of the International Tin Council and is not expected to join, at least not in time for the beginning of the 5th Agreement, commencing in July 1976.

The United States will participate at the negotiating sessions in May 1975 and may be more favourably disposed to membership in the organization than in the past.

At the May negotiating session in Geneva there will be strong pressures for consumer participation in the financing of the buffer stock. Results are hard to predict, but generally higher buffer stock financial resources would decrease the dependance on export controls, stimulate production and thus minimize the chances of reoccuring shortages.

Tariffs

Canada

Item No.		Most Favoured Nation
32900-1	Tin in ores and concentrates	free
33507-1	Tin oxides	15%
33910-1	Collapsible tubes of tin or lead coated with tin	17 1/2%
34200-1	Phosphor tin	7 1/2%
34300-1	Tin in blocks, pigs, bars or granular form	free
34400-1	Tin strip waste and tin foil	free
38203-1	Sheet or strip, iron or steel, corrugated or not, coated with tin	12 1/2%
43220-1	Manufactures of tinplate	17 1/2%

(Tariffs continued on page 532)

Tariffs (concl'd)

United States

Item No.		On or after January 1, 1974
601.48	Tin ore and black oxide of tin	free
608.91	Tinplate and tin-coated sheets, valued at not over 10¢ per pound	8%
608.92	Tinplate and tin-coated sheets, valued at over 10¢ per pound	0.8¢ per lb.
622.02	Unwrought tin other than alloys of tin	free
622.04	Unwrought tin, alloys of tin	free
622.10	Tin waste and scrap	free
622.15	Tin plates, sheets and strips, not clad	6%
622.17	Tin plates, sheets and strips, clad	12%
622.20	Tin wire, not metal-coated or plated	6%
622.22	Tin wire, metal-coated or plated	6%
622.25	Tin bars, rods, angles, shapes and sections	6%
622.40	Tin pipes, tubes and blanks	6%
644.15	Tin foil	17.5%

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Titanium and Titanium Dioxide

MICHEL A. BOUCHER

In 1974, Canada remained the world's premier producer of titania slag, containing 70-72% TiO_2, from the mining of ilmenite ore. Quebec Iron and Titanium Corporation (QIT) is the only titania slag producer in Canada. Approximately 90 per cent of QIT's titania slag is exported to over fifty countries; the remaining 10 per cent is consumed by the two Canadian pigment producers. Canadian Titanium Pigments Limited and Tioxide of Canada Limited are the only two pigment producers in Canada and in 1974 both plants were operating at full capacity.

Estimated world production of ilmenite in 1974 was 3.84 million tons*, compared with 3.89 million tons in 1973. Australia, Canada, United States and Norway produced over 80 per cent of the total. It is estimated that some 353,000 tons of rutile were produced in 1974. Australia accounted for over 95 per cent of the total.

The demand for titanium dioxide was very strong during the year and was reported to be growing faster than announced expansions. In the last quarter, however, demand weakened because of inventory adjustments by major users.

In the United States, the three producers of titanium sponge, namely Timet Division of Titanium Metals Corporation of America, RMI Inc. and Oregon Metallurgical Co. operated at, or near, full capacity. The U.S. annual sponge capacity is estimated at 24,000 tons. In Japan, the two producers of sponge, namely Toro Titanium and Osoka Titanium, operated at near capacity. Inadequate supplies of electric power was the only reason why the plants were not operating at full capacity. The Japanese annual sponge capacity is about 16,000 tons. In Japan, most of the titanium metal is used in the chemical and petrochemical industries whereas in the United States most of the titanium metal is used in the aerospace industry.

Canadian production and developments

QIT mines and processes ilmenite for the production of titania slag used in the manufacture of TiO_2 pigments by the sulphate process. Ilmenite is mined by open-pit methods in the Lac Tio – Lac Allard area of eastern Quebec and is crushed at the minesite to minus 3 inches. The crushed ilmenite is transported 27 miles by rail to the port of Havre-St. Pierre, where it is shipped up the St. Lawrence River to the company's beneficiation plant and smelter at Sorel near Montreal. The crushed ilmenite is upgraded from about 86 per cent to about 93 per cent of combined titanium and iron oxides by means of heavy media separation, spirals and cyclones. The upgraded product is calcined in rotary kilns to lower the sulphur content, cooled, and mixed with powdered anthracite. Electric arc smelting of the calcine – coal mix yields titania slag and molten iron. Pigment-grade slag containing 70 to 72 per cent TiO_2 is in strong demand in world markets.

In 1974, QIT treated 2,223,872 tons of ilmenite to produce 931,168 tons of titania slag valued at $50,133,000; and 619,584 tons of coproduct pig iron valued at $68,832,000. Iron and slag production were a little lower than the previous year because of a failure in the main water supply line to the smelter and because of furnace maintenance problems.

A $15 million program to expand production capacity by five per cent was started in 1974 and is scheduled for completion by mid-1975. In early 1974, QIT acquired an interest in an iron and titanium deposit on the east coast of the Republic of South Africa at Richards Bay. The company has not decided whether or not to build a $300-million processing plant. Pilot plant trials have been conducted with success by a consortium of the Industrial Development Corporation of South Africa, Union Corporation Limited of South Africa and QIT.

There are two companies in Canada that produce pigments. Canadian Titanium Pigments Limited, Varennes, Quebec, increased its plant capacity in 1974 from 30,000 tons of TiO_2 pigment a year to 40,000 tons by improving the operation of its equipment. The other producer of pigments, Tioxide of Canada Limited, at Tracy, Quebec, has a production capacity of 38,000 tons a year. Both plants use the sulphate process, and each plant consumes titania slag containing 70–72 per cent TiO_2 produced by QIT at Sorel, Quebec. These two companies supply the Canadian market for pigments which is estimated at 65,000 tons a year and represents a sales value of about $52 million.

Canada does not produce titanium metal which is

* The net or short ton (2,000 pounds) is used throughout unless otherwise stated.

Table 1. Canada, titanium production and trade, 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Production (shipments)				
Titanium dioxide slag	..	46,619,469	..	51,396,000
Imports				
Titanium dioxide pure				
United States	2,072	1,112,000	2,503	1,600,000
West Germany	1,325	623,000	976	715,000
United Kingdom	1,185	505,000	938	529,000
Belgium and Luxembourg	151	67,000	57	47,000
France	10	5,000	1	1,000
Other countries	1	1,000	—	—
Total	4,744	2,313,000	4,475	2,892,000
Titanium dioxide extended				
United Kingdom	181	91,000	217	130,000
United States	113	48,000	51	51,000
Switzerland	...	1,000	2	8,000
West Germany	125	50,000	6	6,000
Total	419	190,000	276	195,000
Titanium metal				
United States	228	1,734,000	433	4,893,000
United Kingdom	3	40,000	15	410,000
France	3	53,000	3	39,000
Japan	44	261,000	8	37,000
Other countries	...	3,000	...	5,000
Total	278	2,091,000	459	5,384,000
Exports[1] to the United States				
Titanium metal, unwrought, including waste and scrap	120	116,486	142	194,489
Titanium metal, wrought	87	450,075	76	714,623
Titanium dioxide	14,065	6,831,043	7,056	4,783,909

Source: Statistics Canada, except where noted.
[1] U.S. Department of Commerce Imports for Consumption Report F.T. 135; no identifiable classes are available for Canadian export statistics.
p Preliminary; — Nil; .. Not available; ... Less than one ton.

manufactured mostly from rutile. World demand for titanium metal has been growing rapidly in the past few years and, perhaps, with the large quantities of leucoxene and rutile that will soon be available from the exploitation of the Alberta tar sands, (leucoxene is a fine-grained alteration product of ilmenite rich in titanium) Canada may become involved in the production of titanium metal. Companies such as Teledyne Wah Chang Albany of the United States, Noranda Mines Limited and Eldorado Nuclear Limited, both of Canada, have shown much interest in the heavy minerals content of the tar sands.

Canadian Tiron Chemical Corporation is nearing completion of the construction phase of its pilot plant at Pointe-aux-Trembles, Quebec to produce 20,000 tons a year of upgraded ilmenite. The pilot plant is scheduled to commence production in 1976. Ilmenite will be obtained from a high-grade ilmenite – hematite deposit at St. Urbain, northeast of Quebec. The company hopes to produce intermediate titanium

Table 2. Canadian titanium production, trade and consumption, 1965-74

	Production		Imports			Consumption	
	Ilmenite[1]	Titanium Dioxide Slag[2]	Titanium Dioxide Pure	Titanium Dioxide Extended[3]	Total Titanium Dioxide Pigments	Titanium Dioxide Pigments[4]	Ferro-titanium[5]
	(short tons)						
1965	1,318,352	545,888	1,565	9,534	11,099	39,682	65
1966	1,264,704	524,720	1,627	9,774	11,401	43,579	49
1967	1,442,204	602,448	1,616	9,763	11,379	43,447	54
1968	1,619,408	672,896	2,387	9,697	12,084	45,470	22
1969	1,824,144	749,280	2,504	8,651	11,155	47,418	34
1970	2,085,888	844,704	2,781	8,174	10,955	44,412ʳ	27
1971	2,087,008	852,992	5,942ʳ	5,725	11,667	45,990	21
1972	2,258,480	920,416	5,893	1,192	7,085	..	147
1973	2,295,216	942,704	4,744	419	5,163	..	15
1974ᵖ	2,223,872	931,168	4,475	276	4,751	..	..

Sources: Statistics Canada and company reports.
[1] Ore treated at Sorel. [2] Gross weight of 70–72 per cent TiO_2 slag produced. [3] Approximately 35 per cent TiO_2. [4] Includes pure and extended TiO_2 pigments. [5] Ti content.
ᵖ Preliminary; .. Not available; ʳ Revised.

dioxide products grading 90–95 per cent TiO_2 and an unfinished high-grade, anatase grade material grading 98–99 per cent TiO_2. If the pilot project proves successful, the company intends to build a commercial scale plant to produce at least 100,000 tons a year of the above products.

International Titanium Limited, plans to build a plant in Quebec where it will process titaniferous magnetite from a deposit located some 50 miles north of Montreal and make the following products: 99 per cent TiO_2 suitable for direct reduction to titanium metal, a byproduct of super concentrate of magnetite (Fe_3O_4 containing less than 0.5 per cent residual TiO_2); a chemically pure prilled hematite (Fe_2O_3) containing 69.3 per cent Fe; and vanadium pentoxide. The company uses a bulk leach system which works very well with their type of ore and pilot plant tests indicate that it can make a synthetic rutile product of good quality. Negotiations are taking place with both U.S. and European industrial and financial interests to bring the operation into commercial production by the end of 1977 at a rate of 100,000 tons of titanium dioxide and proportionate iron products are now under study.

Trade and consumption

Some 90 per cent of the Canadian production of titania slag is exported, mainly to the United States, Japan and Europe. Between 10 and 20 per cent of the titanium pigment produced in Canada is exported.

Imports of titanium dioxide extended (a product used by the paint industry) decreased considerably in the early 1970s when National Lead Industries Inc. of the United States closed its plant because it could not comply with regulations regarding pollution control.

Imports of titanium dioxide pigments declined in 1974 because of the increased capacities of the two Canadian producers and also because of a stronger demand for pigments in other countries. Imports of titanium metal from the United States increased considerably from $1.7 million in 1973 to $4.9 million in 1974. Wrought titanium alloys represent $2.4 million of the total, and titanium alloys intermediate mill shapes accounted for another $1.5 million.

In Canada, about 65 per cent of titanium pigments is consumed by the paint industry, the remainder is used by the paper, plastic and rubber industries. Most of the ferrotitanium is used by the steel and foundry industries. Other titanium alloys are used by the chemical, petrochemical and nuclear industries where corrosion resistance and resistance to high temperatures are important factors.

Foreign developments

NL Industries, Inc., announced a 25 per cent expansion at its Fredrikstad titanium pigment plant in Norway. The plant at Fredrikstad has a capacity of 20,000 metric tons a year (mtpy); the expansion is scheduled for completion in early 1976. NL Industries also announced a 20,000 mtpy addition to its Nordenham plant in West Germany. Ishibara Sangyo, C. Itoh and Brazilian

Table 3. Titania slag and iron production, Quebec Iron and Titanium Corporation, 1969-74

	Ore Treated	Titania Slag Produced	Iron Produced
		(long tons)	
1969	1,628,700	669,000	496,100
1970	1,862,400	754,200	531,200
1971	1,863,400	761,600	535,300
1972	2,016,500	821,800	572,800
1973	2,049,300	841,700	579,000
1974	1,985,600	831,400	553,200

Source: QIT.

interests report they will develop a titanium dioxide plant in Brazil; the project will also include the mining of ilmenite.

Western Titanium N.L. announced that it will develop its Eneabba heavy-mineral sand deposit in Western Australia. Start up is scheduled for 1976 at a milling rate of 250,000 mtpy of ore, for production of about 30,000 mtpy of rutile, 60–70,000 mtpy of zircon and about 150 mtpy of ilmenite.

Minerals and Canadian deposits

Titanium is the ninth most abundant element in the lithosphere, with an average content of approximately 0.50 per cent. It occurs predominantly in rocks of basic affiliations, especially gabbroic and anorthositic rock complexes. Ilmenite ($FeTiO_3$) and rutile (TiO_2) are usually the only two titanium minerals of economic significance. Ilmenite theoretically contains 52.66 per

Table 4. Salient titanium statistics, United States, 1973-74

	Ilmenite		Rutile		Titanium[1]	
	1973	1974[e]	1973	1974[e]	1973	1974[e]
			(short tons)			
Production	813,000	764,000	9,000	6,000	. .	. .
Imports	307,000[2]	348,000[2]	209,000[2]	194,000[2]	5,645	7,500
Consumption	1,090,000[2]	1,050,000[2]	277,000	280,000	20,173	20,500
Price/pound	. .	. .	. .	. .	$1.42	$2.30
Price/ton	$27[3]	$43[3]	$310[4]	$710[4]	. .	. .

Source: U.S. Bureau of Mines, Commodity Data Summaries, January 1975.
[1] Short tons sponge metal. [2] Includes titania slag from Canada. [3] 54 per cent TiO_2, fob Atlantic seaboard, long ton. [4] fob Atlantic and Great Lakes ports, short ton.
[e] Estimated; . . Not available or not applicable.

Table 5. Consumption of titanium concentrates in the United States, by products, 1973

	Ilmenite[1]		Titania Slag		Rutile	
Product	Gross Weight	Estimated TiO_2 Content	Gross Weight	Estimated TiO_2 Content	Gross Weight	Estimated TiO_2 Content
			(short tons)			
Pigments	795,728	470,087	281,791	199,287	232,969	221,658
Welding-rod coatings	(1)	(1)	—	—	10,635	10,059
Alloys and carbides	(1)	(1)	(2)	(2)	—	—
Miscellaneous[2]	12,005	9,144	—	—	33,303	31,648
Total	807,733	479,231	281,791	199,287	276,907	263,365

Source: U.S. Bureau of Mines, *Minerals Yearbook Preprint, 1973.*
[1] Includes mixed product containing rutile, leucoxene and ilmenite. [2] Includes ceramics, glass fibres and titanium metal.
— Nil; (1) Included with miscellaneous; (2) Included with pigments.

cent TiO_2 and 47.34 per cent iron oxide (FeO). It occurs extensively throughout rocks of igneous origin, but is only concentrated in economic deposits in gabbroic and anorthositic rock complexes where it occurs as massive lenses of ilmenite intergrown with hematite or magnetite. Ilmenite is also found as a heavy mineral constituent in beach or placer deposits, which have been derived from igneous rocks by mechanical disintegration.

Rutile is essentially pure TiO_2 but in nature it may contain up to 10 per cent impurities, mainly iron and vanadium oxides. Rutile is a widespread accessory mineral in many types of igneous, metamorphic and sedimentary rocks, but is only of economic significance when it is concentrated in reworked beach or placer deposits in association with other heavy minerals, especially ilmenite and zircon and, occasionally, cassiterite, columbite and tantalite.

Other titanium minerals such as brookite (TiO_2), anatase (TiO_2), perovskite (Ca TiO_3), sphene (Ca $TiSiO_5$) and leucoxene are often found in many ilmenite or rutile or deposits, but rarely in sufficient concentrations to acquire economic significance.

Commercial grade ilmenite concentrates typically contain between 44 and 60 per cent TiO_2 and rutile concentrates normally average 95 per cent TiO_2

The Canadian Shield, especially that part situated in the province of Quebec, contains many titaniferous deposits. Under existing technology and prevailing economics only the high-grade ilmenite-hematite or ilmenite-magnetite deposits attract widespread exploration activity but, ultimately, the largest potential may lie in the vast low-grade titaniferous magnetite deposits. These deposits have an average content of 20 per cent iron and 5 per cent titanium. Known reserves alone total many billions of tons. However, current production is restricted to one high-grade deposit in the Lac Tio – Lac Allard area of eastern Quebec. The ilmenite deposit is mined by open-pit methods, and constitutes one of the world's largest, with reserves exceeding 100 million tons grading 35 per cent TiO_2 and 40 per cent iron. In addition, the surrounding area has potential reserves of billions of tons of low-grade titaniferous magnetite disseminated throughout the gabbroic-anorthosite massif. The Lac Tio deposit occurs as a high-grade, sill-like structure in which the ilmenite forms intimate intergrowths with hematite. Another high-grade titanium deposit located at St. Urbain, 75 miles northeast of Quebec is expected to come into production in the near future, if titanium markets continue to exhibit their present strength. This deposit is a high-grade, massive dyke-like structure of ilmenite-hematite containing 20 million tons, grading 38 per cent TiO_2 and 40 per cent total iron.

The Energy Resources Conservation Board of Alberta has made an estimate of the mineable Alberta oil sand reserves and based on current technology the Board believes that some 66 x 10^9 tons of oil sand with a solids content of roughly 56 x 10^9 tons will be mined. Although there is some variation in heavy mineralization of the sands, it is believed that the in situ content of the sands is 0.21% Ti and 0.05% Zr. A single plant producing 125,000 bbl/day of synthetic crude oil would have the potential to produce 313,000 tons/yr of TiO_2 and 96,000 tons/yr of ZrO_2 SiO_2 from mining 114 x 10^6 tons/yr of oil sand.

Table 6. Production of ilmenite concentrates by countries, 1972-74

	1972	1973	1974[e]
	(thousands of short tons)		
Canada[1]	920	943	931
Norway	671	804	850
United States	681	804	764
Australia	781	781	743
Finland	165	175	
Malaysia	168	168	
Sri Lanka	91	94	
India	79	79	550
Spain	25	26	
Brazil	4	5	
Japan	6	7	
Portugal	1	1	
Total	3,592	3,887	3,838

Sources: U.S. Bureau of Mines, *Minerals Yearbook Preprint 1973;* U.S. Bureau of Mines Commodity Data Summaries, January 1975; Statistics Canada.
[1] Titania slag containing 70–72 per cent TiO_2.
[e] Estimated.

Table 7. Production of rutile concentrates by countries, 1972-74

	1972	1973	1974[e]
	(short tons)		
Australia	349,899	361,422	340,000
United States	—	—	6,000
India	3,379	3,400	
Sri Lanka	2,800	2,900	7,000
Brazil	454	46	
Total	356,532	367,768	353,000

Sources: U.S. Bureau of Mines, *Minerals Yearbook Preprint 1973;* U.S. Bureau of Mines Commodity Data Summaries, January 1975.
[e] Estimated; — Nil.

Table 8. United States, titanium metal data, 1969-73

	1969	1970	1971	1972	1973	1974[e]
	(short tons)					
Sponge metal						
Imports for consumption	5,745	5,931	2,802	3,808[r]	5,172	6,950
Industry stocks	1,909	2,516	2,724	1,816	1,941	..
Government stocks (DPA inventories)	20,385	19,994	19,994	19,994	18,706	..
Consumption	20,124	16,414	12,145	13,068	20,173	27,500
Scrap metal consumption	7,566	7,242	6,149	7,802	10,038	10,700
Ingot[1]						
Production	28,490	24,331	18,387	20,267	28,932	36,650
Consumption	27,082	23,687	17,058	19,499	25,409	31,400
Net shipments of mill products[2]	15,940	14,480	11,241	12,627	14,530	17,250

Source: U.S. Bureau of Mines, *Minerals Yearbook Preprint 1973.*
[1] Includes alloy constituents. [2] Bureau of the Census and Business and Defence Services Administration, current Industrial Report Series BDCF-263.
[e] Estimated; .. Not available.

Prices

During the year, the price of ilmenite ore was raised from $38.00 a long ton to $55.00. Rutile ore, which was selling at $175.00 a short ton in 1972 and $310.00 in 1973 was increased to $700.00 in 1974. Slag remained at $60.00 a long ton, and U.S. sponge was raised from $1.42 a pound to $2.25. The price of titania slag has not increased since 1973 while rutile prices have increased considerably. If slag producers are to raise financing for future projects prices will have to go up; and it is believed that such price increases will occur in 1975.

Prices in the United States published in Metals Week of December 16, 1974

	(U.S. $)
Titanium ore fob cars Atlantic ports, Great Lake ports	
Rutile, 96% per short ton delivered within 12 months	710.00
Ilmenite, 54% per long ton, shiploads	55.00
Slag, 70% per long ton, fob shipping point	60.00
Titanium metal, sponge, per lb fob mine or mill max. 115 Brinell, 99.3%, 500 lb	2.25
Mill products, per lb delivered, 4,000-lb lots	
Billet, Ti6-AL-4V (8" diam. random lengths)	3.91
Bar, Ti-6AL-4V (2" diam.)	5.76
Ferrotitanium, quoted in Engineering and Mining Journal	
Low carbon, per lb Ti delivered, 25-40% Ti	1.35
Titanium dioxide, Canadian prices, quoted in *Canadian Chemical Processing,* of titanium pigments, effective November 1974.	
Anatase, dry milled, bags, car lots, delivered, East, per 100 pounds	36.00

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
32900-1	Titanium ore	free	free	free
34715-1	Sponge and sponge briquettes, ingots, blooms, slabs, billets, and castings in the rough, of titanium alloys, for use in Canadian manufactures (expires October 31, 1977)	free	free	25%
34735-1	Tubing of titanium or titanium alloys for use in Canadian manufactures (expires February 28, 1977)	free	free	25%
34740-1	Sheet or strip of titanium	free	free	25%
37506-1	Ferrotitanium	free	5%	5%
92825-1	Titanium oxides	free	12½	25%
93207-6	Titanium whites, not including pure titanium dioxide	free	12½%	25%

United States

Item No.		
422.30	Titanium compounds	7.5%
473.70	Titanium dioxide	7.5%
601.51	Titanium ore, including ilmenite, ilmenite sand, rutile and rutile sand	free
607.60	Ferrotitanium and ferrosilicon titanium	5%
629.15	Titanium metal, unwrought, waste and scrap (expires June 30, 1975)	free
629.20	Titanium metal, wrought	18%

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Tungsten

R.F. JOHNSON

In 1974, Canadian shipments of tungsten trioxide (WO_3) were 3,557,600 pounds contained in scheelite concentrates, compared with 5,793,000 pounds in 1973. The drop in production was primarily because of the closure of Canex Placer Limited's mine at Salmo, British Columbia following exhaustion of ore reserves. Canadian demand for tungsten containing products remained high during the year.

Tungsten was in short supply in 1974 and prices rose to a record value of over $100 a short ton unit of WO_3. Inventories of tungsten ores and concentrates around the world were substantially reduced and demand eased in the final quarter of 1974 as accumulated inventories of tungsten containing products were run down.

The outlook for 1975 is not promising. Demand will continue to be weak as the downturn in the world economy continues. Prices should decline through the year to a low of $70–75 a short-ton unit of WO_3. Demand will recover if the predicted general recovery in the world economy in 1976 materializes.

Canada, production and trade

Canadian shipments in 1974 were 3,557,600 pounds of tungstic trioxide (WO_3) in scheelite concentrates, compared with 5,793,000 pounds of WO_3 in scheelite concentrates in 1973. Canada Tungsten Mining Corporation Limited is currently Canada's only producer of tungsten concentrates.

Canada Tungsten is 42 per cent owned by Amax Inc. Canada Tungsten's sales are arranged through another Amax subsidiary, the Tungsten Division of Climax Molybdenum Company, but all sales are subject to approval by Canada Tungsten. In 1971, Canada's major market was Europe, with over 80 per cent of Canadian exports but, in 1973, less than 10 per cent of Canadian exports went to Europe. Currently, the United States constitutes the major market, taking over 70 per cent of Canadian exports, and Japan is the next most important market, taking about 20 per cent of Canadian exports.

Prior to 1973, Canada was also an importer of tungsten concentrates. The principal importer was Macro Division of Kennametal Inc., Canada's only producer of tungsten powders. In 1973, Macro replaced concentrate with tungsten scrap and metal powder as the feed materials, so imports consequently became zero. Canada is a significant importer of tungsten products — ferrotungsten, tungsten powders and tungsten carbide cutting tools. Much of the imported powders originates from parent companies of Canadian operations in the United Kingdom and the United States.

Canada Tungsten's mine and mill are located at Tungsten in the Flat River valley, Northwest Territories. In 1974, Canada Tungsten produced 177,880 short ton units* of tungstic trioxide (stu WO_3) and 163,665 pounds of copper in concentrate. All copper concentrates produced during the year were stockpiled.

In September 1973, Canada Tungsten closed its open-pit operation and began production from a new underground mine in 1974. Because of the climate the open-pit mine was able to operate on a seasonal basis only about six months a year, and ore had to be stockpiled for the year-round operation of the concentrator. Prior to closure of the open-pit mine, some 120,000 tons of ore was stockpiled to supply feed to the mill while the transition to underground mining took place. Some low-grade ore remains in the open pit. The underground mine, which will operate on a year-round basis, cost some $5 million to bring into production. Reserves at the underground mine site were estimated to be 4,436,000 tons averaging 1.63 per cent WO_3 and 0.23 per cent copper on December 31, 1974. The underground ore was considered to have better milling characteristics than the open-pit ore, and Canada Tungsten hoped that the effective capacity of the concentrator would be raised from 500 tons a day to 600 tons a day once ore from the underground mine was treated. However, some separation problems have been encountered with a talc-like material in the ore and recovery of WO_3 dropped to 63.78 per cent in the first quarter of 1975, when underground ore only was treated, from 80.20 per cent in 1973, when ore from the open pit only was treated. Canada Tungsten is investigating means of floating and discarding the talc-like material, and it is expected that recovery will be improved to 75 per cent before year-end. Canada Tungsten produces two types of marketable concentrates. The first is a gravimetric concentrate, which is roasted and leached at Tungsten to reduce impurities, and the second is a flotation concentrate produced at

* A ton unit is 1% of a ton, so a short ton unit (stu) represents 20 pounds. A concentrate containing x% WO_3 would contain x units of WO_3/ton.

Tungsten that is then leached at Vancouver. This flotation concentrate contains about one half calcite and the calcite is removed by leaching with sulphuric acid at Vancouver to upgrade the tungsten content of the concentrate. The recovery problems are being encountered with the flotation concentrate.

Canada Tungsten's production was reduced by strikes in October and November. The labour contract with the United Steelworkers of America expired on October 31, 1974. Two wildcat strikes occurred in October and the mine was closed until a new contract was signed in late November. About one and one half months production was lost.

Brunswick Tin Mines Limited, a subsidiary of the Sullivan Mining Group Ltd., continued metallurgical testing on ores from its Mount Pleasant property, about 40 miles north of St. Andrews in Charlotte County, New Brunswick. The orebody has a complex mineralogy, and ore reserves have been estimated at 30 million tons in the Fire Tower Zone and 12.6 million tons in the North Zone, averaging 0.2 per cent tungsten, 0.08 per cent molybdenum, 0.08 per cent bismuth, about 5 per cent fluorite, 1.0 oz a ton indium and minor amounts of copper, lead, zinc and tin. At the end of 1973, a decline was started to give access to the Fire Tower Zone to obtain a bulk sample for

Table 1. Canada, tungsten production, imports and consumption, 1973-74

	1973		1974p	
	(pounds)	($)	(pounds)	($)
Production[1] (WO_3)	4,640,000	..	3,544,000	..
Imports				
Tungsten in ores and concentrates				
United States	12,000	1,000	—	—
Total	12,000	1,000	—	—
Ferrotungsten[2]				
United Kingdom	172,000	404,000	386,000	1,422,000
United States	..	2,000	24,000	122,000
Total	172,000	406,000	410,000	1,544,000
Metallic carbide tips or blanks				
United States		158,000		226,000
Sweden		50,000		18,000
Others		72,000		20,000
Metallic carbide inserts				
United States		566,000		1,033,000
United Kingdom		92,000		656,000
Others		726,000		797,000
Metallic carbides nonagglomerated				
United States	1,147,000	4,219,000	1,270,300	5,036,000
Sweden	89,100	591,000	181,500	777,000
Others	12,700	69,000	44,200	187,000
Consumption (W content)				
Tungsten metal and metal powder	486,245	..		..
Tungsten wire	27,932	..		..
Other[3]	505,529	..		..
Total	1,019,706	..	..	..

Source: Statistics Canada.
[1] Producers' shipments. [2] Gross weight. [3] Includes tungsten ore, tungsten carbide.
p Preliminary; .. Not available; — Nil.

metallurgical testing and to allow a better delineation of the deposit through underground drilling and sampling. A horizontal heading into the main orebody was completed early in 1975. Bulk samples were sent to the Department of Energy, Mines and Resources for testing. The tests, which should be completed by the fall of 1975, will investigate four possible flow sheets for the treatment of the ores. The samples contain a better than average tungsten content, about 0.3 to 0.4 per cent tungsten. Tungsten will be recovered as a concentrate, part of which, at least, will require leaching to remove associated minerals, and magnetic separation to produce a marketable product. The envisioned production is in the vicinity of 1,500 tons a day which would indicate a production of between 2 and 3 million pounds of tungsten a year. Brunswick Tin and its parent, Sullivan Mining Group, deserve full credit for their perseverance in attempting to develop a very complex orebody. Total expenditures on the deposit since 1967 are about $7 million.

Amax Exploration, Inc., a wholly-owned subsidiary of Amax Inc., reported in 1973 that it had identified a scheelite deposit in the MacMillan pass area, about 240 miles northeast of Whitehorse on the Yukon-Northwest Territories boundary. Amax outlined, by exploration and drilling a deposit with erratic mineralization and wide variation in grade. In excess of 30 million tons, averaging 0.9 per cent WO_3 have been indicated. In 1974, metallurgical and preliminary feasibility studies were conducted on the deposit, but no further exploration work was undertaken. In 1975, studies on the environmental impact will be undertaken; however, no further drilling or exploration is planned for the year.

Canadian consumption

Canadian consumption is either in the form of refined tungsten products or scrap. There is only one producer of intermediate products in Canada, Macro Division of Kennametal Inc. which produces tungsten powders from scrap. In recent years, a number of companies have at one time produced ferrotungsten; however, this has been on a sporadic basis and a ferrotungsten industry per se seems to be an unviable proposition in Canada.

The following are the major consumers of intermediate tungsten products (excluding scrap) in Canada:

Canadian General Electric Company Limited (C, W)
Deloro Stellite Division of Canadian Oxygen Limited (T)
Kennametal of Canada, Limited (C)
A.C. Wickman Limited (C)
GTE Sylvania Canada Limited (W)
Canadian Westinghouse Limited (W)
Atlas Steels Division of Rio Algom Mines Limited (F)
Colt Industries (Canada) Ltd. (F)
Dominion Colour Corporation (P)

C – tungsten carbide powder
T – tungsten metal powder
P – tungsten chemicals
W – tungsten wire
F – ferrotungsten

A number of Canada's major consumers are subsidiaries of companies based elsewhere in the world. Some of these companies receive the intermediate products from the parents or subsidiaries of the parents. This is probably the principal reason why Canada does not produce more intermediate tungsten products.

World developments

World production in ores and concentrates was about 5,230,450 stu of WO_3 in 1974, a decrease of 0.1 per cent from 1973. Mine production is approximately divided equally between communist and noncommunist countries. In recent years, consumption has exceeded production with the difference being supplied by the General Services Administration (GSA) stockpile in the United States; however, several projects scheduled for completion between 1975 and 1977 should alleviate this undersupply situation.

Table 2. Canada, tungsten production, trade and consumption, 1965-74

	Production[1] WO_3 Content	Imports		Consumption W Content
		Tungsten Ore[2]	Ferrotungsten[3]	
	(pounds)			
1965	3,824,660	357,400	354,000	877,614
1966	4,263,927	523,600	192,000	941,207
1967	267,600	233,600	192,000	891,411
1968	3,584,920	131,700	118,000	1,181,541
1969	4,063,488	426,500	210,000	1,050,824
1970	3,726,800	182,200	200,000	984,777
1971	4,624,208	153,300	222,000	639,765
1972	4,447,316	239,900	254,000	1,176,564
1973	4,640,400	12,000	172,000	1,019,706
1974p	3,544,000	—	410,000	. .

Source: Statistics Canada.
[1] Producers' shipments of scheelite (WO_3 content). [2] W content. [3] Gross weight.
pPreliminary. — Nil. . . Not available.

In Turkey, Etibank, the state-owned mining company, will bring a new tungsten mine into production in 1975 at Bursa. Production will be about 3,000 tons a year of concentrate, averaging 65 per cent WO_3. Reserves are estimated to be 13.5 million tons, grading 0.5 per cent WO_3. The mine was initially to be in production by April 1975, however, a fire in the concentrator has delayed the start up until the fall of 1975. A small project in Brazil will produce about 90 tons a year of 70–75 per cent WO_3 concentrate from mine tailings commencing in early 1976. The new company, Brejui Mineraçao e Metalurgia SA, will be 51 per cent owned by Brazilian interests and 49 per cent owned by Japanese interests. Centromin Peru has engaged consultants to conduct a feasibility study for expansion of its La Oroya copper smelter by 17,000 metric tons a year of copper. Tungsten is recovered as a byproduct of copper refining and this planned expansion may lead to additional recoveries of tungsten. In 1977, Wolfram GmbH, a joint venture of Metallgesellschaft AG and Vereinigte Oesterreichische Eisen und Stahlwerke (Voest), will begin production at a new mine near Mittersill in Austria. The production will be converted to either tungsten metal powder or tungsten carbide powder. Production will be in the order of 1,000 tons a year of tungsten contained in tungsten metal or carbide powder.

In the United States, several developments will improve the U.S. supply situation for tungsten. In 1974, Reeves Mining Ltd. started production of tungsten from a former gold-silver property near Austin, Nevada. Production will be in the order of 100 tons a year. Union Carbide Corporation plans to open a new tungsten mine near Alamo, Nevada, in late 1976. Although grade and reserves have not been announced, production will probably be in the range of 2,000 tons a year of WO_3, and mine life in the vicinity of 20 years. The ore will likely be processed at Union Carbide's Pine Creek, California treatment plant. In North Carolina, the Tungsten Queen mine and mill of Ranchers Exploration and Development Corp., which has been on a care-and-maintenance basis in recent years, may reopen in late 1975, depending on market conditions. Yellowstone Mines Ltd. has begun the second phase of a drilling program at its Yellow Hammer tungsten-copper deposit in the Gold Hill area of Utah where production must begin by September 20, 1975 if the company is to retain its development option. A 250-foot length of mineralization, 10-feet wide and 200-feet deep, grading 2–3 per cent WO_3 has been identified. In addition, there is recoverable tungsten in adjacent old workings.

Worman International Ltd., formerly King Island Scheelite Ltd., which produces about two thirds of Australia's tungsten, will change over from open-cut mining to underground mining in 1975. Reserves in the two principal deposits are estimated to be 7 million tons averaging 0.75 per cent WO_3; however, while recovery from the deposit currently being mined is an estimated 90 per cent, the second, and larger, deposit has a different mineralogy and tungsten recovery may be as low as 50 per cent. Another problem encountered with the ore has been a relatively high molybdenum content and investigation of chemical procedures to produce a molybdenum-free scheelite concentrate are nearing completion.

Beralt Tin and Wolfram (Portugal) SARL turned one of its best profits in recent years. Production was

Table 3. Tungsten production in ores and concentrates, 1973-74

	1973	1974
	(thousands of pounds of contained tungsten)	
Europe	22,543	21,900^e
of which		
France	1,532	1,307
Portugal	3,310	3,258
Spain	688	661
U.S.S.R.	16,310^e	16,000^e
North America	11,758	11,900^e
of which		
Canada	3,678	2,810
United States	7,057	7,833
Mexico	674	665^e
South America	8,699	9,450^e
of which		
Bolivia	4,573	5,567
Brazil	2,193	2,250^e
Peru	1,752	1,503
Africa	1,721	1,850^e
Asia	35,586	35,500^e
of which		
People's Republic of China	17,632^e	17,500^e
Democratic People's Republic of Korea	4,750^e	4,800^e
Japan	1,832	1,695
Republic of Korea	4,221	4,805
Thailand	5,735	5,254
Oceania	2,733	2,355^e
of which		
Australia	2,732	2,352
Total	83,040	82,955^e

Sources: Tungsten Statistics July 1975, UNCTAD Committee on Tungsten, and estimates by Mineral Development Sector.
^{e} Estimated.

2,013 tons of wolframite concentrate, and sales were 3,341 tons of concentrates. The sales substantially reduced the company's stockpile, which was the largest in Europe. Since 1972, Beralt has been conducting extensive exploration on the southern portion of its deposit at the Panasqueira mine. Selective development of their better grade tungsten zones has taken place and this has been one of the reasons for the improved financial operating results at Beralt.

The discovery of large tungsten deposits at Khao Soon and Doi Mok in the southern peninsula area of Thailand resulted in a substantial increase in tungsten production. The deposits are being exploited by many small groups and the resulting high waste rates and high grading of the deposit may make more orderly exploitation in the future difficult. Late in 1974, heavy rainfall and subsequent flooding washed out some of these operations; however, mining activity is not believed to have been seriously hampered for more than a few months.

In the U.S.S.R. the Tyrnyauz Mining and Milling Combine is the major mine source of tungsten. Mine production is some 13,000 tons a day of ore averaging 0.2 per cent WO^3 and 0.04 per cent molybdenum sulphide. This indicates a production rate of 14 to 15 million pounds a year of WO^3. Also reported is the discovery of a rich tungsten deposit near Luchegorski and mining of this deposit was to have begun in 1974. In Mongolia, the production capacity of a mine and mill at Burentsogt was doubled with technical assistance being provided by German Democratic Republic (East Germany). In return for this aid, it is believed that East Germany will receive some of the Mongolian production.

In Bolivia, Empressa Nacionale de Fundiciones (ENAF) is studying the feasibility of constructing an ammonium paratungstate (APT) plant. The APT would be exported in preference to concentrate. The study is being done in conjunction with Skoda Export of Czechoslovakia and the plant as envisioned would process about 250 tons a year of tungsten concentrate. In 1975, Bolivia's target is to export some 3,000 tons of tungsten concentrate.

Korea Tungsten Mining Co. (KTMC) is moving into semi-finished tungsten products. Currently, KTMC's production is approximately divided equally between tungsten concentrates and ammonium paratungstate, both of which are exported. KTMC is completing new facilities which include a ferrotungsten plant and a tungsten metal powder and tungsten carbide powder plant in the Dalsong area. Some of these products will be consumed domestically but the bulk will be exported.

In France and Japan, there have been calls for the formation of tungsten stockpiles. In France, $170 million has been set aside to form a strategic stockpile of copper, molybdenum, tungsten and, possibly, some precious metals. No details on tonnage goals have been announced. In Japan, a plan to stockpile 330 tons of ferrotungsten as well as copper, nickel and ferrochromium was killed when the government refused to help finance the stockpile. The General Services Administration (GSA) stockpile in the United States stood at 114 million pounds of which 89 million pounds is available for release. Sales during 1974 amounted to 4.7 million pounds.

Uses

From the viewpoint of consumption, the high price of tungsten ore, its relative shortage, variable supply and concern over world reserves have created a situation in which the general response of consumers has been to minimize tungsten usage where possible. Substitutions or partial substitutions have limited tungsten markets in the past and probably will restrict the growth of tungsten markets, at least, in the near-future. The principal uses of tungsten are in tungsten carbides, tungsten-bearing steels, nonferrous alloys, tungsten mill products and tungsten chemicals.

Tungsten carbide (WC) is one of the hardest materials known. It is produced by chemical combination of tungsten metal powder and finely divided carbon. Cobalt is added as a binder and the material is then compacted to the desired form and sintered to produce the cemented tungsten carbides. The largest end use of cemented tungsten carbides is in cutting tools which includes both mechanically-held and brazed-in-place inserts. Cutting tools are used in machining steel, cast iron and nonferrous metals and in the woodworking and plastics industries as shaping tools. Tantalum, titanium and columbium carbides are frequently added to tungsten carbide-cobalt mixtures to lower the coefficient of friction of the cemented carbides and, thereby, produce grades better suited to the machining of specific products, particularly steel. In the more abrasive applications such as dies for wire and tube drawing, punches and dies for metal forming, bits and tools for drilling equipment and wear-resistant parts, a straight tungsten carbide-cobalt mixture is used almost exclusively. Other uses of tungsten carbide are in tire studs, studs in golf spikes and armour piercing projectiles.

Titanium carbide has been produced commercially in recent years, but on its own, it has not found wide applications. Titanium carbide compositions are extremely brittle and under current technology it seems unlikely that titanium carbide will replace tungsten carbide to a major extent. However, the coating of tungsten carbide tools with 0.0002 inch of titanium carbide enhances their life in machining steel. This development should moderate increased demand for tungsten carbide cutting tools. Ceramics may be substituted for tungsten carbides in applications involving machining with high speeds and light cuts, but ceramics usually lack sufficient toughness and wear resistance despite their higher hardness in the more abrasive applications.

Tungsten carbides should retain the market for abrasive applications; i.e., wear resistant and drilling applications. There will probably be a trend to: use increasing amounts of mixed carbides for cutting tools; coating of tungsten carbide cutting tools to extend their life; and substitution of tungsten carbide in the less abrasive applications by the cheaper ceramics and titanium carbide.

Tungsten is added to steels either as ferrotungsten (80 per cent W), melting base (30–35 per cent W), scheelite ($CaWO_4$) or as tungsten-bearing scrap. The principal tungsten-bearing steels are tool steels. These steels are used in some of the applications of the carbides, but usually in the applications where lower operating temperatures are encountered. Some tungsten is also consumed in certain stainless steels that are used in elevated temperature environments. In addition, tungsten was used in some magnet and die steels that have largely been supplanted by other products.

Tungsten usage in the steel industry has stagnated or declined in most countries because of the availability of lower-cost substitutes. Molybdenum-tungsten tool steels have to a large extent supplanted tungsten tool steels. Molybdenum, while it imparts slightly inferior properties to the steel compared with tungsten, is a lower-cost addition and because of this and its greater availability, molybdenum has been substituted for substantial portions of the tungsten in tool steels. Also, there are competitive stainless steels for the tungsten-bearing stainless steels and the applications will largely determine which are used. At this time, it is probable that the maximum substitution of tungsten has occurred and that tungsten usage will again commence growth in the steel industry, but significant growth will only occur if the price and availability of tungsten are comparable with those of molybdenum.

The most important tungsten-containing alloys are superalloys. The tungsten is added usually in the form of tungsten metal powder, although tungsten scrap can be used to satisfy part of the tungsten requirements. Superalloys, which are used in applications where high strength is required at high temperatures, can be classified into three principal types: nickel base, iron base and cobalt base. At present, the principal usage of tungsten is in the cobalt-base or 'stellite' superalloys. The nickel- and iron-base superalloys currently contain little or no tungsten; however, several companies are developing new alloys that contain several per cent tungsten and should substantially increase the use of tungsten in the nickel- and iron-base superalloys. The expected rapid growth in usage of superalloys combined with a greater usage of tungsten in superalloys should make this an important growth market for tungsten.

The most important properties of tungsten in its metallic form are its high-melting point, low-vapour pressure, high hardness, good electrical conductivity and low coefficient of thermal expansion. Tungsten mill products are made by compressing the tungsten metal powder into the desired shape and then sintering the compressed shape to produce a uniform product. The principal tungsten products produced are rods, wire and flat products.

Discs cut from tungsten rods are used as electrical contacts. Tungsten is used in electrical contacts to furnish improved resistance to heat deformation where sparking and high temperatures occur at electrical contact points. Pure tungsten contacts have found their principal use in ignition circuits of automobiles and aircraft; however, the increased use of electronic ignition systems will decrease usage of tungsten in this application. Tungsten discs are also used as heat sinks in semiconductor applications. Tungsten is also used in combination with other elements in electrical contacts and breakers for industrial applications.

Tungsten wire is used for the filaments in incadescent lamps and for heating elements in fluorescent lamps and vacuum tubes. The use of vacuum tubes is declining, but tungsten wire usage should continue to grow as demand for the different types of lamps grow. The use of tungsten wire in automobile windshields for deicing and defogging is an important new application.

Flat products are used in fabricating parts for electron tubes and radiation shields and in parts for very high-temperature applications in reducing or inert atmospheres.

Among other uses of metallic tungsten, the most important is in heavy metals. Heavy metals are used in areas where counterweights or high-density material are required in limited spaces, e.g., in self-winding watches and in aircraft. Tungsten usage in heavy metals will grow at a slow rate because of the increasing availability and lower cost of depleted uranium, which has only a slightly lower density than tungsten. Steel tubes filled with tungsten carbide powder are used as electrodes in a welding method known as the Tungsten Inert Gas (TIG) method.

Tungsten compounds are used in small volume throughout the chemical industry. The principal end use is as sodium tungstate, phospotungstic acid and phospotungstomolybdic acid in dyes, toners, phorsphors, chemical reagents and corrosion inhibitors. A minor and unpredictable use is as petrochemical and chemical catalysts.

Price stabilization

The United Nations' Committee on Tungsten, which contains representatives of both consuming and producing nations, has been in existence since the early sixties. The Committee has met regularly to discuss problems relating to the tungsten industry. In November 1974, a meeting was held with the major point of discussion being price stabilization policies. No decision was reached at that time and consideration was deferred until the next meeting. In February 1975 at a meeting of the Committee on Commodities, the developing countries expressed dissatisfaction at the slow progress being made toward a price stabilization policy for tungsten. An early meeting of the Committee was called in order to deal further with this problem. In April 1975, Bolivia hosted a meeting of government representatives of ore producing countries to discuss price stabilization policies in an attempt to establish a common front for the upcoming Committee meeting.

In conjunction with this meeting, a meeting of producing companies took place at which a formal producer group consisting of companies only was formed. The members of the group are companies not governments; however, in a number of cases, such as the Republic of Korea and Bolivia, the effect is the same. Representatives from the tungsten mining industries of Australia, Bolivia, France, Peru, Portugal, Republic of Korea and Thailand were the founding members.

In June 1974, the group of producing countries met for the first time. At that time, the producers discussed the necessity of stable economic conditions to encourage exploration for tungsten in order to provide an adequate supply of tungsten. Two decisions were made at the meeting: first, to establish a secretariat and a formal group to provide information and a forum for discussion; and second, to approach the GSA in the United States about a long-term policy to govern stockpile releases. In November, representatives of the companies met again and set out objectives and bylaws for the new organization. In April 1975, the bylaws were formally adopted and a group called the Primary Tungsten Association was formed. Participants at the meeting discussed alternate methods of price stabilization and appointed a working group to examine the various policies. The results of the investigations will be sent to the governments of the member companies in order to help them formulate a statement on price stabilization for presentation at the upcoming United Nations Committee on Tungsten meeting. The company members claim to control 75 per cent of production exclusive of production in the Communist countries and in North America.

Prices

Tungsten prices climbed from about \$45 a short ton unit of WO_3 (stu WO_3) in January 1974 to a peak of about \$104 a stu WO_3 in September and decreased to about \$80 a stu WO_3 by December. Prices strengthened slightly in the first quarter of 1975.

The Canton Fair, at which the People's Republic of China sells, among other goods, tungsten concentrates on a semi-annual basis, has been a major determinant of tungsten prices. The fair, traditionally held in late spring and late fall, places forward tonnages on the market and this, coupled with estimates of demand, usually determine price levels during the year. In addition, the tungsten price usually stabilizes or declines in advance of anticipated sales at the Canton Fair. From March to May 1974, prices almost doubled because of strong demand, small amounts of tungsten sold by the Chinese at the spring fair, and high prices asked by the Chinese at that time. Contrary to tradition, the Chinese offered ore in August for delivery in December 1974 and onwards. This may represent an attempt by the Chinese to spread sales over the year and minimize the short-term effects on prices caused by the Canton Fair. At the fall fair, little or no ore was again available and this helped maintain prices in the face of weakening demand.

In the last quarter of 1974, the trading firms had high-cost inventories of tungsten ore and prices were probably supported to some extent by the traders because of these high-cost inventories. Prices declined from September to December 1974 because of the weakening demand, accumulated stocks of tungsten products, and the anticipation of the delivery of Chinese ore in December 1974. However, the shortage of prompt ore to the European market, the flooding in Thailand and the high-cost inventories of the traders all contributed to the slight increase in prices in the first quarter of 1975. The fire at Turkey's new mine in early 1975 delayed the opening for six months (into the fall of 1975). This will probably raise prices.

Outlook

In 1975, prices should decline during the year as the downturn in the world economy continues. Prices, however, will likely not return to their low levels of previous years in 1975 with a minimum price in the area of \$70–75 an stu WO_3. Prices should recover with the general economic recovery predicted for 1976. In the longer-term, a major determinant of price will be the effect that the newly-formed producer group will have, either as a price-setting group or as a stimulus to the formation of some type of producer-consumer agreement. The creation of a stockpile in France, and possibly other countries, could add more volatility to tungsten pricing if releases are made on the open market.

In the next three to four years, there will be an oversupply of tungsten as the new mines in Turkey, the United States and Austria commence production.

In the medium-term, supply and demand should come into balance as there apparently will be a lull in mine development after 1977. Depletion of reserves at some mines; e.g., Union Carbide Corporation's Bishop, California mine, and the economic viability of some producers, such as King Island Scheelite and Beralt, where they must mine lower grade ores or poorer quality deposits will be important considerations in the long-term and, the latter to a large degree, will depend on the outcome of actions taken by the producer group. The clouded political future of Thailand that may cause disruptions in production is also an important consideration. The relatively low number of deposits of tungsten under investigation at the present time combined with these other factors indicate a shortage of tungsten in the long-term.

Tungsten prices according to Metals Week for December 1973 and 1974

	1973	1974
	(U.S. $)	
Tungsten ore, 65% minimum WO_3, per stu of WO_3		
	effective Dec. 3, 1973	effective Dec. 2, 1974
G.S.A. Domestic, duty excluded	46.928	88.265
G.S.A. Export, duty excluded	47.270	82.149
	effective Dec. 27, 1973	effective Dec. 12, 1974
L.M.B. ore quoted by London Metal Bulletin, cif	44.065-44.590	81.588-85.772
	effective Jan. 2, 1971	effective Nov. 8, 1974
Ferrotungsten, per pound W, fob shipping point, low-molybdenum	4.60	..
Tungsten metal, per pound, cif U.S. ports		
	effective June 1, 1971	
Carbon red, 98.8%, 1,000 pound lots	4.50	..
	effective Oct. 2, 1972	effective June 17, 1974
Hydrogen red, depending on Fisher No. range	4.970-6.740	9.640-11.340

.. Not available.

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
32900-1	Tungsten ores and concentrates	free	free	free
34700-1	Tungsten metal in lumps, powder, ingots, blocks or bars and scrap of tungsten alloy metal	free	free	free
34710-1	Tungsten rod and tungsten wire	free	free	25%
35120-1	Tungsten alloys in powder, pellets, scrap, ingots, sheets, strip, plates, bars, rods, tubing, wire (expires October 31, 1975)	free	free	25%
37506-1	Ferrotungsten	free	5%	5%
37520-1	Tungsten oxide in powder, lumps, briquettes	free	free	5%
82900-1	Tungsten carbide in metal tubes	free	free	free

United States

Item No.		
422.40	Tungsten carbide, on W content	21¢ per lb + 12.5%
422.42	Other tungsten compounds, on W content	21¢ per lb + 10%
601.54	Tungsten ore, on W content	25¢ per lb
607.65	Ferrotungsten, on W content	21¢ per lb + 6%
629.25	Tungsten metal waste and scrap, not over 50% tungsten, on W content	21¢ per lb + 6%
629.26	Tungsten metal waste and scrap, over 50% tungsten, on W content	10.5%
629.28	Tungsten metal, unwrought, other than alloys: lumps, grains, powders, on W content	21¢ per lb + 12.5%
629.29	Tungsten metal, unwrought, other than alloys: ingots and shot	10.5%
629.30	Other unwrought tungsten metal	12.5%
629.32	Unwrought tungsten alloys, not over 50% tungsten, on W content	21¢ per lb + 6%
629.33	Unwrought tungsten alloys, over 50% tungsten	12.5%
629.35	Wrought tungsten metal	12.5%

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Uranium

R.M. WILLIAMS

Uranium was in short supply in 1974 for the first time in almost 20 years, and prices increased sharply from their recent low levels. As surplus inventories became exhausted and excess production capacities became fully committed, existing producers firmed up their plans for expansion and several new developments materialized, notably in Australia, Canada and the United States. These developments will add significantly to world uranium production capacity by the end of the decade. Beyond 1980, the outlook for the uranium industry continued to strengthen as electrical utilities around the world became more firmly committed to the nuclear power option in the wake of the international oil crisis.

Several programs were underway in Canada in 1974 which will more than double production capacity by the end of the decade. All three producers were in various stages of expansion, construction of one new facility was essentially complete at year-end, and planning for a second new operation began. In addition, a feasibility program was initiated at another prospective producing operation, and plans were being prepared to reactivate a past producer. Finally, there were positive signs of a resumption of uranium exploration activity in many areas of Canada.

Canadian producers were particularly successful in the marketplace during 1974, and by year-end had negotiated several significant export contracts, a few extending beyond 1990. In the face of these increasing export commitments, the federal government moved, in late 1974, to protect the needs of Canada's domestic nuclear program by issuing more specific guidelines for the approval of exports of Canadian uranium. Canada's total commitment to nuclear power grew to 14,770 MWe (net electrical megawatts) in 1974, with the confirmation that a 600-MWe CANDU staion will be built at Point Lepreau, New Brunswick. These reactors provide for a firm domestic requirement of 74,000 tons of U_3O_8 *(uranium oxide) over a 30-year period.

Production and development plans

Production of uranium in Canada was down slightly in 1974, with three operations, two at Elliot Lake, Ontario, and one near Uranium City, Saskatchewan, accounting for a total of 4,443 tons of U_3O_8. Shipments, however, totalled 4,795 tons of U_3O_8, some 88 per cent of which were from Elliot Lake.

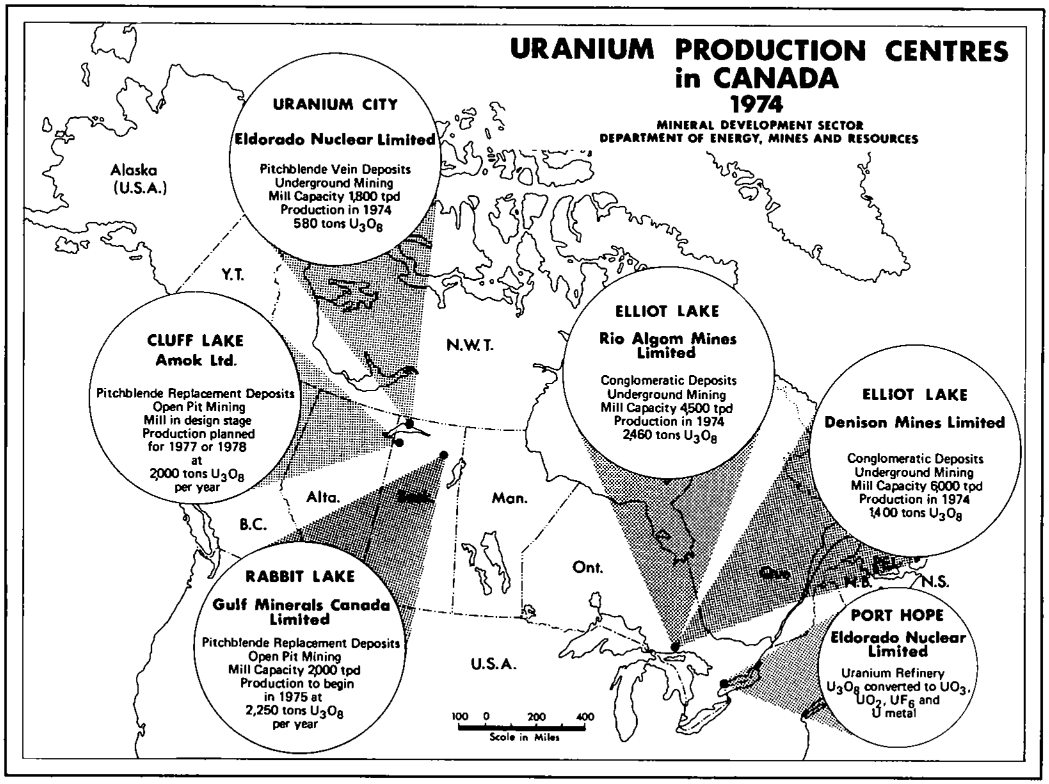
* Short tons used throughout; 1 short ton U_3O_8 = 769.3 kgms uranium metal.

Table 1. Uranium production in Canada, by provinces, 1973-1974

	1973		1974	
	(pounds)	($)	(pounds)	($)
Production (U_3O_8 shipments)				
Ontario	8,114,567	..	8,442,966	..
Saskatchewan	1,402,567	..	1,147,545	..
Total	9,517,134	..	9,590,511	..

Source: Statistics Canada.
.. Not available for publication.

At Elliot Lake, Denison Mines Limited operated its mill at an average of 3,970 tons a day, about 10 per cent below its in-service leaching capacity; a total of 1,290,000 tons of ore was treated with an average grade of 2.33 pounds of U_3O_8 a ton to produce 2,806,593 pounds of U_3O_8, about 18 per cent less than in 1973. The decline in production, while partly due to work interruptions, was also due to planned decreases in the grade of ore mined as part of the company's long-term mining plan. Expansion of the mill to 7,100 tons a day was about 75 per cent completed at year-end, the principal remaining segment being an addition to the boiler plant. While the principal aspect of the company's expansion was the installation of 10 new pachucas in the mill's leaching circuit, modifications to the production shaft's hoisting system were also underway to bring its capacity up to the required level of some 10,000 tons a day (five-day mining week). Underground, work continued on the Roman Island ventilation raise, a 1,750-foot fresh air intake, which will permit a doubling of fresh air volumes from 650,000 cfm to 1.3 million cfm. Also requisite to supplying increased tonnages of ore to the expanded mill, will be the provision of more underground production centres, equipment for which was



tendered early in 1974. In addition, the company was considering various options for a second phase of expansion later in the decade.

Rio Algom Mines Limited, also at Elliot Lake, operated its 4,500-ton-a-day Quirke mill at an average of 4,240 tons a day in 1974. Production, which was about the same as in 1973, continued to come entirely from the New Quirke mine; 1,446,000 tons of ore were treated, with an average mill recovery of 95.3 per cent to produce 4,931,000 pounds of U_3O_8. Average recovered grade remained unchanged at 3.4 pounds U_3O_8 a ton. Plans were finalized for the company's first phase of expansion, for completion by 1978, which will consist primarily of enlarging the Quirke mill to 7,000 tons a day. Also inherent in the expansion is the driving of a decline at New Quirke, in which a conveyor haulage system will be installed to permit the development and mining of the orebody below the eighth level. This project was commenced in 1974 and was scheduled for completion in 1976. Subsequently the company plans to reactivate and expand the Nordic mill, located on the south limb* of the Quirke Syncline, to 7,000 tons a day. In total, tonnage from these two mills is expected to provide an annual output of some 8 million pounds of U_3O_8 a year. The company also indicated that a further phase of expansion was under active consideration which could boost annual output to some 10 million pounds of U_3O_8 a year.

At Agnew Lake, 30 miles west of Sudbury, Ontario, Agnew Lake Mines Limited announced a two-year, $3 million program designed to investigate the feasibility of an "in-situ" mining-leaching method of uranium recovery. Briefly, the method consists of shrinkage stoping and leaching of the run-of mine broken ore in the stopes. Engineering studies of the process have given positive results and the pilot study will permit an assessment to be made of the possibility of using the method for full-scale mining. Near Bancroft, Ontario, consideration was being given by Federal Resources Corp. to reactivating the Faraday uranium mine which operated from 1957 to 1964. A sales contract had been negotiated with an agency of the Italian government, but it had not been approved by the Canadian government at year-end.

* The Nordic deposit, located on the south limb of the Quirke Syncline, is largely within the bounds of four properties, the Nordic, Lacnor and Milliken properties controlled by Rio Algom, and the Stanleigh property controlled by Preston Mines Limited, a sister company of Rio Algom.

In northern Saskatchewan, Eldorado Nuclear Limited completed a sixth year of reduced production, operating its 1,800 ton-a-day mill at less than half capacity. A total of 167,119 tons of ore was treated to produce 1,147,545 pounds of U_3O_8, down some 18 per cent from the amount produced in 1973, due largely to declining ore volumes from the Hab orebody. A gradual increase in output is planned beginning in 1975, with a return to full capacity by about 1979. A number of projects necessary to this planned expansion were either underway or planned for 1975. Development work was proceeding on three new levels from the internal Fay shaft which bottomed in 1973, with first production from these areas expected in 1976. A program of rehabilitation of the Verna mine was initiated in late 1974 with the objective of providing renewed producion in 1977 or 1978. In addition, a program of renovation and upgrading of several sections of the mill, beginning with the grinding circuit, was begun in the fall of 1974. Finally, requisite to Eldorado's ability to attract manpower to its northern location, will be a program to construct some 50 frame houses and install about 25 mobile homes in the company's subdivision in Uranium City over the winter of 1974/75. Some $3.2 million was spent on the latter project in 1974.

In the Wollaston Lake area of northern Saskatchewan, construction of Gulf Minerals Canada Limited's* new 2,000 ton-a-day mill at Rabbit Lake, was essentially complete at year-end. The principal elements of the mill process (Canada's first new uranium mill since the 1950's) will be autogenous grinding, acid-leaching of the uranium, counter-current-decantation for liquid-solid separation, and solvent-extraction for uranium recovery. Particularly significant will be a planned program to test the feasibility of recirculating all waste water. Stripping of the ore body began in the fall of 1974 and mining is scheduled for early 1975. Ore will be stockpiled by grade prior to blending as it is fed to the mill when operation begins in the spring of 1975. Significant to the long-term outlook for the operation was the continuation during 1974 of a major drilling program in the vicinity of Rabbit Lake aimed at outlining additional reserves.

One of the more significant developments in 1974 was an announcement in March that Amok Ltd. intends to proceed to production in 1978, or possibly 1977, at a rate of up to 2,000 tons U_3O_8 a year at its Cluff Lake property in the Carswell dome area of northern Saskatchewan. Since 1967, when an airborne reconnaissance program identified several anomalies in the area, the company has spent over $10 million on detailed geophysical, geochemical, and geological studies including over 250,000 feet of drilling. At the time of the announcement, Amok had outlined reserves of 20,000 tons of U_3O_8 contained in three deposits located in an area of 5,000 acres. All occur in the basement rock or in shales at the contact between the basement and the overlying Athabasca Sandstone Formation; two of the deposits were described as conventional in grade, but the third, which accounts for about one-third of the total reserves, is exceptionally high grade, with complex mineralogy. The deposits are amendable to open pit extraction and detailed planning toward this had begun at year-end. It is expected that the cost of bringing the deposits into production will exceed $50 million. Meanwhile, Amok continued with a broader exploration program covering some 457,000 acres in the Carswell dome area.

* In partnership with Uranerz Canada Limited.

Exploration

There were positive signs during 1974 that uranium exploration in Canada was receiving a high level of priority by an increasing number of companies. Much of renewed activity, however, was still of a preliminary nature at year-end and had not yet led to any large number of promising prospects. The number of exploration permits issued by the Atomic Energy Control Board (AECB) was again low (only five), and several older permits were revoked during the year, leaving only some 60 in force at year-end.

In eastern Canada, one of the more promising regions continues to be the Makkovik-Kaipokok area of eastern Labrador where British Newfoundland Exploration Limited (Brinex) resumed its program of exploration jointly with Metallgesellschaft A.G. of West Germany in the vicinity of its Kitts and Michelin deposits. The company's 1974 program included the reevaluation of both deposits, which together contain an estimated 6,200 tons of U_3O_8, and the examination of other known occurrences in the area. Ownership in any production venture would be shared 60 per cent by Brinex and 40 per cent by Metallgesellschaft. Elsewhere in the Atlantic region, Radex Minerals Limited resumed its research for uranium on the Burin Peninsula of Newfoundland, and BP Canada Limited continued a fairly extensive program of exploration in the Permo-Carboniferous basin of the Maritime Provinces.

Several areas of Quebec were of interest, particularly the region which will eventually be flooded by the James Bay hydro project. At Sakami Lake, The International Nickel Company of Canada, Limited (Inco), together with James Bay Development Corporation (JBDC), continued to investigate a very promising occurrence of uraniferous quartz-pebble conglomerates discovered in 1973. Also, Eldorado entered into a joint-venture exploration program in the James Bay area with JBDC and SERU Nucléaire (Canada) Limitée, a subsidiary of the French Commissariat à l'Energie Atomique. Imperial Oil Limited conducted programs in the Bedard Lake area of Ungava and the Grindstone Lake area near Temiscaming.

Table 2. Uranium production by major producing countries, 1964-74

	Canada	United States	Africa	Other[1]	Australia	France[2]	Total[3]
				(short tons U_3O_8)			
1964	7,285 $83,509,429	11,847	4,445	144	370	2,113	27,204
1965	4,443 $62,361,377	10,442	2,942	179	370	2,210	20,586
1966	3,932 $54,334,787	9,587	3,286	162	330	2,223	19,520
1967	3,738 $53,021,936	9,125	3,214	273	330	2,272	18,952
1968	3,701 $52,284,580	12,570	3,883	289	330	2,234	23,007
1969	3,854 $53,150,657	12,281	3,979	332	330	2,306	23,082
1970	4,104 ..	12,768	4,119	301	330	2,202	23,824
1971	4,107 ..	12,273	4,189	342	115[4]	3,010	24,036
1972	4,881 ..	12,900	4,001	436	—	3,473	25,691
1973	4,759 ..	13,235	3,410	265[e]	—	3,707	25,376
1974	4,795	11,700	3,388	300[e]	—	3,700	23,883

Sources: Statistics Canada; U.S. Bureau of Mines *Minerals Yearbooks;* U.S. Commodity Data Summaries, January 1975 and South African Chamber of Mines.
[1] Includes Argentina, Portugal, Spain and Sweden; [2] Includes Gabon, Malagasy Republic (until 1967) and Niger (from 1970); [3] Totals are of listed figures only. Other countries are known to have produced small quantities of uranium and estimates have been included in totals for year 1964 and earlier in tables of this series in previous reviews; [4] Estimate, production ceased April 1971.
.. Not available for publication; [e] Estimate; — Not available.

Renewed interest was also shown in the Johan Beetz area on the north shore of the St. Lawrence River where Denison, Imperial Oil and others were active, and, finally, interest continued to be shown in the area north of Mont Laurier.

The most active area in Ontario was Elliot Lake where two deep-drilling programs were underway. Kerr-McGee Corporation announced early in the year that it would drill two deep holes on its ground in cooperation with its Japanese partners. Raylloyd Mines & Explorations Limited was completing its second deep hole near Matinenda Lake late in the year. Both companies were investigating the possibility of uranium occurring in conglomerates in westward extensions of the Quirke Lake Syncline. Huronian sediments were also being examined in the Sudbury district by Amax Exploration, Inc., and in the Bancroft area Imperial Oil and others were again evaluating various uranium possibilities in pegmatites.

Saskatchewan was the scene of several projects during 1974. Already mentioned were the continuing major programs of Amok and Gulf in the Carswell dome and Wollaston Lake area, respectively. Numac Oil & Gas Ltd. also continued to be active in both these areas, and Inexco Mining Company, together with Uranerzbergbau GmbH and Co KG, was active on the southeast perimeter of the Athabasca Basin. Three other areas of significant activity were the north shore of Lake Athabasca, the Carrot River area east of Prince Albert, and the Lac La Ronge area in north-central Saskatchewan. In early 1974, Eldorado purchased the uranium properties of Gardex Mines Limited near Uranium City, including the Lake Cinch uranium mine which produced from 1957 to 1960 and shipped ore to the Lorado custom mill. After a period of exploration-development, Eldorado plans to resume shipments from the Lake Cinch property. Several other companies were also active in the Uranium City area, including Imperial Oil, Kintla Explorations Limited, Gulch Mines Inc., and Dejour Mines Limited, all of which were reported to be engaged in drilling programs.

A number of projects were underway in the Carrot River area, largely precipitated by the release, in late 1973, of the results of a joint federal-provincial airborne gammaray spectrometry survey over the region, which indicated some uranium anomalies. Noteworthy participants in this activity were Denison, Rio Algom, Canwex Explorations Ltd., and Sastex Petro-Minerals Ltd. Finally, in the Sandfly Lake area northwest of La Ronge, a number of companies were active, including Brascan Resources Limited, Noranda Mines Limited, Husky Oil Ltd., and the provincially-owned Saskatchewan Mining Development Corp.

Scattered uranium activity was also evident in other areas of Canada. Pan Ocean Oil Ltd. and Dynamic Mining Explorations Ltd., resumed their program in the Baker Lake area, Northwest Territories, Shell Canada Limited was exploring a uranium prospect east of Yellowknife, Rio Algom took an option on Vestor Explorations Ltd.'s uranium properties in the east arm of Great Slave Lake, Consolidated Rexspar Minerals & Chemicals Limited was again examining its Birch Island uranium property in British Columbia, Aggressive Mining Limited was exploring in Northern Alberta, and Lacanex Mining Company Limited was exploring for uranium in Northern Manitoba, jointly with Rayrock Mines Limited and Noranda. Perhaps the most significant aspect of 1974's uranium activity, other than the fact that exploration occurred in literally every province of Canada, was the fact that several company programs were very wide-ranging. Imperial Oil was typical of the more senior companies, being active in at least three areas of Quebec, as well as in Ontario and Saskatchewan. Of the juniors, a good example was Aggressive, being active in Quebec, Ontario and Saskatchewan.

Government initiatives

In January 1974 at a First Ministers' Conference on Energy, the federal government made known its intention of firming up its uranium export policies, particularly as they relate to maintaining adequate reserves and productive capacity for domestic consumption. Specific guidelines related to these aspects were developed and announced in September. Basically they provide for "sufficient uranium to be reserved for domestic use to enable each nuclear power reactor operating, committed for construction or planned for operation ten years into the future, to operate at an average annual capacity factor of 80 per cent for 30 years from the start of the period, or in the case of reactors which are not in operation, for 30 years from their in-service dates."

The more important elements of the policy include the following: Each producer will be allocated a domestic reserve margin based on the ratio of its uranium reserves to the total Canadian reserves, available at prices up to twice the current market price, these reserves to be determined by a uranium resource appraisal group set up within the Department of Energy, Mines and Resources (EMR). Domestic utilities will be required to maintain at least a contracted 15-year forward supply of fuel for operating and committed reactors. Export contracts will be limited to a maximum duration of ten years, with contingent approval for an additional five years. All uranium exported will be processed to the most advanced form possible in Canada. Prices under uranium export contracts will not be more favourable than those for domestic purchasers. The government stockpile* will only be disposed of in the domestic market but, prior to its disposal, will be available on a commercial loan-basis for short-term needs of Canadian producers.

At year-end the federal government announced its decision to require more stringent safeguards in respect to the sale abroad of Canadian nuclear technology, facilities and material, including uranium, thorium, plutonium and heavy water. The safeguards will apply to all future sales as well as to existing contracts, although existing and pending contracts will be allowed to proceed for one full calendar year while new safeguards are being negotiated. Basically, the new provisions go beyond those provided for under the safeguard arrangements administered by the International Atomic Energy Agency (IAEA) under the terms of the Non-Proliferation Treaty, in that they will require binding assurance that Canadian-supplied nuclear material, equipment and technology will not be used to produce a nuclear explosives device, whether the development of such a device is stated to be for peaceful purposes or not.

During 1974, the federal government took several steps to assist industry to expand its efforts in the field of uranium exploration, in line with its commitment made at the First Ministers' Conference in January. As a direct involvement, the government provided the crown company, Eldorado Nuclear Limited, with an initial funding of $15 million to be spent on off-property exploration over a period of five years. Plans were also initiated in EMR to expand programs in the field of uranium resource potential, uranium exploration methods and uranium processing techniques. In addition, in December 1974, provincial Ministers of Mines "agreed in principle with the establishment of a uranium reconnaissance program as proposed by the federal government."

* Following deliveries under contracts to Spain and Japan, announced in 1972 and 1973, respectively, the government stockpile will contain 14.5 million pounds U_3O_8 plus or minus 1.5 million pounds, depending upon delivery options under the contracts.

Several provincial initiatives were taken in 1974 to enter directly in the field of uranium exploration. Already mentioned were projects undertaken by the James Bay Development Corporation to examine the economic potential of areas to be flooded as a result of the James Bay hydro development. Quebec Mining Exploration Company (SOQUEM), a provincial crown company, also stepped up its uranium exploration, either directly or through industry-government consortia. Late in the year, the formation of Ontario Energy Corporation was proposed which would have a broad mandate in the sphere of energy development, including exploration for energy resources. In Saskatchewan, the Saskatchewan Mining Development Corp. was established in mid-1974 with the authority to play an active role in exploration and development of mineral resources in the Precambrian Shield area of northern Saskatchewan. This Corporation is seen as the main instrument in implementing new Saskatchewan policy announced in 1974 which requires government participation (up to 50 per cent) in all new mineral development programs in northern Saskatchewan.

International developments

Uranium exploration activity in the United States increased in 1974 but not to the levels earlier predicted. Due largely to a shortage of drill rigs and logging equipment, exploratory and development drilling fell some 25 per cent short of the projected 29.1 million feet for the year. A number of projects were underway, however, which will add to United States production capability in the near-term.

Early in the year Western Nuclear Inc. announced its intention of doubling the capacity of its mill at Split Rock, Wyoming, from 700 to 1,400 tons a day. A new production shaft was also under development at nearby Crooks Gap. Later in the year, Western Nuclear announced that it was negotiating with the Spokane Tribal Council relative to bringing into production its Sherwood deposit located on the Spokane Indian Reservation in Washington. United Nuclear Corp. announced plans to build a 3,000-ton-a-day mill, beginning in 1975, adjacent to its Church Rock orebody near Ambrosia Lake, New Mexico. Also under consideration by the company was a second shaft at the Church Rock property and the feasibility of a mine and mill complex at its Morton Ranch property in Wyoming. In addition, United Nuclear was involved (89 per cent) in Uranium Recovery Corporation which has obtained a contract in one case, and a letter of intent in another, to enable it to recover uranium from the phosphoric acid production of two fertilizer producers in central Florida. Gulf Minerals announced that it will sink two deep shafts to develop its Mt. Taylor orebody in the Grants district of New Mexico. Finally, Sohio Petroleum Company and Reserve Oil and Minerals Corp. began construction of their 1,000-ton-a-day mill west of Alburquerque, New Mexico, and Kerr-McGee Corporation and Exxon Nuclear Company continued with their shaft-sinking programs in the Powder River Basin of Wyoming.

Particularly noteworthy was Commonwealth Edison Co.'s 100 per cent acquisition of Cotter Corp.'s uranium production operation near Cannon City, Colorado, which has operated at about 450 tons of ore a day since 1958. Another utility, the Tennessee Valley Authority (TVA), acquired 94,000 acres of uranium properties in South Dakota and Wyoming from Susquehanna-Western Inc. as well as the 650 ton-a-day, inactive uranium mill of Mines Development, Inc., near Edgemont, South Dakota. Still another utility, Texas Utilities Fuel Co. (TUFCO), moved to acquire a primary source of uranium by entering a joint venture with Ranchers Exploration and Development Corp., whereby TUFCO will finance 90 per cent of a three-year, $3 million exploration program on 100,000 acres of Ranchers' land in New Mexico. Options provide for continuation of the program for up to seven years, to be financed 85 per cent by TUFCO, with the provision that ownership and development of any discovery would be shared equally.

In Australia, the significant development of the year was the announcement by the Minister of Minerals and Energy in October, that "the Australian Atomic Energy Commission (AAEC) will participate, as agent of the Australian government, in the mining and treatment, and undertake the sale, of the government's uranium located in the Northern Territory and will also undertake all new exploration in the future for uranium in the Territory". Specifically, the first deposits to be developed will be the Ranger deposits, which will be developed jointly by the AAEC and Peko Mines N.L./Electrolytic Zinc Company of Australia Ltd. A mill with a capacity of 3,300 tons of U_3O_8 a year will be built, financed 72 1/2 per cent by the AAEC and 27 1/2 per cent by Peko/EZ. However, Peko/EZ will receive the net proceeds from the sale of 50 per cent of the uranium produced from the deposits. Early duplication of the operation was anticipated.

Initial production from the Ranger deposits will be used to meet existing contracts (approved prior to December 2, 1972) of Peko/EZ and Queensland Mines Limited and future sales will be made on a government-to-government basis by the AAEC. To meet deliveries under these contracts in 1977, prior to commencement of production (which is anticipated in 1978), the AAEC will make available concentrates from its uranium stockpile. The AAEC will sell uranium only to countries that have signed the Non-Proliferation Treaty.

Also pertinent to Australia's near-term production capability was a decision to reactivate the Mary Kathleen Uranium Limited mine in Queensland by early 1976, at a rate of some 1,000 tons of U_3O_8 a year. The move was made possible by AAEC underwriting a share issue which will give the government a reported 42 per cent interest in the project. In addition, it was announced late in the year that the Australian government was in general agreement with production plans for Western Mining Corporation Limited's Yeelirrie deposit in Western Australia.

In Australia's Northern Territory, Queensland Mines announced that it had reached an agreement with the Oenpelli aboriginal people relative to exploitation of the Nabarlek deposit located in the Oenpelli Aboriginal Reserve. However, no response to the agreement had been received from the government at year-end. Late in the year, Pancontinental Mining Ltd. and Getty Oil Company announced an increase in the reserves contained in their Jabiluka deposits, also in the Northern Territory. Indicated reserves in the two deposits were reported to total 74,200 tons U_3O_8, with additional inferred reserves of 40,900 tons U_3O_8. This will increase total Australian reserves beyond the 188,000 ton U_3O_8 figure (reasonably assured resources available at up to $15 (US) per pound U_3O_8) released by the AAEC in mid-1974.

In Africa, two new producers continued to prepare for production, Rossing Uranium Limited in South West Africa (Namibia) and Cie Miniére d'Akouta (COMINAK) in Niger. Spain's Empressa Nacional del Uranio S.A. (ENUSA) took a 10 per cent interest in COMINAK early in the year. Several new exploration efforts were also reported in Africa including a joint-venture of the CEA and Continental Oil Co. of the United States in Niger, and programs in Algeria with West German assistance and in Morocco with Soviet assistance. The latter included a program to examine the feasibility of extracting uranium as a by-product of Morocco's expanding phosphate industry.

Refining and Enrichment

At its Port Hope, Ontario refinery, Eldorado continued with its planned program to enlarge its uranium hexafluoride (UF_6)production capacity. A total of $1 million was spent in 1974 on this program; the planned increase in capacity from 3,200 to 5,000 tons of uranium a year was expected to be completed in 1975 or 1976, as markets permit. Requisite to the expansion program was the installation of a falling-stream sampling facility which was completed in 1974. In addition, the company initiated studies to determine the timing and location of additional conversion capacity which will be required in the future, in line with the federal government's policy to encourage further processing of Canada's uranium prior to export.

Eldorado continued to supply all of the natural ceramic uranium dioxide (UO_2) for Canada's nuclear power program, as well as for the first cores for CANDU reactor exports and more than 1 million pounds of UO_2 were produced during the year. The Company's metallurgical facilities were also active during the year producing enriched uranium zircalloy (U–Zr) for booster fuel for Ontario Hydro's Bruce Nuclear Generating Station, enriched uranium carbide (U–C) for Atomic Energy of Canada Limited's (AECL) Whiteshell reactor, and depleted uranium metal castings for a number of applications, including a large spent-fuel transport cask. In addition, development work continued on other high density fuel materials for the AECL's nuclear power program.

Brinco Limited continued its study, began in 1971, on the possibility of establishing a multinational group to build a uranium enrichment plant in Canada. In July 1974, a second study was announced jointly by James Bay Development Corporation, Canadian Pacific Investments Limited, Cominco Limited and SERU Nucléaire Canada Limitée, a subsidiary of the French Commissariat à l'Energie Atomique. A joint company, CANADIF, was formed to investigate the possibility of utilizing power from Quebec's James Bay hydroelectric project for an enrichment plant based on French gaseous diffusion technology. Neither the Brinco nor the CANADIF study had led, at year-end, to a commitment to undertake a feasibility study.

Markets and Prices

Uranium markets shifted very early in 1974 in favour of producers. Prospective Australian producers were unable to participate in the market due to the Australian government's decision not to approve contracts until after its new energy policy was formulated. France withdrew from the market early in the year, partly due to unsettled situations in countries where its production is located, and partly due to its accelerated domestic nuclear program. Nuclear Fuels Corporation of South Africa (Pty) Ltd. (NUFCOR) also was not very active. The only major non-North American sale announced was one by Rossing Uranium Limited to Tokyo Electric Power Co. Inc. (TEPCO) for 30 million pounds of U_3O_8 over the period 1984 to 1993.

Several major consumers were only partly successful in obtaining responses to rather large offers to purchase. For example, TVA invited bids early in the year in a second attempt to obtain some 86 million pounds of U_3O_8 over the period 1979 to 1990, and Spain's ENUSA sought supplies of some 63.6 million pounds of U_3O_8 over the period 1978 to 1985. The rapid price increases that began in late 1973 continued, but levelled off in the range of $12.50 to $13.50 per pound U_3O_8 for delivery in 1974 and 1975. The concept of future pricing on the basis of the world price at time of delivery seemed to gain in popularity and there were indications that "floor prices" in contracts using this mechanism could escalate from the present $13.00 per pound level to levels in excess of $20.00 per pound by 1980. Important to the world market, but somewhat anticlimactic, was confirmation in October that the United States Atomic Energy Commission's (USAEC) plan to remove restrictions on enrichment

Table 3. Exports of uranium concentrates from Canada, 1964-74

	United States[1]	Britain	West Germany	Japan	France	Total
			(thousands of dollars)			
1964	34,863	39,627	159	4	—	74,653
1965	14,749	38,948	—	—	—	53,697
1966	13,761	22,605	—	—	—	36,366
1967	1,047	22,772	—	55	—	23,874
1968	3	26,064	—	—	—	26,067
1969	477	14,997	5,469	3,564	—	24,507
1970	17,031	8,990	—	—	—	26,021
1971	6,213	11,473	—	1	—	17,687
1972	23,040	17,070	—	—	—	40,110
1973	46,794	17,356	—	—	—	64,150
1974	27,974	22,121	—	—	1,215	51,310

Source: Statistics Canada, exports of radioactive ores and concentrates that cleared customs.
[1] For years 1970 to 1974, almost entirely destined for a third country, following enrichment, primarily West Germany and Japan.
— Nil.

of foreign uranium for domestic use, announced in late 1973, had been approved and would be implemented over the period 1977 to 1984.

Canadian producers were particularly successful in 1974 and by year-end had negotiated a number of new contracts, bringing total commitments made since 1966 to over 135,000 tons U_3O_8, mostly for export to Japan, Britain, Western Europe and the United States. Of this total, more than 17,000 tons had been delivered over the period 1968 to 1974, leaving forward commitments of some 118,000 tons U_3O_8. More than half of these commitments had not been approved by the AECB at year-end, pending implementation of the government's new export guidelines and a review of safeguard provisions to be applied under Canadian nuclear exports.

Although few particulars about the new Canadian contracts were available for publication at year-end, there were several company announcements that deserve recording. First, the Denison-TEPCO agreement, announced in principle in late 1973, was formalized in early 1974, and calls for a total of 40 million pounds of U_3O_8 to be delivered in equal quantities over the period 1984 to 1993. Denison also agreed to sell its 4 million pound U_3O_8 inventory to ENUSA at 1 million pounds a year beginning in 1975. Rio Algom agreed to deliver a total of 20 million pounds U_3O_8 to British Nuclear Fuels Limited (BNFL) over the period 1982 to 1991, also in equal quantities, as well as 20 million pounds U_3O_8 to Duke Power Co. of North Carolina at 2 million pounds a year from 1981 to 1990. In addition, Rio Algom agreed to deliver a total of 17 million pounds U_3O_8 to TVA at the rate of 1 million pounds in each of 1979 and 1980 and 1.5 million pounds a year from 1981 to 1990. Finally, TVA announced that it had purchased 1.2 million pounds of U_3O_8 from Uranerz Canada Limited for delivery from 1982 to 1984.

Nuclear power developments

World* nuclear generating capacity continued to grow in 1974, reaching some 52,600 net electrical megawatts (MWe), a 25 per cent increase over 1973. More significantly, capacity of nuclear plants under construction in 1974 totalled in excess of 135,000 MWe, 2 1/2 times the capacity operating at the end of 1974. For the longer-term, world utilities have placed orders which would increase total world installed capacity to over 350,000 MWe by 1982.

Adding impetus to utility plans for nuclear power were dramatic increases in prices of oil, natural gas and coal which significantly raised the cost of electricity produced from fossil fuels, making nuclear power even more attractive than before. For example, the cost of electricity produced at Ontario Hydro's four-unit 2,032 MWe Pickering Nuclear Generating Station in 1973 was 6.20 mills per kilowatt hour compared with 7.04 mills at its Lambton Generating Station, an equivalent coal-fired plant. By the end of 1974 the comparative figures were 6.34 mills for Pickering and 8.89 mills for Lambton. Costs of electricity from oil-fired stations have increased even more sharply.

Canada's nuclear power program attracted world attention on the basis of the excellent operating performance of the Pickering station. Again in 1974, Pickering produced more electricity than any other nuclear plant in the world. The performance was even more

* Excluding the People's Republic of China.

Table 4. World nuclear power reactors operating and under construction—1974

	Operating	Under Construction
	(Net electrical Megawatts (MWe))*	
Argentina	320	600
Austria	—	700
Belgium	400	3,000
Brazil	—	600
Bulgaria	400	1,200
Canada	2,500	6,300
Czechoslovakia	110	1,500
Finland	—	2,100
France	2,870	19,800
West Germany	3,410	15,300
East Germany	430	400
Hungary	—	900
India	600	900
Italy	610	3,700
Japan	4,470	10,300
Rep. of South Korea	—	600
Netherlands	530	—
Pakistan	120	—
Spain	1,070	5,600
Sweden	440	6,900
Switzerland	1,010	2,000
Taiwan	—	3,100
United Kingdom	5,800	6,500
United States	24,060	37,100
USSR	3,510	5,900
Yugoslavia	—	600
Total	52,660	135,600

* Rounded

Sources: Nuclear Engineering International April, 1975; International Atomic Energy Agency Power And Research Reactors In Member States, 1974 Edition.
— Nil.

remarkable by virtue of the fact that one of the four units was shut down for an extended period for repairs. The repairs were necessitated when cracks were found in the rolled-joint position in a number of fuel channels and it was decided to check all channels. Not only were repairs successfully made but an improved rolled-joint design was effected which will be used on all future CANDU reactors.

Construction continued almost on schedule at Ontario Hydro's Bruce Generating Station, near Kincardine, Ontario, and commissioning of the various systems of the first of four 750 MWe-units continued throughout 1974. First steam to the turbine is now expected in January 1976 rather than September, 1975, as originally scheduled. The 208 MWe Douglas Point Generating Station continued operation in its dual role as a supplier of steam to the Bruce heavy water production plant and of electricity to the Ontario Hydro grid. Also providing electricity to the grid was the 22 MWe Nuclear Power Demonstration Station, at Rolphton, Ontario, which operated at high capacity throughout the year.

Site construction started in 1974 on Ontario Hydro's Pickering B project. This project will be essentially a mirror image of Pickering A, resulting in an 8-unit, 4,064 MWe station by 1982. The utility also authorized Atomic Energy of Canada Limited (AECL) to proceed with preliminary engineering work for Bruce B which will be essentially a duplicate of Bruce A. Although Bruce B had been approved by Ontario Hydro's board of directors, endorsement of the project by the Ontario government was still pending at year-end.

The Quebec Hydro-Electric Commission's (Hydro-Quebec) 250 MWe CANDU-BLW* prototype Gentilly-1 Generating Station was returned to operation in December after being shut down since 1972 due to AECL's shortage of heavy water. In April 1974, the Atomic Energy Control Board (AECB) issued Hydro-Quebec a construction permit for Gentilly-2, a 600 MWe CANDU-PHW. Pouring of concrete for the reactor building base slab followed quickly, and by October 9 the exterior wall of the reactor building had been poured to completion. The wall was poured in only 16 days using the slip-form method of construction; the station is scheduled to be on line in 1979. Both Gentilly-1 and Gentilly-2 will be capable of supplying process steam to the La Prade heavy water plant. (see below)

In March 1974, the New Brunswick government announced that it will build a 600 MWe unit, similar to Gentilly-2, at Point Lepreau on the Bay of Fundy. The New Brunswick Electric Power Commission was given site approval by the AECB late in 1974 and site clearing had begun by year-end. Application for a construction permit was made early in 1975 with construction planned for later in the year. The station will be financed jointly (50 per cent) by the federal government.

Canada's nuclear power program has necessitated the establishment of several heavy water production facilities, the development of which has been discussed in earlier issues of this annual review. During 1974 there were two producing plants, Ontario Hydro's Bruce plant at Kincardine, Ontario, having a capacity of 800 tons of D_2O a year and Canadian General Electric Company Limited's (CGE) plant at Port Hawkesbury, Nova Scotia, having a capacity of 400

* Canadian Deuterium Uranium-Boiling Light Water, in contrast to the Pickering and Bruce reactors which are CANDU-PHW; i.e., Pressurized Heavy Water type.

tons a year. Rehabilitation by AECL of the Deuterium of Canada Limited–Nova Scotia government plant at Glace Bay, Nova Scotia was nearing completion at year-end and production was expected to begin late in 1975 at a rate of 400 tons a year.

Table 5. Forecast[1] of world[2] nuclear power growth.

Year	Low	Medium Range[3]		High
	(10^3 net electrical megawatts installed)			
1975	81	92	92	99
1980	198	242	242	269
1985	521	603	647	695
1990	1050	1255	1280	1475
1995	1700	2127	2187	2560
2000	2450	3220	3330	3950

Source: United States Atomic Energy Commission, WASH 1139 (74).
[1] Assumes commercial breeders in late 1980's. [2] Excludes the People's Republic of China. [3] Lower forecast assumes energy conservation measures in United States.

Site work began in November on the 800-ton-a-year La Prade heavy water production plant, announced in December 1973, to be built by AECL at the Gentilly site near Trois-Rivières, Quebec. Also in 1974, Ontario Hydro announced that the Bruce plant would be enlarged to a total of 3,200 tons of D_2O a year. Finally, federal government authorization was given during the year for AECL to negotiate the purchase of the Port Hawkesbury and Glace Bay plants and negotiations were proceeding at year-end. The production from all plants now operating, under construction and committed will be sufficient to meet expected heavy water needs of both domestic and export reactors until the 1980's.

Since 1972 Canadian supplies of heavy water have been managed through a "heavy water pool agreement" between AECL and Ontario Hydro to ensure that their separate programs will be equitably satisfied. All heavy water produced by either party, as well as that produced from the CGE plant and purchased from foreign sources, is consigned to the pool, which is administered by AECL. During fiscal year 1974-75 the pool purchased some 644 tons of D_2O from Ontario Hydro's Bruce plant; 307 tons from the CGE plant; 82 tons from Sweden and 66 tons from the USSR. The pooling agreement is due to expire on January 1, 1978.

AECL concluded a contract, jointly with Italimpianti of Italy, in December 1973 for the construction of a 600 MWe CANDU-PHW at Rio Tercero in Cordoba, Argentina. Argentina's Comision Nacional de Energia Atomica (CNEA) approved the contract in April 1974, and site construction and ordering of major components continued throughout the year. In addition, during 1974, AECL carried out technical and commercial negotiations with the Korea Electric Company, also for the purchase of a 600 MWe CANDU unit; a commercial agreement was signed in January 1975.

Outlook

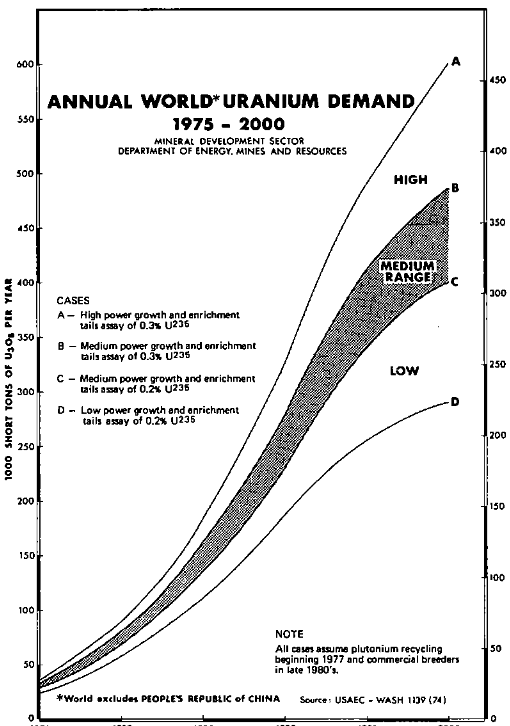
By the end of 1974, electrical utilities around the world had placed orders for over 350,000 MWe of nuclear power generating capacity of which some 188,000 MWe was either operating or under construction. By 1985, total installed capacity is expected to grow to between 500,000 and 700,000 MWe, and by the year 2000

Table 6. Forecast[1] of annual world[2] uranium requirements

Year	Low Range[3]		Medium Range		High Range	
	(10^3 short tons U_3O_8 a year)					
	0.2% U^{235}[4]	0.3% U^{235}	0.2% U^{235}	0.3% U^{235}	0.2% U^{235}	0.3% U^{235}
1975	24.0	28.1	29.6	34.7	30.6	36.0
1980	58.5	69.5	68.5	81.3	76.0	90.4
1985	111.9	133.9	137.1	164.1	156.0	186.6
1990	187.2	225.3	231.2	277.6	271.7	327.0
1995	256.8	310.5	342.2	412.6	406.7	492.3
2000	291.0	353.1	401.4	486.0	495.4	602.6

Source: United States Atomic Energy Commission, WASH 1139 (74).
[1] Assumes plutonium recycling, beginning 1977, and commercial breeders in late 1980's. [2] Excludes the People's Republic of China. [3] Ranges refer essentially to rate of nuclear power growth. [4] Percentages refer to uranium enrichment tails assays.

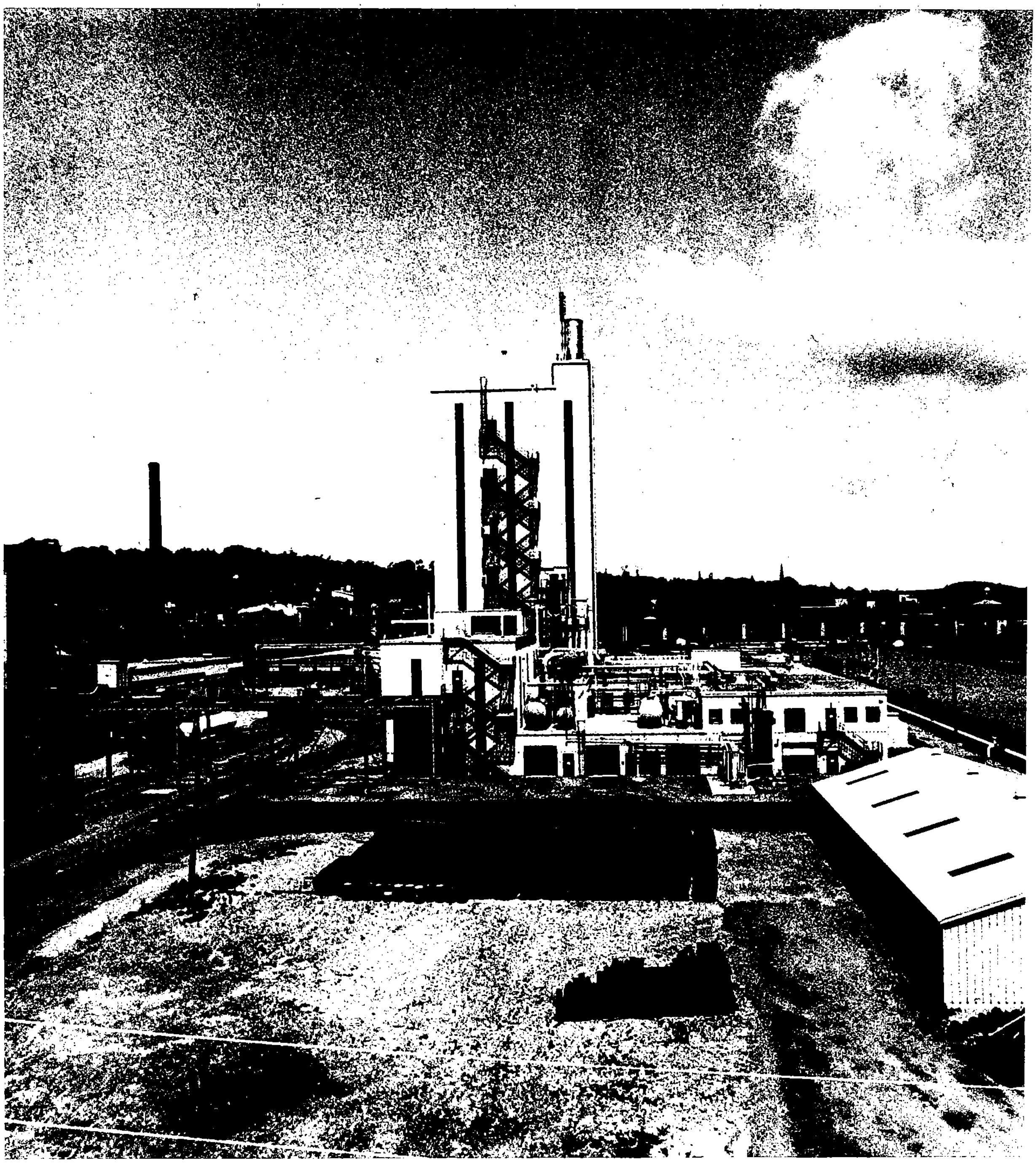
more than half of all electricity generated in the world is expected to be nuclear. Annual requirements for uranium to fuel this capacity will grow rapidly over the next 10 to 15 years, with a rate of increase of some 20 per cent a year, such that by 1985 production levels must reach a range of from 140,000 to 165,000 tons of U_3O_8 a year, assuming a moderate rate of power growth. Beyond 1985, the range of projections widens, depending on a number of factors, the principal of which is the expected rate of electrical power growth. (See Figure 2)



A number of developments occurred in 1974 which, taken individually, could alter this outlook for uranium one way or another but which, on balance, confirm the mid-range of these projections. Positive factors include plans by several countries, particularly France and Japan, to accelerate their nuclear power programs as a result of staggering increases in the cost of fossil fuels; a deteriorating outlook for early solutions to problems besetting the nuclear fuel reprocessing industry, and thus a continued postponement of large scale recycling of plutonium and recovered uranium; the increased possibility of the need to increase operating tails assays of USAEC enrichment plants to offset delays in commitments to new enrichment capacity; and finally, lower-than-expected fuel burn-up experience with presently-operating light water reactors. Factors which offset these pressures to increase uranium requirements include the continued gloomy outlook for public understanding of the environmental impact of nuclear power, continued delays in construction, due to the regulatory and licensing process and also to increased incidence of shortages in equipment and supplies, and finally, the cancellation or postponement of nuclear power projects, particularly in the United States, due largely to the inability of utilities to raise the large amounts of required capital.

On the supply side the picture altered dramatically during 1974 from one of surplus to one of scarcity. Excess inventories and stockpiles, as well as surplus capacity, were virtually fully committed by year-end and prices had responded by returning to more equitable levels. Despite the various projects and plans for new production capacity around the world, annual capability to produce could well fall short of requirements by the turn of the decade. This emphasizes the need for a substantial acceleration in exploratory effort in order to find new deposits to support the additional capacity that will be required in the 1980's. Fortunately there were positive signs of a rejuvenation in exploration activity and, more important, significant examples of initiatives by consumers to participate in this exploration challenge. Hopefully, there will be a continued evolution in methods of financing these efforts in ways that will satisfy the growing aspirations of governments and, at the same time, provide the needed financial incentive to industry, as well as an assurance of supply to any participating consumers.

Canadian uranium production will begin to expand in 1975 and by 1980 a productive capacity of some 14,000 tons of U_3O_8 a year is expected to be in place. This level of production should be sufficient to meet both export commitments and domestic requirements until about 1985. Additional capacity will be required, however, beginning in the early 1980's, if Canada is to continue to be in a position to meet a growing portion of the needs of its trading partners. Requisite to this new capacity will be the discovery of new deposits at an increasing rate, something which can only occur as the result of a substantial acceleration of exploratory activity. Hopefully, the positive indications of 1974 will be but the beginning of an expansion of effort toward this end.



Eldorado Nuclear Limited's uranium hexafluoride plant, Port Hope, Ontario, with 14-ton capacity uranium hexafluoride shipping containers in foreground.

Vanadium

MICHEL A. BOUCHER

Vanadium pentoxide (V_2O_5) has not been produced in Canada since June 1973 when Masterloy Products Limited suspended production. There are two producers of ferrovanadium in Canada: Masterloy Products Limited, with a plant near Ottawa, Ontario; and Fundy Chemical International Ltd., with a plant at Duparquet, Quebec. However, because vanadium pentoxide was in short supply in 1974 Fundy Chemical did not produce any ferrovanadium. As a result, imports increased to 408 short tons in 1974 from 168 short tons in 1973.

World supply of V_2O_5 was disrupted during the year by interruptions of production at the world's largest producer and owned by Highveld Steel and Vanadium Corporation Limited in the Republic of South Africa. Strikes at Lourenco Marques, the Mozambique port through which South African production is exported, further complicated the supply problem. Most vanadium is consumed by the steel industry. In 1974 the world steel industry operated at full capacity and as a result demand for vanadium was very strong. In the United States, the strong demand was due to increased production of full-alloy steel*, growing consumption of high-strength, low-alloy (HSLA) steel and expanded aircraft construction activity. Outside the United States, pipeline construction was the major factor in above-average demand for vanadium. Among the non-communist countries, the United States is the largest consumer, followed by West Germany and Japan.

Canadian developments

The prospect of significant Canadian production of vanadium pentoxide lies in the development of the tar sands of Alberta which contain 150 parts per million vanadium. Fly ash produced by combustion of petroleum coke obtained from the tar sand bitumen contains 2 per cent vanadium and one per cent nickel.

In 1972 a pyrometallurgical process was developed by the Canada Centre for Mineral and Energy Technology, (CANMET) Department of Energy, Mines and Resources. This process permits the recovery of vanadium and nickel from fly ash derived from the tar sands. It has been estimated that the economic recovery of both nickel and vanadium will become feasible when total oil production from the tar sands attains 200,000 barrels of synthetic crude oil a day. This production is expected to be reached between 1980 and 1985. Falconbridge Nickel Mines Limited, Renzy Mines Limited, Quebec Vanadium Ltd. and Fundy Chemical International Ltd. have expressed interest in the recovery of nickel and vanadium from the tar sand operations.

During 1974 the Quebec Department of Natural Resources and CANMET conducted research on a metallurgical process that would permit the recovery of some of the elements contained in the Magpie deposits located about 80 miles north of Mingan, Quebec. The deposits contain more than one billion tons of titaniferous magnetite grading 43 per cent Fe; 10.5 per cent TiO_2; 1.6 per cent Cr, and small amounts of vanadium, nickel and aluminum. Also, the Quebec Department of National Resources is working on an ilmenite-magnetite deposit located in the Lac Dore area of Chibougamau, Quebec that contains 1.3 per cent vanadium. Laboratory work has produced a magnetite concentrate containing 60 per cent Fe and 10–12 per cent TiO_2. Most vanadium is consumed as ferrovanadium and in Canada the major consumers include: The Algoma Steel Corporation, Limited; Atlas Steels Division of Rio Algom Mines Limited; Burlington Steel Division of Slater Steel Industries Limited; Sydney Steel Corporation (Sysco); Dominion Foundries and Steel, Limited (Dofasco); Sidbec-Dosco Limited; Manitoba Rolling Mills Division of Dominion Bridge Company Limited; The Steel Company of Canada, Limited (Stelco); and Colt Industries (Canada) Ltd.

World developments

In 1974 a new vanadium pentoxide plant went on stream in the Republic of South Africa. The plant has a production capacity of 3 million pounds of V_2O_5 a year.

* A steel in which the maximum of the range given for the content of alloying elements exceeds one or more of the following limits: Mn 1.65 per cent; Si 0.60 per cent; Cu 0.60 per cent.

Highveld Steel and Vanadium Corporation will increase its production capacity by 25 per cent in 1975 when planned capacity expansion is completed. The plant will be capable of producing 29 million pounds a year of V_2O_5 in slag.

The Wundowie vanadium project of Agnew Clough Limited, 40 miles from Perth in Western Australia is now a joint venture between British Oxygen Limited and Mitsui Mining Co. Ltd. Plans call for the construction of a plant to recover 7 million pounds of V_2O_5 a year by late 1976. The plant will use ore from an open-pit operation, with reserves estimated at more than 550 million pounds of ore grading 2 per cent V_2O_5.

A study of the feasibility of producing ferrovanadium in Bolivia is under way by Skoda Export (a Czechoslovakian company) and the Andean Development Corporation. Projected capacity is 50,000 pounds of vanadium a year. In the United States, Philipp Brothers, a Division of Engelhard Minerals and Chemicals Corporation, established a plant to produce vanadium in Strasburg, Virginia. The plant's basic source of vanadium consists of domestic and foreign slags and residues.

Table 1. Canada, vanadium imports and consumption, 1973-74

	1973		1974^p	
	(short tons)	($)	(short tons)	($)
Imports				
Ferrovanadium				
United States	168	985,000	263	1,506,000
South Africa	—	—	52	361,000
United Kingdom	—	—	54	304,000
Austria	—	—	39	222,000
Total	168	985,000	408	2,393,000
Consumption				
Ferrovanadium				
Gross weight	399	..		..
Vanadium content	312	..		..

Source: Statistics Canada.
^{p} Preliminary; — Nil; .. Not available.

Minerals and world occurrences

Vanadium is one of the most common trace elements, ranking twenty-second in abundance in the earth's crust. Despite its apparent overall abundance, vanadium only rarely obtains levels to be economically significant, and even then it is often mined as a byproduct. Over one hundred vanadium minerals are known. Patronite, roscoelite, bravoite, carnotite, cuprodescloizite, descloizite, brannerite and coulsonite are the most common. Patronite and bravoite are complex sulphides, and were an important source of vanadium, prior to 1955, from asphalt-coke sediments at Mina Riga in the Peruvian Andes. The most important sources of vanadium are the vanadium-bearing titaniferous magnetite and coulsonite deposits of the Republic of South Africa, Finland and Norway. Similar deposits are known to exist in Canada, U.S.S.R. and the United States. Vanadates of lead, zinc and copper, such as carnotite, cuprodescloizite and descloizite are a common constituent in uraniferous sandstone deposits, such as those that occur at the Colorado Plateau in the United States. Vanadium also occurs in certain phosphatic ores, such as those in Wyoming, United States; and in association with chromite in Quebec and complex sulphide veins in Butte, Montana, and Cornwall, England. The affinity of vanadium for carbonaceous materials, is exemplified by anomalous concentrations in black shales, asphalt, coal, tar sands and graphite.

The bulk of present world production is obtained from the sedimentary sandstone deposits of the Colorado Plateau with grades exceeding 1.5 per cent, the lateritic deposits in Arkansas, the phosphatic sediments in Idaho and the titaniferous magnetite deposits predominantly in the Republic of South Africa, Norway and Finland. The South African deposits contained in the Bushveld complex are especially rich, grading 1.5 – 2.0 per cent V_2O_5.

Vanadium is widely distributed in Canada, but as yet no commercial deposits have been found. Most of the ilmenite-magnetite and ilmenite-hematite deposits within gabbro-anorthosite complexes are vanadiferous, notably the ilmenite-magnetite deposit in the Lac Dore complex near Chibougamau, Quebec, and the ilmenite-hematite deposit from the Lac Allard area, Quebec. Significant vanadium values averaging 150 parts per million are known to occur in the Athabasca tar sands, and the development of these tar sands as an important source of oil should precipitate the recovery of vanadium from the coke residue formed during the distillation process.

Current technology and uses

The steel industry consumes over 90 per cent of the world's total production of vanadium in the form of standard ferrovanadium or other vanadium ferroalloys. The addition of vanadium to steel retards the crystallization and grain growth of the austenite phase and promotes the nucleation phase, producing a steel with increased strength, impact and wear resistance, corrosion resistance and maintenance of hardness at elevated temperatures.

HSLA steels consume some 40–50 per cent of vanadium production. Because of their high strength-to-weight ratio these steels can realize large savings in

Table 2. World production of vanadium in ores and concentrates, 1971-74

	1971	1972	1973	1974e
	(short tons)			
Republic of South Africa	6,530	8,230	9,070	11,000
United States	5,252	4,887	4,377	..
U.S.S.R.	2,917	3,720	3,700	..
Finland	1,222	1,312	1,388	..
Chile	660	720	1,060	..
Norway	1,100	1,060	800	..
Southwest Africa	730	650	800	..
France	100	100	90	..
Other free world[1]	—	—	—	4,150
Total	18,511	20,679	21,285	..

Sources: U.S. Bureau of Mines, *Minerals Yearbook Preprint for 1973.* U.S. Commodity Data Summaries, January 1975 for 1974.
[1] Excluding United States.
[e] Estimated; .. Not available; — Nil.

construction, transportation and welding costs. The steels are finding extensive applications in structural applications, pressure storage tanks, truck frames, automobile components and in oil and natural gas transmission pipelines. The chemical composition (%) of Arctic oil pipeline steel is as follows: C 0.12; Mn 1.37; Si 0.29; S 0.011; P 0.014; V 0.07; Al 0.02. Such a steel has a yield strength of 74,000 lb/in^2.

Table 3. Vanadium consumed in the United States, 1973-74

	1973	1974
	(pounds of vanadium)	
Ferrovanadium	10,566,844	11,652,968
Oxide	245,566	98,722
Ammonium metavanadate	89,834	85,883
Other	1,112,385	1,707,683
Total	12,014,629	13,545,256

Source: U.S. Bureau of Mines, Mineral Industry Surveys.

Vanadium is also finding increased application in high-speed tool steels, where vanadium is added in concentrations of 1 to 5 per cent. Vanadium forms a stable carbide which refines the austenitic grain size and imparts excellent wear resistance to steel. Tool steel applications consume about one quarter of the world's total vanadium production.

Table 4. Vanadium consumed in the United States, by end use, 1973-74

	1973	1974p
	(short tons of Vanadium)	
Steel		
High-speed tool	997	809
Stainless	26	37
Alloy (excluding stainless and tool)	3,796	4,136
Carbon	687	797
Other steel	—	—
Welding and hardfacing rods and materials	11	9
Cast iron	56	40
Nonferrous alloys	543	720
Chemical and ceramic uses	163	88
Miscellaneous and unspecified	114	137
Total	6,393	6,773

Sources: U.S. Bureau of Mines, *Minerals Yearbook Preprint for 1973* and U.S. Bureau of Mines, Mineral Industry Surveys for 1974.
[p] Preliminary; — Nil.

Significant quantities of vanadium in conjunction with chromium and molybdenum are also used in the heat-resisting alloy steels and find wide applications in automobile components, nail punches and sets and railway springs. The refining of the austenitic grain size gives more reliable and reproducible mechanical properties and these alloy steels now account for approximately 15–17 per cent of the world's vanadium

Table 5. Composition of rail steels that have increased resistance to brittle fracture

Composition	Heavy duty rail for overhead cranes	Notch ductile rail steel for low-temperature service
	(%)	(%)
C	0.4 – 0.5	0.36
Mn	1.2	1.4
Si	0.2	1.0
V	0.09	0.19
N	—	0.02
Yield strength	65,000 lb/in^2	76,600 lb/in^2

Source: Collison, Hodgson, McNeeley, ISI Rail Steel Meeting, London, 1972.
— Nil.

Table 6. Composition of vanadium ferroalloys

	V	C	Si	N	Fe	Cr
			(per cent)			
Standard ferrovanadium	35-85	0.5-2.0	0.5-11			
Carvan	83-86	10-13			1-3	
Solvan	25-30		0.8-5.0 max		0.3 max	
Ferrovan	42.6	0.75	6.5			6.4
Nitrovan	75-80	10-12		6-7		

Source: Mineral Development Sector, Department of Energy, Mines and Resources.

consumption. Vanadium is also used in plain carbon steels as reinforcing bars and pilings and also in open-die steel forgings for large turbine rotors and shafts.

Titanium-based vanadium alloys have gained acceptance in many industries, especially the aerospace industry where the alloys are used in the manufacture of aircraft frames, engine castings and other aircraft components. The chemical industry also consumes vanadium, particularly for use as catalysts in the processing of such end-use products as phosphatic fertilizers, unsaturated polyesters (Dacron), poly vinyl chloride, nylon, ethylene and propylene rubber. Vanadium is used to colour ceramic tile, pottery, glass and some laboratory chemicals.

Outlook

In 1975, demand for vanadium is expected to decline in the United States, following the general economic downtrend. New pipeline contracts signed by German and Italian steel producers will assure a reasonable level of consumption in Europe in 1975 despite deteriorating economic conditions. Japanese pipeline production for internal use and for exports is expected to drop substantially.

Consumption in Canada should increase due to pipeline construction. Adequate supplies of vanadium pentoxide should be available due to mine expansions in the Republic of South Africa and the United States and a general slowdown of world vanadium consumption expected in 1975.

Prices

At the beginning of 1974, U.S. vanadium pentoxide was quoted at $1.50 a pound. During the year, U.S. prices were pushed up by strong demand, coupled with supply difficulties in South Africa and at the end of 1974, vanadium pentoxide was selling at $2.45 – $3.06 a pound. Standard grades of ferrovanadium were raised from $4.19 a pound of vanadium to $6.35 while "Carvan" and "Ferrovan" rose from $3.66 – $3.68 a pound of vanadium to $5.10 at the end of the year.

Outside Canada and the United States, vanadium pentoxide was generally quoted at $1.40 – $1.60 a pound in early 1974 and at the end of the year the price was raised to about $2.00. The price of ferrovanadium was raised from $3.30 – $3.60 to $5.00 a pound.

United States vanadium prices in U.S. currency published in *Metals Week* of December 28, 1973 and December 27, 1974.

	December 28 1973	December 27 1974
	$	$
Vanadium pentoxide, per lb of		
V_2O_5, fob mine or mill 98% fused	1.50	2.45 – 3.06
Air dried (technical)	2.21	2.98 – 3.06
Dealers (mainly export)	1.50	—
Ferrovanadium, per lb V packed fob shipping point, freight equalized to nearest main producer		
Standard grade	4.19	6.35
Carvan	3.66	5.10
Dealers (mainly export)	*n*	—
Ferrovan	3.68	5.10

n Nominal; — Not available.

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
			(%)	(%)
32900-1	Vanadium ores and concentrates	free	free	free
37520-1	Vanadium oxide	free	free	5
35101-1	Vanadium metal, ex-alloy	free	5	25
37506-1	Ferrovanadium	free	5	5

United States

Item No.		
601.60	Vanadium ores and concentrates	free
632.58	Vanadium metal, unwrought, waste and scrap (duty on waste and scrap suspended to June 30, 1973)	5%
632.68	Vanadium alloys, unwrought	7.5%
633.00	Vanadium metal, wrought	9.0%
607.70	Ferrovanadium	6.0%
422.60	Vanadium pentoxide	16.0%
422.58	Vanadium carbide	6.0%
427.22	Vanadium salts	16.0%
422.62	Other vanadium compounds	16.0%

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Zinc

G.S. BARRY

The year 1974 was one of transition for the consumers of zinc. It began with high prices and acute supply-demand problems and ended on a pessimistic note, mainly due to the dismal performance of the automotive industry. For producers, 1974 was highly profitable, as average prices were higher than at any time in history, and inflation had not yet caught up to profit margins.

The early months of 1974 saw a continuation of the strong demand of 1973, and prices remained firm with the London Metal Exchange (LME) moving to a record peak monthly average of £738 (80.8¢/lb U.S.) a metric ton in April. The peak daily market price of £825 (87.3¢/lb U.S.) a metric ton was established on December 5, 1973. Producers' prices were also firm; in Europe, the producers' price rose from £300 (31.5¢/lb U.S.) a metric ton at the beginning of the year to £360 (38.1¢/lb U.S.) a metric ton in September.

Several developments fueled the supply problem. During the first half of 1974, industry in the United Kingdom operated at half capacity due to the energy shortage. In April, two major American zinc producers announced cuts in contracted deliveries due to strikes. Later in the year the tightness of supplies was partially aggravated by strikes in Canada and Australia. For most of the year, smelters, particularly custom smelters, experienced difficulties in concentrate supply.

Sluggish demand for metals finally caught up with zinc and, by October, a sharp downturn in demand was evident, especially by the automotive and construction industries. Under these influences, the LME price declined sharply and by year-end it was at a substantial discount to the 360 a metric ton European producers' price.

Japan was the first to react to the changing situation, initially by cutting imports of zinc concentrates, principally from Australia and Canada; and, subsequently by cutting zinc metal output, initially by 10 per cent, and by December, 20 per cent. With no apparent improvement in demand, further production curtailment in the first two months of 1975 saw the Japanese smelters operate at less than 60 per cent capacity at time of writing. Further reductions in primary output were announced near the end of 1974 by Belgian and French producers, to be followed in early 1975, by German, British, Italian, Mexican, and U.S. producers. Canadian producers were considering cuts early in March.

The critical shortage of zinc supplies throughout 1973 and 1974 saw all major producers, including those in the developing countries, exercise firm discipline in pricing and supply allocations. This posture augurs well for the industry in the future. A critical over-supply situation in 1975 that might depress prices to levels at,

Zinc: Salient Statistics — Canada

	1970	1971	1972	1973	1974p	1975e
			(000's of short tons)			
A) Mine production	1,381	1,400	1,402	1,496	1,364	1,380
B) Production of primary zinc	455	411	525	587	470	500
C) Export of zinc in conc.	892	891	766	944	958	900
D) Export of primary zinc	351	312	408	466	326	330
E) Domestic consumption (primary zinc only)	106	115	129	139	153e	120
Export processing index (D/D&C) x 100	28	26	35	33	25	26

pPreliminary; eEstimated.

or below, production costs and force mine closures is not expected because responsible graduated production cuts are being made, and because inventories are low and producers can absorb significant increases to their stocks.

Canadian consumption of zinc in 1974 is estimated at 154,000 tons*, which is 14,000 tons above last year's record. The galvanizing sector was the strongest, with consumption increasing from 67,121 tons in 1973 to 71,000 tons in 1974. The automotive and home appliance diecasting sector was also very strong with only a slight decrease in consumption apparent in the fourth quarter of the year. Total diecasting consumption was 28,277 tons of which 38.3 per cent was automotive, 5.0 per cent machinery and tools, 28.0 per cent building hardware, 10.3 per cent appliances, and 18.2 per cent electronic, office equipment and other.**

In 1974, exports of refined zinc were 325,572 tons. They decreased by 30 per cent from 1973 exports, principally because of strike-disrupted production. Exports to the United States were 263,029 tons compared with 348,467 tons in 1973. Decreases were also registered for most other countries. Exports of zinc in concentrates increased from 944,127 tons in 1973 to 957,766 in 1974.

As indicated in the tabulation of salient statistics, mine output is not expected to increase in 1975, and combined exports of refined zinc and zinc in concentrates will be the same as in 1974, or slightly lower.

Domestic Industry

Mine Production. Table 2 gives information on the operations of 33 mining enterprises that produced zinc-bearing ores or concentrates on a regular basis during 1974 and whose content of zinc was destined for recovery. In general about 90 to 94 per cent of zinc in the concentrates is recovered at the zinc plants and 85-90 per cent is paid for to independent mine producers. Of the 19 mines that produced more than 20,000 tons of zinc in concentrates in 1974, 5 showed an increase in output and 14 a decrease from the previous year. Major strike related production cutbacks were experienced by Cominco Ltd.'s Sullivan and H.B. mines, by Brunswick Mining and Smelting Corporation Limited's Bathurst area mines and by Noranda Mines Limited's Geco mine. The Mattagami Lake Mines Limited, Mattabi mine decreased output substantially on account of lower grade of ore mined.

The 33 mining enterprises listed in Table 2 had a combined mill capacity of 105,143 tons of ore a day of which the 23 large concentrators (1,000 tons-a-day and over) accounted for 102,400 tons. Zinc production per ton of installed concentrator capacity in 1974 was 12.9 tons compared with 14.4 tons in 1973. The 23 large concentrators milled 29,347,588 tons, operating at 78.5 per cent of their nominal annual capacity of 37,376,000 tons based on a 365-day year. The zinc producing enterprises reported a total employment of 14,109 in 1974 compared with 13,488 in 1973.

Newfoundland. The Buchans mine operated satisfactorily in 1974 (after the 29-week strike that paralyzed production in 1973); the new labour contract will be in effect until February 1976. Some output problems were experienced at mid-year as a result of a reagent shortage. The mill, with a capacity of 1,250 tons a day, operates five days a week. Present reserves of some 1,500,000 tons are sufficient for another five years of operation. The feasibility of mining several million tons of low-grade ore is under study and a pilot project to recover barite from the 3.5 million tons of tailings was initiated. The mine is jointly owned by American Smelting and Refining Company, the operator, and by Terra Nova Properties Limited, a wholly-owned subsidiary of Price (Nfld.) Pulp & Paper Limited.

Newfoundland Zinc Mines Limited is expected to bring a zinc mine at Daniel's Harbour on the west coast of Newfoundland into production by mid-1975. The milling and mining rate will be 1,500 tons a day for an annual output of about 40,000 tons of zinc in high-purity concentrates. Capital costs are estimated at $18 million.

Construction of mine buildings and a 5,000 ft, 9 degree access decline were started in October. The new mine will employ about 140 people. Mining will be principally by trackless methods, with access provided by the decline, although some ore will be available for open-pit mining. Milling will be by conventional flotation methods and is expected to produce a concentrate grading more than 62 per cent zinc with a recovery of 95 per cent. The concentrate will be trucked 45 miles to Hawkes Bay, a port which is generally free of ice for eight months of the year, and shipped from there to zinc refineries in Canada and the United States.

Mineable ore reserves to date are about 4,400,000 tons grading 8.8 per cent zinc after dilution, sufficient for 8 to 10 years of operation. Material of lower grade that may become economic to extract in the future is also present. Newfoundland Zinc Mines Limited is controlled by Teck Corporation Limited (63.4 per cent) and Amax Zinc (Newfoundland) (32 per cent), a subsidiary of Amax, Inc. Noranda Mines Limited contracted to purchase about two thirds of the concentrates (Teck's share).

Nova Scotia. The Gays River deposit is of similar geological type to the Daniel's Harbour deposit but the Gays River deposit contains lead. The deposit has undergone extensive exploration in 1973 and 1974 by Imperial Oil Limited (60 per cent ownership) and Cuvier Mines Ltd. (40 per cent). While new estimates on ore reserves have not yet been announced, these are expected to be in the range of 15 to 20 million tons grading about 2 to 3 per cent lead and 4 to 6 per cent

(text continued on page 573)

*The short ton (2,000 pounds) is used throughout unless otherwise stated.

**Consumption statistics from industry sources.

Table 1. Canada, zinc production, trade and consumption 1973-74

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Production				
All forms[1]				
Ontario	456,365	220,387,609	465,260	324,751,000
Northwest Territories	181,275	87,541,226	195,511	136,467,000
New Brunswick	192,562	92,992,396	174,774	121,992,000
Quebec	155,259	74,977,615	137,667	96,091,000
Yukon	126,661	61,167,027	98,247	68,576,000
British Columbia	151,437	73,132,035	91,672	63,987,000
Manitoba	66,396	32,064,061	86,820	60,600,000
Newfoundland	8,695	4,199,158	21,208	14,803,000
Saskatchewan	13,424	6,482,546	6,980	4,872,000
Total	1,352,074	652,943,673	1,278,139	892,139,000
Mine output[2]	1,496,500		1,363,916	
Refined[3]	587,038		469,883	
Exports				
Zinc blocks pigs and slabs				
United States	348,467	149,772,000	263,029	175,683,000
United Kingdom	70,609	29,847,000	32,916	20,995,000
Singapore	4,406	1,849,000	4,783	3,207,000
Brazil	6,059	2,680,000	3,749	2,721,000
India	1,982	705,000	3,535	2,213,000
Venezuela	4,650	1,818,000	2,741	1,871,000
Hong Kong	3,266	1,286,000	2,759	1,844,000
Taiwan	3,291	1,309,000	2,164	1,470,000
Thailand	3,306	1,332,000	2,177	1,424,000
Guatemala	1,105	441,000	1,003	674,000
Italy	4,193	1,446,000	1,001	658,000
Philippines	677	303,000	875	606,000
France	1,289	527,000	796	544,000
Colombia	1,351	553,000	764	524,000
Turkey	—	—	668	486,000
Pakistan	1,653	638,000	659	453,000
Netherlands	—	—	300	358,000
Other countries	9,271	3,647,000	1,653	1,586,000
Total	465,575	198,153,000	325,572	217,317,000
Zinc contained in ores and concentrates				
Belgium and Luxembourg	294,616	61,462,000	251,762	81,306,000
Japan	229,961	54,318,000	216,243	75,043,000
United States	135,131	22,250,000	180,800	53,387,000
Germany, West	115,929	21,048,000	82,897	24,387,000
France	49,436	10,341,000	60,864	21,508,000
Netherlands	53,208	10,648,000	50,666	17,990,000
Italy	22,080	5,027,000	31,371	9,777,000
United Kingdom	—	—	26,562	8,655,000
South Africa	—	—	13,340	4,458,000
Spain	20	7,000	9,660	3,315,000
Poland	11,062	2,653,000	8,431	3,092,000
Finland	14,982	3,745,000	8,420	2,472,000
Other countries	17,702	4,132,000	16,750	5,572,000
Total	944,127	195,631,000	957,766	310,962,000

(table continued on page 572)

Table 1. (cont'd)

	1973		1974p	
	(short tons)	($)	(short tons)	($)
Exports (con't)				
Zinc alloy scrap dross and ash (gross weight)				
United States	3,455	1,168,000	12,474	4,646,000
United Kingdom	1,197	359,000	3,618	1,138,000
South Africa	539	112,000	2,051	530,000
Italy	72	30,000	743	497,000
France	20	2,000	254	224,000
Netherlands	1,637	172,000	466	205,000
Germany, West	264	73,000	819	172,000
Other countries	2,900	535,000	1,147	480,000
Total	10,084	2,451,000	21,572	7,892,000
Zinc dust and granules				
United States	3,218	1,903,000	3,620	3,695,000
United Kingdom	128	48,000	441	276,000
Venezuela	13	8,000	136	143,000
Belgium and Luxembourg	20	8,000	64	22,000
Colombia	—	—	14	19,000
Nicaragua	8	6,000	8	10,000
South Africa	—	—	20	7,000
Costa Rica	—	—	1	1,000
Total	3,387	1,973,000	4,304	4,173,000
Zinc fabricated material nes				
United States	7,293	4,434,000	3,683	3,522,000
United Kingdom	659	322,000	709	570,000
Singapore	—	—	344	322,000
Japan	275	123,000	120	89,000
Italy	181	87,000	134	77,000
Hong Kong	6	3,000	45	58,000
Venezuela	56	31,000	62	50,000
France	—	—	55	44,000
Other countries	232	86,000	97	87,000
Total	8,702	5,086,000	5,249	4,819,000
Imports				
In ores and concentrates	4,088	878,000	2,343	961,000
Dust and granules	898	492,000	276	270,000
Slabs, blocks, pigs and anodes	20,416	8,609,000	7,740	5,604,000
Bars, rods, plates, strip and sheet	554	471,000	2,208	2,264,000
Slugs, discs, shells	—	—	—	—
Zinc oxide	2,434	966,000	2,524	1,647,000
Zinc sulphate	1,122	194,000	1,882	630,000
Zinc fabricated material nes	947	1,295,000	1,420	2,545,000
Total	30,459	12,905,000	18,393	13,921,000

(table concluded on page 573)

Table 1. (concl'd)

	1973			1974p		
	Primary	Secondary	Total	Primary	Secondary	Total
	(short tons)			(short tons)		
Consumption						
Zinc used for or in the manufacture of:						
Copper alloys (bronze, brass, etc.)	15,988			15,538		
Galvanizing electro	2,347	922	84,031	2,417	756	81,242
hot-dip	64,774			62,531		
Zinc diecast alloy	20,237		20,237	17,791		17,791
Other products (including rolled and ribbon zinc, zinc oxide)	26,307	2,504	28,811	22,941	7,680	30,621
Total	129,653	3,426	133,079	121,218	8,436	129,654
Consumer stocks on hand at end of year.	12,897	1,377	14,274	15,731	1,490	17,221

Source: Statistics Canada.
[1]New refined zinc produced from domestic primary materials (concentrates, slags, residues, etc.) plus estimated recoverable zinc in ores and concentrates shipped for export. [2]Zinc content of ores and concentrates produced. [3]Refined zinc produced from domestic and imported ores.
pPreliminary; . . Not available for publication; — Nil; nes Not elsewhere specified.

zinc (or alternatively stated to be about 7 per cent combined lead-zinc).

The ore is of good milling quality and is amenable to low-cost, trackless, underground mining methods. Less than one million tons could be mined by open-pit methods. A decline will be driven in the first part of 1975. The companies are expected to spend about $1.5 million on property development in 1975. High recovery and concentration ratios can be expected for this type of ore.

A number of other companies were active in the area and some obtained indications of favourable mineralization; e.g., Silvermaque Mining Limited. On the nearby property of Getty Oil (Maritime) Ltd., a deposit of some 5 million tons has been indicated.

New Brunswick. Production losses at Brunswick Mining and Smelting Corporation Limited, the largest mine producer in the province, were substantial. The company experienced an illegal one-week strike in March to support demands for contract negotiations. Subsequently, because of frequent production disruptions, the company announced that normal production was no longer possible and locked out the mine employees from April 22 to June 25 when the new contract was signed. Production in 1974 was much lower than in 1973. Tons milled per day averaged 9,100 for the non-strike period compared with 9,000 in 1973.

A $48-million-expansion program is well underway at the company's No. 12 mine at Bathurst, which will raise capacity of the mine from the initial 6,350 tons a day to 11,000 tons a day of ore by 1979. The capacity of the No. 12 mill has already been raised to about 9,800 tons a day.

About half of the expansion expenditure will be for a new, 4,500-ft shaft that was collared in late 1973 and scheduled for completion in late 1977. It will be one of the largest in Canada, and is "sunk" by raise boring and then slashing to its designed 30-ft diameter. It will have an ultimate hoisting capacity of 11,000 tons a day.

The company's No. 6 open-pit mine, operating at a rate of 3,600 tons a day will be phased out by 1977. Open-pit production may stop by late-1975, but more ore will be extracted for about a year by means of a decline which is now being driven under the No. 6 orebody.

Zinc-lead ore reserves at the No. 12 mine, as of December 31, 1974 increased to 90,070,000 tons, averaging 13.2 per cent combined zinc and lead from the 1973 reserves of 84,720,000 tons averaging 13.2 per cent combined zinc and lead.

The province's second largest base metal producer, Heath Steele Mines Limited at Little River completed a year without major difficulties having signed a labour

(text continued on page 584)

Table 2. Principal Zinc Mines in Canada 1974 and [1973]

Company and Location	Mill or Mine Capacity	Grade of Ore Milled: Zinc	Grade of Ore Milled: Lead	Grade of Ore Milled: Copper	Grade of Ore Milled: Silver	Ore Milled	Zinc Concentrate Produced	Grade of Zinc in Concentrate	Contained* Zinc Produced	Destination** of Zinc
	(tons ore/day)	(%)	(%)	(%)	(oz/ton)	(tons)	(tons)	(%)	(tons)	
Newfoundland										
American Smelting and Refining Company, Buchans Unit, Buchans	1,250 [1,250]	11.24 [11.51]	6.28 [6.48]	1.01 [1.00]	3.25 [3.45]	264,000 [124,000]	42,326 [20,561]	55.30 [55.81]	27,267 [13,272]	8, 9, 11, 12 [8, 9, 10, 11, 12]
New Brunswick										
Brunswick Mining and Smelting Corporation Limited, Bathurst	10,000 [9,850]	6.70 [7.00]	1.96 [2.81]	0.38 [0.34]	2.32 [2.53]	2,607,965 [3,288,081]	255,965 [330,811]	52.23 [52.28]	112,971 [188,946]	9 [9]
Heath Steele Mines Limited, Newcastle	3,100 [3,100]	4.39 [4.90]	1.72 [1.64]	1.04 [0.86]	1.98 [1.83]	1,085,495 [1,077,816]	73,229 [78,094]	48.07 [48.99]	37,758 [40,526]	6, 8, 12 [8, 9, 12]
Nigadoo River Mines Limited, Robertville	1,000 [1,000]	2.74 [—]	2.53 [—]	0.33 [—]	3.74 [—]	205,691 [—]	8,739 [—]	44.72 [—]	3,672 [—]	9 [—]
Quebec										
Falconbridge Copper Limited, Lake Dufault Division, Noranda	1,500 [1,500]	3.54 [4.41]	.. [..]	2.38 [3.65]	0.99 [1.41]	553,187 [555,292]	29,660 [36,185]	51.99 [51.82]	17,850 [18,974]	8 [8]
Joutel Copper Mines Limited, Joutel	700 [700]	6.81 [10.32]	.. [..]	.. [..]	.. [..]	101,396 [151,427]	10,038 [25,030]	51.67 [52.74]	5,187 [13,200]	6 [6]
Kerr Addison Mines Limited (Normetal Mines Limited), Normetal	838 [1,000]	4.58 [4.86]	— [—]	0.97 [1.38]	1.1 [1.37]	250,492 [297,889]	18,694 [23,690]	51.68 [52.66]	9,662 [12,475]	6 [6]
Manitou-Barvue Mines Limited, Val d'Or	1,600 [1,600]	2.20 [2.07]	0.35 [0.30]	.. [..]	2.58 [..]	225,303 [197,312]	6,695 [5,982]	56.3 [56.0]	3,770 [3,467]	6 [6]

Table 2. (cont'd)

Company and Location	Mill or Mine Capacity	Grade of Ore Milled Zinc	Lead	Copper	Silver	Ore Milled	Zinc Concentrate Produced	Grade of Zinc in Concentrate	Contained* Zinc Produced	Destination** of Zinc
	(tons ore/ day)	(%)	(%)	(%)	(oz/ton)	(tons)	(tons)	(%)	(tons)	
Mattagami Lake Mines Limited, Matagami	3,850 [3,850]	7.5 [7.4]	— [—]	0.62 [0.57]	0.88 [0.84]	1,406,265 [1,387,251]	183,559 [178,104]	52.7 [52.2]	97,794 [92,997]	3, 12 [3, 6, 12]
Orchan Mines Limited, Matagami, Orchan and Garon mines	1,900 [2,000]	4.78 [5.77]	0.05 [. .]	1.18 [1.16]	0.50 [0.69]	364,030 [450,230]	27,155 [40,936]	52.38 [53.38]	14,821 [21,853]	3 [3]
Sullivan Mining Group Ltd., Stratford Centre, Cupra Division	1,500 [1,500]	4.78 [4.88]	0.59 [0.66]	2.49 [2.41]	1.112 [1.092]	87,474 [89,814]	5,907 [6,178]	57.32 [56.65]	3,386 [3,500]	6, 9 [7]
D'Estrie Mining Company Ltd.	— [—]	2.72 [3.16]	0.61 [0.74]	2.56 [2.74]	1.155 [1.227]	162,081 [130,265]	6,338 [5,800]	56.99 [56.71]	3,612 [3,289]	6, 9 [7]
Weedon Mines Ltd.	— [—]	— [0.59]	— [—]	— [2.17]	— [0.332]	— [50,591]	— [254]	— [50.76]	— [129]	— [7]
Clinton Copper Mines Ltd.	— [—]	2.50 [—]	0.48 [—]	2.64 [—]	0.951 [—]	52,656 [—]	1,494 [—]	52.81 [—]	789 [—]	7 [—]
Ontario										
Ecstall Mining Limited, Timmins	10,000 [10,000]	9.20 [9.78]	0.30 [0.33]	1.75 [1.61]	3.17 [3.72]	3,723,865 [3,609,657]	580,534 [589,894]	52.14 [52.66]	302,702 [325,888]	5, 6, 7, 12 [5, 6, 7, 12]
Lynx-Canada Explorations Limited Long Lake mine, Parham	200 [200]	12.17 [11.3]	— [—]	— [—]	— [—]	39,589 [55,042]	24,231 [32,108]	19.76 [19.35]	4,921 [6,214]	6 [6]
Mattabi Mines Limited, Sturgeon Lake	3,000 [3,000]	8.81 [11.37]	0.96 [1.06]	0.91 [1.10]	4.31 [5.31]	1,138,965 [1,111,765]	164,896 [202,513]	54.43 [55.38]	90,703 [113,732]	3,6,12 [2, 3, 6]
Noranda Mines Limited, (Geco Division) Manitouwadge	5,000 [5,000]	4.72 [4.53]	0.20 [0.20]	1.72 [1.70]	1.56 [1.63]	1,826,704 [1,463,585]	132,400 [100,890]	53.50 [53.89]	70,965 [54,366]	3, 6 [3]

Table 2. (cont'd)

Company and Location	Mill or Mine Capacity	Grade of Ore Milled: Zinc	Grade of Ore Milled: Lead	Grade of Ore Milled: Copper	Grade of Ore Milled: Silver	Ore Milled	Zinc Concentrate Produced	Grade of Zinc in Concentrate	Contained* Zinc Produced	Destination** of Zinc
	tons ore/ day)	(%)	(%)	(%)	(oz/ton)	(tons)	(tons)	(%)	(tons)	
Ontario (cont'd)										
Selco Mining Corporation Limited South Bay Division, Uchi Lake	500 [500]	11.96 [13.04]	— [—]	1.92 [1.86]	3.08 [3.18]	195,000 [191,614]	38,318 [41,878]	. . [. .]	20,500 [23,062]	6, 12 [12]
Sturgeon Lake Mines Limited, Sturgeon Lake	1,200 [—]	7.59 [—]	1.09 [—]	2.05 [—]	. . [—]	82,592 [—]	. . [—]	53.54 [—]	4,266 [—]	12 [—]
Willroy Mines Limited, Manitouwadge Division, Manitouwadge	1,700 [1,700]	3.06 [2.74]	0.23 [0.17]	0.42 [0.98]	1.37 [1.42]	394,154 [430,486]	19,826 [17,295]	52.66 [52.45]	10,441 [9,071]	6 [9]
Manitoba and Saskatchewan										
Hudson Bay Mining and Smelting Co., Limited, Flin Flon	8,500 [8,500]	3.22 [3.61]	0.12 [. .]	2.34 [2.45]	0.63 [0.75]	1,574,948 [1,815,027]	69,550 [90,796]	48.6 [48.84]	42,451 [55,598]	2 [2]
(Flin Flon, Schist Lake, White Lake, Dickstone, Chisel Lake, Stall Lake, Osborne, Anderson, Ghost, and Centennial mines)										
Sherritt Gordon Mines, Limited										
Fox Mine	3,000 [3,000]	1.98 [2.07]	— [—]	2.10 [2.01]	0.33 [. .]	1,008,111 [963,416]	19,033 [17,005]	49.39 [49.1]	9,400 [8,352]	2 [2]
Ruttan Mine	10,000 [10,000]	1.68 [2.01]	— [—]	1.07 [1.14]	0.20 [. .]	3,358,257 [1,518,052]	39,343 [46,717]	49.21 [49.79]	39,343 [20,759]	2, 7 [2, 6, 7]

Table 2. (cont'd)

Company and Location	Mill or Mine Capacity	Grade of Ore Milled: Zinc	Grade of Ore Milled: Lead	Grade of Ore Milled: Copper	Grade of Ore Milled: Silver	Ore Milled	Zinc Concentrate Produced	Grade of Zinc in Concentrate	Contained* Zinc Produced	Destination** of Zinc
	(tons ore/ day)	(%)	(%)	(%)	(oz/ton)	(tons)	(tons)	(%)	(tons)	
British Columbia										
Bradina Joint Venture, Owen Lake	— [500]	— [4.57]	— [1.02]	— [0.43]	— [4.88]	— [98,471]	— [8,277]	— [48.18]	— [3,991]	— [7]
Cominco Ltd., Sullivan Mine, Kimberley	10,000 [10,000]	4.49 [4.99]	4.11 [4.97]	— [—]	1.41 [1.76]	1,416,489 [2,214,415]	114,154 [198,454]	48.24 [48.3]	58,335 [102,559]	1 [1]
H.B. Mine, Nelson	1,200 [1,200]	3.70 [4.2]	1.1 [1.6]	— [—]	.. [..]	256,121 [351,682]	15,750 [24,348]	52.3 [52.8]	8,604 [13,653]	1 [1]
Consolidated Columbia River Mines Ltd., Golden	— [500]	— [5.08]	— [3.69]	— [0.09]	— [5.02]	— [26,957]	— [1,150]	— [48.0]	— [552]	— [6]
Kam-Kotia Burkam Joint Venture Silmonac Mine, Sandon	140 [150]	4.16 [5.41]	3.28 [5.36]	— [—]	12.76 [14.45]	12,034 [13,949]	747 [1,133]	51.11 [52.45]	446 [693]	6 [6]
Reeves MacDonald Mines Limited, Remac Annex Mine	1,000 [1,000]	3.84 [4.49]	1.18 [1.67]	— [—]	0.64 [1.06]	195,565 [191,438]	12,526 [14,129]	51.98 [52.01]	6,820 [7,864]	6 [6]
Teck Corporation Limited, Beaverdell Mine, Beaverdell	110 [110]	0.52 [0.61]	0.41 [0.62]	0.003 [..]	9.06 [12.36]	37,184 [37,202]	287 [318]	39.90 [47.54]	188 [227]	1 [1]
Western Mines Limited, Lynx and Myra Falls, Buttle Lake, V.I.	1,100 [1,000]	8.05 [8.29]	1.48 [1.28]	1.28 [1.39]	4.52 [4.60]	297,290 [354,420]	37,346 [44,736]	51.14 [53.34]	21,910 [26,372]	6, 7 [6, 7]

Table 2. (concl'd)

Company and Location	Mill or Mine Capacity	Grade of Ore Milled Zinc	Lead	Copper	Silver	Ore Milled	Zinc Concentrate Produced	Grade of Zinc in Concentrate	Contained* Zinc Produced	Destination** of Zinc
	(tons ore/ day)	(%)	(%)	(%)	(oz/ton)	(tons)	(tons)	(%)	(tons)	
Yukon Territory										
Cyprus Anvil Mining Corporation, Faro	10,000 [8,000]	5.60 [6.37]	4.51 [4.88]	— [—]	. . [1.0]	2,925,000 [2,899,145]	207,437 [233,049]	50.29 [51.11]	116,281 [142,680]	7 [7]
(also bulk lead-zinc conc.)							72,294 [79,197]	30.35 [29.76]	included above	
United Keno Hill Mines Limited, Elsa, Husky, No Cash mines, Elsa	255 [500]	1.15 [1.00]	4.22 [4.00]	— [—]	37.73 [34.62]	93,232 [94,819]	527 [1,238]	53.0 [. .]	273 [673]	6 [6]
Northwest Territories										
Pine Point Mines Limited, Pine Point	11,000 [11,000]	5.28 [6.01]	2.58 [2.9]	— [—]	. . [. .]	4,135,380 [3,896,357]	357,457 [370,831]	56.66 [57.57]	205,484 [216,589]	1, 2, 12 [1, 2, 12]

* Total zinc contained in concentrates.
** Destination of concentrates: (1) Trail; (2) Flin Flon; (3) Valleyfield; (4) Belledune; (5) Timmins; (6) U.S.A.; (7) Japan; (8) Germany; (9) Belgium; (10) France; (11) Britain; (12) Unspecified and other countries.
— Nil; . . Not available.

Table 3. Prospective zinc-producing mines

Company and Location	Year Production Expected	Mill or Mine Capacity	Indicated Ore Reserves	Grade of Ore: Zinc	Grade of Ore: Lead	Grade of Ore: Copper	Grade of Ore: Silver	Remarks
		(tons ore/day)	(tons)	(%)	(%)	(%)	(oz/ton)	
Newfoundland								
Newfoundland Zinc Mines Limited, Daniel's Harbour	1975	1,500	5,400,000	7.70	..	..	..	Optioned to Teck Corporation and Amax Resources. Reserves include 3,700,000 tons grading 8.5% zinc. Good construction progress to date.
Quebec								
Lemoine Mines, Limited Chibougamau	1975	400	625,000	10.8	..	4.5	2.7	Shipments of concentrates to Europe are scheduled to start in December 1975.
Noranda Mines Limited Magusi Mine, Magusi	1976	1,500	4,110,000	3.55	—	1.2	0.9	Property sold by Iso Mines and Copperfields Mining Corp. which retain 10% int. Half can be mined by open-pit.
Orchan Mines Limited, Norita Mine	1976	—	1,637,000	7.6	—	0.7	1.0	Site preparation completed and mining plant erected. Shaft collared and sinking to depth of 1,600 feet began in March 1974, but was behind schedule at the end of the year.
Radiore No. 2	1976	—	139,400	1.1	—	2.2	..	Mining scheduled for late 1974, was postponed. Milling in the Orchan concentrator.
Ontario								
Mattagami Lake Mines Limited, Lyon Mine Sturgeon Lake	1976	1,000	3,096,000	6.20	0.60	1.15	3.30	Ore reserves to 1,000 foot level with possibility of substantial additions.
Manitoba								
Hudson Bay Mining and Smelting Co., Limited, Snow Lake area Centennial mine	1975	—	1,400,000	2.6	—	2.06	..	Reserves are to 1,200 foot level; orebody open at depth. Development is on schedule. Some development ore, milled in 1974.

Table 3. Prospective zinc-producing mines (concl'd)

Company and Location	Year Production Expected	Mill or Mine Capacity	Indicated Ore Reserves	Grade of Ore Zinc	Grade of Ore Lead	Grade of Ore Copper	Grade of Ore Silver	Remarks
		(tons ore/ day)	(tons)	(%)	(%)	(%)	(oz/ton)	
Northwest Territories								
Mineral Resources International Limited, Strathcona Sound	1978	1,500	6,900,000	14.1	1.4	—	1.77	Construction commenced in 1974. Satisfactory progress on construction to date. Initial output is expected in 1977.

. . Not available; — Nil.

Table 4. Indicated zinc deposits under exploration

Company and Location	Indicated Ore Tonnage	Grade of Ore Zinc	Grade of Ore Lead	Grade of Ore Copper	Grade of Ore Silver	Remarks
	(tons)	(%)	(%)	(%)	(oz/ton)	
New Brunswick						
Anaconda Canada Limited, Bathurst, Caribou property	50,000,000	4.43	1.7	0.47	. .	In temporary production 1971 and in 1974. Feasibility studies continue on bringing this property into production (late 1970's?).
Chester Mines Limited, Newcastle	1,600,000	2.12	0.82	0.63	. .	Ore available for open-pit mining.
	3,300,000	. .	—	0.82	—	
	13,000,000	. .	—	0.77	. .	Ore available for underground mining. Feasibility study completed in 1970.
Key Anacon Mines Limited, Bathurst	1,950,000	5.87	2.18	0.24	2.31	Mine partly developed. Revaluation of property in 1970 led to decision to defer placing the property into production at that time.

Table 4. Indicated zinc deposits under exploration (cont'd)

Company and Location	Indicated Ore Tonnage	Grade of Ore				Remarks
		Zinc	Lead	Copper	Silver	
	(tons)	(%)	(%)	(%)	(oz/ton)	
New Brunswick (concl'd)						
Teck Corporation Limited, Portage Lakes area, Restigouche property	3,270,000	5.9	4.6	..	2.50	Partly recoverable by open pit. Further exploration in 1974 and 1975.
Nova Scotia						
Cuvier Mines Ltd., Gays River	about 20,000,000	5.6	2.3	—	..	Optioned to Imperial Oil Limited. Under exploration since 1972. Full potential not determined yet. Intensive program for 1975, including production feasibility study.
Getty Oil (Maritime) Ltd.	about 5,000,000	..	..	..	..	Exploration in progress.
Quebec						
Noranda Mines Limited, Barraute Mine	about 4,000,000	3.5	..	..	1.2	Former producer (1952-1957). Property optioned from Manitou-Barvue Mines Limited in 1974. Exploration in progress.
Selco Mining Corporation Limited, Frotet Lake	1,200,000	3.7	—	1.8	1.0	Optioned from Muscocho Explorations Limited which retains 20% interest.
Phelps Dodge Corp. Lagauchetiere deposit	1,500,000	4.0	—	1.0	1.0 – 1.5	Additional mineralization present at depth. Exploration will continue in 1975.
Selco Mining Corporation Ltd., Pickands Mather & Co., Brouillan property	large	..	..	..	..	Drilling in 1974 indicated a copper-silver deposit of major mine potential.
Ontario						
Giant Yellowknife Mines Ltd., Errington and Vermilion Lake mines, Sudbury area	4,418,500 and 9,038,317	3.9 3.82	1.0 0.99	1.33 1.14	1.61 1.58	Extensive underground development in 1961-1967 period. Ore difficult to concentrate. Reserves only for underground explored areas with low pyrite and high pyrite ore respectively.

Table 4. Indicated zinc deposits under exploration (con't)

Company and Location	Indicated Ore Tonnage	Grade of Ore				Remarks
		Zinc	Lead	Copper	Silver	
	(tons)	(%)	(%)	(%)	(oz/ton)	
Manitoba						
Stall Lake Mines Limited, Snow Lake	672,000	2.28	..	5.38	..	Falconbridge Nickel Mines Limited is joint owner of this property. Exploration completed in 1971. Feasibility study on production completed. Decision deferred.
Saskatchewan						
Bison Petroleum & Minerals Limited, Brabant Lake	4,330,000	4.43	..	0.64	..	Further exploration planned.
Yukon Territory						
Hudson Bay Mining and Smelting Co., Limited, Tom deposit MacMillan Pass	8,645,000	8.4	8.1	—	2.75	Underground work through adit including diamond drilling in 1970-1972. Further development planned.
Kerr Addison Mines Limited, Swim Lake deposit, Vangorda Creek	5,000,000		9.5 (Pb + Zn)	..	1.50	
Kerr Addison Mines Limited, — Aex Minerals Corporation Grum deposit Vangorda Creek	large	..	..	..	..	Drilling in 1974 indicated a lead-zinc deposit of large mine potential. Underground evaluation planned for 1975.
Vangorda Mines Limited, Vangorda Creek	9,400,000	4.96	3.18	0.27	1.76	Feasibility study made. No further exploration.

Table 4. Indicated zinc deposits under exploration (concl'd)

Company and Location	Indicated Ore Tonnage	Grade of Ore: Zinc	Lead	Copper	Silver	Remarks
	(tons)	(%)	(%)	(%)	(oz/ton)	
Northwest Territories						
Arvik Mines Ltd., Little Cornwallis Island	25,000,000 plus		18.4 (Pb + Zn)		1.0	Cominco Ltd. — 75% and Bankeno Mines Limited — 25%. Underground program (5,300-foot adit) and metallurgical tests completed. Feasibility study completed. Decision on mining to be made in 1975.
Buffalo River Exploration Limited, Pine Point	1,350,000	9.6	3.4	—	..	Feasibility study for joint production with Coronet Mines Ltd. completed in 1971. Decision was not made to put the property into production at present.
Bathurst Norsemines Ltd., Hackett River, Bathurst Inlet area	about 20,000,000	..	..	..	..	Optioned to Cominco. Large deposit in three zones with high zinc and silver values. Under active exploration from 1970 to present. Total values of metals in ore was estimated at about $90/t. in March 1975.

.. Not available; — Nil.

contract readjustment agreement in May, despite the fact that the actual contract expires in August, 1975. A drop in production was recorded for the year, mainly due to lower grades of zinc ore treated. The company's $12 million expansion program was more than 60 per cent completed. A new 3,000-ft shaft reached a depth of 2,300 ft in December, and equipment is being added to increase production to about 4,000 tons a day by January 1976.

The company has further potential for expansion based on current reserves of 36.5 million tons grading 4.37 per cent zinc, 1.56 per cent lead, 1.15 per cent copper and 1.73 ozs. of silver a ton.

Nigadoo River Mines Limited resumed output at its Beresford mine near Robertsville at about the beginning of the year, after being out of production since January 1972. In the period since startup to the end of the year, the concentrator processed 205,691 tons of ore grading 2.74 per cent zinc, 2.53 per cent lead, 0.33 per cent copper and 3.74 ozs. of silver a ton.

Production has now reached 20,000 tons a month and it is planned to increase mill capacity from 1,000 to 1,200 tons a day. Ore reserves in the main zone are about 1,150,000 tons grading 3.15 per cent zinc, 3.14 per cent lead, 0.39 per cent copper and 3.98 ozs. silver a ton. Exploration in 1974 confirmed the presence of possibly some 500,000 tons of ore having a slightly higher grade, in what is known as the Anthonian zone. Nigadoo is 96.1 per cent controlled by the Sullivan Mining Group Ltd.

Caribou-Chaleur Bay Mines Ltd. (67.5 per cent Anaconda Canada Limited and 22.5 per cent Cominco Ltd.) closed its small open-pit copper operation 30 miles west of Bathurst, at the beginning of November, but the company is continuing metallurgical research on the treatment of ore from a more than 50-million-ton deposit that underlies the original copper-rich lense. This deposit has very fine grained ore, difficult to concentrate, grading about 4 per cent zinc, 2 per cent lead, 0.5 per cent copper and 1 oz. of silver a ton. A pilot-mill test program on the ore is currently being conducted at the Canada Centre for Mineral and Energy Technology (CANMET) laboratories in Ottawa.

The Bathurst mining camp has some 33 primary sulphide deposits, and many are expected to achieve production in the future. A metallurgical breakthrough — such as hydrometallurgical extraction — is needed to promote the region into one of the larger mining camps in the world.

Deposits under active investigation at this time include:

— the Chester Mines Limited property, (100 per cent owned by the Sullivan Group) with reserves of about 18 million tons grading 0.8 per cent copper and 2 per cent zinc. A decline is now being driven to reach some 2.8 million tons that has a higher grade, particularly in copper (1.6 per cent). When this access to the mineralized zone is completed, the company will be able to assess the production potential of the property.

— the Restigouche property (3.3 million tons of 11 per cent combined lead-zinc and 2.5 ozs. of silver a ton) and the Kennco-Murray property (23.6 million tons of 1.95 per cent zinc, 0.48 per cent copper, 0.86 per cent lead and values in gold and silver), were optioned to Canex Placer Limited in May 1974. Placer paid $2 million to acquire a 75 per cent interest in the Restigouche property with Gowganda Silver Mines Limited retaining 25 per cent.

— the Half-Mile Lake property, recently purchased by Texasgulf Inc., and the Bay Copper Mines Limited property, 80 per cent owned by Conwest Exploration Company Limited. This is a common boundary deposit containing an estimated 6.8 million tons grading 6.5 per cent zinc and 2.5 per cent lead, with an additional one million tons or so of ore grading about 2 per cent copper. Texasgulf will spend a minimum of $100,000 a year for the next five years to explore the property further.

— the Key Anacon Mines Limited (1,859,000 tons of 7.43 per cent zinc, 3.03 per cent lead, 0.2 per cent copper and 2.67 ozs. of silver a ton). A shaft to 1,500 ft was sunk on this property in 1952.

Some of the other major companies active in the area are: Noranda; Union Minière Explorations and Mining Corporation Limited (Umex); Kerr Addison Mines Limited; S.E.R.E.M. Ltd.; Boliden-Preussag Exploration; Newmont Mining Corporation; and Imperial Oil.

Quebec. Quebec mines produced less zinc in 1974 than in 1973. Six out of nine producing mines recorded decreases in output.

The Lake Dufault Division of Falconbridge Copper Limited decreased production mainly on account of lower-grade ore. The company experienced some mining problems in higher-grade stopes. In December the company announced that it will temporarily close its Norbec mine at year-end, principally because of the low copper price. The principal concentrator however will continue to process Norbec ore from the surface stockpile. Ore reserves at the Millenbach mine are 2,141,000 tons, averaging 4.33 per cent zinc, 3.54 per cent copper, 1.49 ozs. silver a ton. In addition, the Norbec surface stockpile has 315,000 tons of lower-grade ore. A significant copper-zinc orebody was outlined by surface exploration about 7,000 feet southwest of the Millenbach shaft. Planning was in progress at year-end for a two-year, $8 million underground exploration program that would include a 4,000-ft exploration — production shaft.

Manitou-Barvue Mines Limited, operated at normal levels throughout the year. The company intends to continue production at the same level and reports reserves for about five years of operation. The company optioned their former Barvue mine to Noranda after dewatering the old open pit in September. At closing time, in 1957, reserves were estimated at 4,000,000 tons averaging 3.5 per cent zinc and 1.2 ozs. of silver a ton. Development ore last milled in 1957 was 360,119 tons, grading 3.3 per cent zinc and 1.3 ozs. of silver a ton.

Table 5. Canada mine output, zinc, 1973-74

	1973	1974p
	(short tons)	
Newfoundland	12,913	26,913
Nova Scotia	20	—
New Brunswick	214,512	169,104
Quebec	170,616	154,496
Ontario	509,502	508,060
Manitoba-Saskatchewan	80,233	80,395
British Columbia	148,742	93,787
Yukon Territory	143,373	126,176
Northwest Territories	216,589	204,985
Total	1,496,500	1,363,916

Source: Statistics Canada.
p Preliminary; — Nil.

Mattagami Lake Mines Limited produced at a slightly higher rate than in 1973. Grades of ore, concentrate and recovery were improved. A new zinc regrind mill and a computer system for the flotation circuits were installed during 1974. The company continued active exploration and commenced development at its Lyon property in Ontario. Ore reserves totalled 12,000,000 tons averaging 8.7 per cent zinc, 0.66 per cent copper, 0.98 oz. of silver and 0.015 oz. of gold a ton.

Production at Orchan Mines Limited was down by one third compared with 1973 production. Ore treated in the Orchan mill totalled 364,030 tons including 219,865 tons averaging 6.96 per cent zinc and 1.00 per cent copper from the main mine and 144,165 tons averaging 1.47 per cent zinc and 1.45 per cent copper from the Garon Lake mine. Shortage of skilled labour and high turnover were the main causes of lower output. Ore reserves were reduced to 1,350,750 tons averaging 8.8 per cent zinc and 1.1 per cent copper at the Orchan mine and 215,120 tons averaging 1.5 per cent zinc and 1.8 per cent copper at Garon Lake.

There were some delays in development at the new mine of Norita Quebec Mines Limited (scheduled for production 1976) where shaft sinking advanced to 993 feet below surface. Reserves there are 1,637,000 tons of ore averaging 7.6 per cent zinc and 0.7 per cent copper. At the Radiore No. 2 property, the ramp decline was completed, but further development and production plans have been deferred pending higher copper prices.

Table 6. Canada, zinc production, exports and consumption, 1965-74

	Production		Exports			
	All Forms[1]	Refined[2]	In ores and concentrates	Refined	Total	Consumption[3]
	(short tons)					
1965	822,035	358,498	487,445	264,200	751,645	93,796
1966	964,106	382,605	591,332	256,153	847,475	107,052
1967	1,111,453	405,136	735,705	297,652	1,033,357	107,779
1968	1,159,392	426,728	855,818	318,707	1,174,525	115,978
1969	1,207,625	466,357	804,665	307,394	1,112,059	118,681
1970	1,251,911	455,471	892,043	351,454	1,243,497	105,641
1971	1,249,734	410,643	891,092	312,462	1,203,554	115,433
1972	1,244,142	524,885	766,202	408,310	1,174,512	130,764
1973	1,352,074	587,038	944,127	465,575	1,409,702	129,653
1974p	1,278,139	469,883	957,766	325,572	1,283,338	121,218

Source: Statistics Canada.
[1] New refined zinc produced from domestic primary materials (concentrates, slags, residues, etc.) plus estimated recoverable zinc in ores and concentrates shipped for export.
[2] Refined zinc produced from domestic and imported ores.
[3] Refined primary zinc only, reported by consumers.
p Preliminary.

At Joutel Copper Mines Limited, production declined markedly in 1974 principally because the estimated grade of zinc ore in reserves has not been achieved in mining. The mine will close in June 1975. The Normetal mine of Kerr Addison Mines Limited continued salvage operations throughout 1974 and is expected to close in the second quarter of 1975 almost one year later than originally anticipated.

The Sullivan Group reported output for 1974 at the same levels as for 1973, with some additional output from the Clinton mine offsetting the lost output from the Weedon mine which closed in 1973. The Clinton mine is a deposit with limited reserves and its future as a viable operation is uncertain due to the current low price of copper.

Quebec Mining Exploration Company (SOQUEM) has greatly increased potential ore reserves at its Louvem mine during 1974. The zinc-rich mineralization occurs in three orebodies, apart from the copper ore. The combined reserves are now estimated at 1,115,000 tons grading 8.4 per cent zinc. Reserves in the first zone, from which production started in early 1975, are placed at 500,000 tons averaging 12 per cent zinc. Louvem Mining Company Inc. can now count on six to eight years of continuous operations. Ore is currently trucked to the Manitou-Barvue mill, but consideration is being given to the installation of a concentrator at the mine.

Selco Mining Corporation Limited and Pickands Mather & Co. continued an intensive drilling program in Brouillan Township, Detour River area, approximately 60 miles west of Matagami. Good copper and zinc values were obtained over impressive widths of up to 200 feet, but the average grade of zinc appears to be in the order of 2 to 2.5 per cent. This deposit has major tonnage potential (upwards of 30 million tons), and appears to be one of the best finds in the province since the discovery of the Mattagami deposit. It will take many months to delineate its full potential, as it apparently has a geologically complex structure. Selco has also been active in the Frotet Lake area, where encouraging mineralization has been found on the optioned Lessard property (Selco 80 per cent — Muscocho Explorations Limited 20 per cent). Drilling on this and the nearby Moleon property (Falconbridge Nickel Mines Limited) in which Selco has 54 per cent interest, resulted in ore intersections, but it is currently considered that more tonnage will have to be found before viable mining operations can be contemplated. On the Lessard option alone, reserves to the 1,200-ft level are estimated at 1.2 million tons averaging 3.4 per cent zinc, 1.56 per cent copper and 0.83 oz. of silver a ton.

Noranda has bought the Magusi copper-zinc property in Hebecourt township, 25 miles northwest of Noranda. It adjoins west of the New Insco Mines Ltd. *et al.* copper property taken over last year. The deposit contains 4,110,000 tons averaging 3.55 per cent zinc, 1.2 per cent copper, 0.91 oz. of silver and 0.032 oz. of gold a ton. Half of this ore is amenable to open-pit mining and the deposit could be in production by 1978 or 1979.

Patino Mines (Québec) Limited made a discovery in late 1973 of copper-zinc mineralization, 16 miles southeast of Chibougamau. Drilling to April 1974 outlined 625,000 tons averaging 10.8 per cent zinc, 4.5 per cent copper, 2.7 ounces silver and 0.138 ozs. of gold a ton. The deposit is being developed by a subsidiary company, Lemoine Mines Limited. Shaft sinking to a depth of 1,000 ft began in 1974 and in early 1975 reached a depth of 700 feet. It was earlier reported that the ore will be trucked to the Chibougamau concentrator; the company however bought a second-hand mill and is now installing it on the property. Initial production is scheduled for late 1975 – early 1976 at approximately 400 tons per day.

Abcourt Metals Inc. took a close look in 1974 at the possibility of mining its zinc-silver deposit in Baurraute Township where underground work was carried out previously. One of several estimates places reserves at 700,000 tons grading 4.2 per cent zinc, and 7.7 ounces silver a ton, and another at 2.1 million tons grading 3.1 per cent zinc and 4.0 ounces of silver a ton.

Ontario. Ecstall Mining Limited (Texasgulf Inc.) recorded a slightly lower production than last year mainly because of a decrease in the grade of zinc in the ore. The company completed its second year of underground mining and, in 1974, 968,000 tons of ore production came from underground while 2.7 million tons were mined from the open pit. At the beginning of 1975 about 40 per cent of production came from underground, and the underground output is gradually being increased, so that it will supply the entire mill feed of 10,000 tpd by 1976–77.

The company recently embarked on a $95-million mine expansion program designed to increase mining from 3.6 to 5.0-million tpy. Sinking of a new 5,300-ft shaft has begun, and the 210-ft headframe was completed. This expansion program was initially suspended between May and July 1974 while the company considered the effects of the proposed and, subsequently, amended Ontario tax legislation.

From the start of operations in 1966 to the end of 1974, the Kidd Creek mine produced 28.6 million tons of ore that assayed 1.56 per cent copper, 0.38 per cent lead, 9.66 per cent zinc and 4.3 ounces of silver a ton. At the beginning of 1975 unmined ore reserves above the 2,800-ft level were estimated at 94 million tons. No definite estimate of reserves below the 2,800-ft level has been made; however, ore reserves are sufficient to operate the deeper "second mine" for many years. The orebody is still open at depth and the deepest drilling intersection is approximately 5,000-ft beneath the surface. Copper grade increases with depth and zinc decreases.

Mattabi Mines (60 per cent owned by Mattagami Lake Mines Limited and 40 per cent by Abitibi Paper Company Ltd.) completed its second year of full production with a considerable decrease in zinc output, since a much lower grade of ore was processed. This decrease was planned by the company, and the output in 1975 will be slightly less than that of 1974. Plans are underway for underground mining, since the open-pit ore will be mined out by the end of 1978. At the end of 1974, ore reserves were calculated at 11,059,035 tons averaging 6.51 per cent zinc, 0.64 per cent lead, 0.74 per cent copper and 2.42 ounces silver a ton.

During the year, Mattagami Lake Mines decided to bring into production its Lyon Lake property, 5 miles east of the Mattabi mine. A $5 million shaft to a depth of 1,500 feet will be started in early 1975. Shaft rock-structure probing holes encountered ore grade mineralization at the 1,500 to 1,600-ft level and there was some delay in finalizing the shaft location. To the 1,000-ft level, reserves at the Lyon and Creek zones were reported at 3,096,000 tons averaging 6.20 per cent zinc, 1.15 per cent copper, 0.60 per cent lead and 3.3 ozs. of silver a ton.

In October, Sturgeon Lake Mines Limited, opened its zinc-copper-lead-silver mine, which adjoins the Mattabi mine, three months ahead of schedule. The initial mill rate is 800 tpd and will be raised in 1975 to 1,200 tpd. Ore reserves are 2,172,000 tons grading 10.19 per cent zinc, 2.80 per cent copper, 1.42 per cent lead and 5.82 ozs. of silver a ton. The mine is owned 67 per cent by Falconbridge Copper Limited and 33 per cent by NBU Mines Limited. Falconbridge provided 93.4 per cent of mine financing of about $16 million.

Willroy Mines Limited, completed normal year of operations recovering slightly more zinc than last year since a higher grade of ore was mined. The company completed a 3-year exploration program without much success and has ore reserves for about 2 years.

In the same area, Geco Mines Limited produced substantially more zinc than last year, when a 65-day work stoppage occurred. Ore reserves are sufficient for another 15 years of mining.

At its South Bay Mine, in the Uchi Lake area of northwestern Ontario, Selco Mining Corporation completed a successful year of operation. The company embarked on a $2.5 million development program which includes deepening the shaft from the 1,400- to the 2,100-ft level. The company reported that a "significant new ore zone" was found between the 600- and 900-ft levels and shaft pilot hole drilling encountered good ore at depth. Two years ago the company had only three years reserves in sight; management now considers that mining will continue for several years.

Manitoba and Saskatchewan. Hudson Bay Mining and Smelting Co., Limited recorded a lower zinc output in 1974 than in 1973. This was partly due to the continuing shortage of experienced miners, partly to mining lower grade ore, and partly to difficult mining conditions and interruptions by development work in some of the higher grade mines. The company decided to close the Schist Lake mine in late 1975 or early 1976. Proven reserves in the 10 mines in the Flin Flon-Snow Lake area at year-end totalled 17,973,800 tons assaying 2.7 per cent zinc, 2.89 per cent copper and 0.50 oz. of silver a ton. The grade of reserves now reported has been reduced as the calculation includes a 15 per cent dilution factor and an estimated recovery of 90 per cent. Formerly, a 10 per cent dilution factor was used.

The company continued development at the new Centennial mine, scheduled for production in 1975 at a rate of 685 tpd. Ore reserves are 1.4 million tons grading 2.06 per cent copper, 2.6 per cent zinc, 0.70 oz. of silver and 0.04 oz. of gold per ton. Development also started during the year at the Westarm property, discovered in 1973, with reported reserves of 710,000 tons grading 4.63 per cent copper and 0.6 per cent zinc. The company is also studying the possibility of mining a large block of ore located "just under a lake" at its rich Chisel Lake mine.

Sherritt Gordon Mines, Limited increased production at its Fox mine. The increase, although grade was down, was accounted for by an increase in the total tons mined and a slight increase in recovery. The improvement in recovery was a result of modifications to the zinc circuit of the mill, but the company still considers overall zinc recoveries to be disappointing. The access decline to deepen the mine from the 2,000-ft to the 2,200-ft level was completed during the year. Ore reserves decreased and as of year-end were 10,700,000 tons averaging 2.07 per cent zinc and 1.95 per cent copper.

The Ruttan mine completed its first year of operation, and start-up problems related to the first winter of operations under severe weather conditions (equipment failures and faulty equipment problems) were ironed out. Labour shortage problems were also felt, but not as intensely as at the Fox Lake mine where the situation was described as critical. Work proceeded on the underground mine, where two declines, one for equipment and one for an ore conveying system, were driven to the 1,000-ft level by October 1974. These will be continued to the level of the lowermost crusher unit at 1,975-ft. Many phases of the underground program however were behind schedule and capital costs are rapidly escalating. A complete review of the underground mine is now underway. Originally it was planned to phase in the underground mine by 1979 with transition to complete underground mining by 1981. Ore reserves at year-end were 45,900,000 tons grading 1.52 per cent zinc and 1.45 per cent copper. The grade may have to be revised as information indicates that at upper levels, ore grade was about 20 per cent below the feasibility projections.

British Columbia. In British Columbia, Cominco's Sullivan mine at Kimberley and the H.B. mine at Salmo were shut down by a four-month strike from July 1 to November 1, 1974. As a result, zinc mine production was only 58 per cent of last year's output. The United Steelworkers of America, representing 4,200 workers, reached a contract agreement in mid-October, but did not return to work while the contract of some 500 office and technical workers represented by the Association of Commercial and Technical Employees remained to be settled. The two unions agreed to a 30-month contract, ending on April 30, 1977. As a result of the lengthy closure, full mine production was not restored until the end of the year. For the first six months, however, the two mines had a higher output than for the corresponding period of last year.

Production at the Lynx and Myra Falls mines of Western Mines Limited, on Vancouver Island, fell from last year's levels; ore grades were slightly lower but lower throughput of ore accounted for most of the decline. At year-end, ore reserves were reported at 1,887,900 tons, with an average grade of approximately 7.5 per cent zinc, 1.2 per cent lead and 4 ounces silver a ton.

Reeves MacDonald Mines Limited continued operations at its Annex mine (with small amounts of ore coming from the Reeves mine) in southern B.C., on a slightly higher level than last year. Zinc production in concentrates decreased slightly due to lower grade. The company completed the installation of a tailings pond in July 1974 at a cost of $350,000 and opened the old No. 3 Reeves shaft. With limited reserves and escalating operating costs, the company decided to close the mine on February 11, 1975. Salvage operations which will include treating about 30,000 tons of ore will continue to the end of April 1975.

Output for 1974 was lower at the Silmonac mine of Kam-Kotia-Burkham Joint Venture. Ore reserves are limited, but management is considering further exploration.

Consolidated Columbia River Mines Ltd. stated that it will attempt to arrange financing to reopen its 55 per cent held, Ruth Vermont Mine near Golden. Production at this mine resumed in September 1973, but the mine was shut down at the end of December. Reserves are estimated at 291,384 tons grading 5.65 per cent zinc, 4.78 per cent lead and 6.62 ounces of silver a ton.

Zeballos Development Company Ltd. did some development work on the Alice Lake Mines Limited property at the north end of Vancouver Island where some 100,000 tons of ore grading about 12.5 per cent zinc were outlined. The company purchased a mill in Timmins, Ontario and they intend to reinstall it during the first three months of 1975 and begin production at 200 tpd by mid-1975.

Dolly Varden Mines Ltd. is considering opening up its mine located 17 miles from Alice Arm at a rate of about 1,000 tpd. Costs would be about $9 to 10 million. At last report, reserves were placed at 1,712,444 tons grading 9.52 ounces of silver a ton, 0.82 per cent zinc and 0.53 per cent lead.

Northair Mines Ltd. announced that it will put into production its gold-zinc-lead property located 70 miles north of Vancouver at 300 tpd. Reserves on three veins calculated after allowance for dilution are as follows: Warman vein, 250,000 tons (0.71 ounce gold, 0.85 ounce silver per ton, 0.25 per cent copper, 1.42 per cent lead, 2.35 per cent zinc); Manifold vein, 87,400 tons (0.27 ounce of gold, 14.3 ounces silver, 0.28 per cent lead and 0.57 per cent zinc); Discovery vein, 121,800 tons (0.10 ounce gold, 1.18 ounces silver, 0.55 per cent copper, 5.43 per cent lead and 6.58 per cent zinc). Production is scheduled to start by the end of 1975.

Yukon Territory. Cyprus Anvil Mining Corporation Limited completed the year with a 27 per cent lower zinc production than in 1973 due to a 33-day walk-out that closed the mine in May and June. Milling of lower grade ore also contributed to the decline. Subsequently, transportation problems were encountered. The labour contract expires in September 1975, but an interim 29.2 per cent wage increase for the remainder of the contract was negotiated.

The merger between Dynasty Exploration Limited and Anvil Mining Corporation, agreed upon in March, has been held up on account of U.S. tax rules, but the formalities are expected to be completed before mid-1975. The company is currently operating under the name Cyprus Anvil Mining Corporation.

United Keno Hill Mines Limited milled a lower tonnage of ore than last year, principally due to a critical shortage of experienced miners. Output of zinc was down markedly as erratic zinc grades with high iron content contributed to a low zinc recovery, down 11 per cent from the previous year. At year-end, the company reported proven and probable reserves sufficient for two more years of operation. A very active exploration program was maintained throughout the year.

The Yukon Territory experienced its third year of high exploration activity. The highlight for the year was the discovery of another zinc-lead-silver deposit in the Vangorda Creek area by Kerr Addison Mines Limited (60 per cent)and Aex Minerals Corporation (40 per cent). Although the deposit has significant tonnage potential, no reliable reported figure is yet available. Grades of most of the significant intersections are in the range of 5 to 10 per cent zinc, 3 to 6 per cent lead and 1.0 to 2.5 ozs. of silver a ton. A 55,000-ft drilling program was about three quarters completed. Part of the orebody might be mined as open pit, but most of the values are in deeper zones suitable only for underground mining.

The Bonnet Plume area was also the centre of intense activity with the best showing to date being Barrier Reef Resources Ltd.'s Goz Greek property where some 1 million tons grading in excess of 15 per cent zinc (and low lead), have apparently already been outlined within a selected faulted zone of a stratiform carbonate formation that contains extensive disseminated mineralization of lower grade (in the 3 to 6 per cent zinc range).

Several other companies have good prospects in the area, some with mineralization containing more lead than at Goz Creek. It is believed that unabated exploration will continue in this district in the 1975 field season. Placer Development Limited continued its program in the Summit Lake area (Howard's Pass property) where several million tons of good grade ore are already delineated in a black shale horizon which is regionally widespread. The mineralization is stratiform, and grades of up to 30 per cent combined zinc-lead over widths of up to 50 feet have been reported. At McMillan Pass, Hudson Bay Mining and Smelting Co., Limited holds the Tom deposit, where reserves are reported at 8.6 million tons of 8.4 per cent zinc, 8.1 per cent lead and 2.75 ozs. of silver a ton. This deposit was not fully outlined, and potential for more ore is excellent.

In the presence of a strong market for zinc concentrates, which is most likely to be the case, the aforementioned discoveries allow one to envisage one more large mine in the Ross River-Anvil district, and one in the McMillan Pass area (Tom deposit) by 1980; the Summit Lake area could have a mine by that time or in the early-1980s; the Bonnet Plume and Godlin Lakes area could have one producing mine each by the mid-1980s. The Yukon and the adjacent part of N.W.T. would claim a zinc production of some 600,000 tpy by about 1986. This would include Anvil, since it would still be in production.

Northwest Territories. Pine Point Mines Limited, in the N.W.T., had a normal year of production despite the strike at Trail where about 70 per cent of its concentrates are usually shipped. Production was marginally lower than in 1973. All production was shipped, but some was rerouted overseas. Ore reserves at year-end increased to 39.5 million tons grading 5.7 per cent zinc and 2.2 per cent lead. During the year, Pine Point started production from the Coronet deposits purchased in 1972, and purchased the Conwest 408 orebody for $3.5 million. There are no definite plans to start mining the 408 orebody, but it adds an estimated 1,414,000 tons grading 9.6 per cent zinc, and 3.4 per cent lead to a depth of 350 feet to the Pine Point reserves.

In the Godlin Lake area of the N.W.T., Welcome North Mines Ltd., and a number of other companies completed an extensive exploration program resulting in numerous zinc-lead showings being outlined for future detailed exploration. Cominco optioned the Bear Twit property from Welcome North Mines and apparently outlined in excess of 10 million tons of ore grading between 8 to 10 per cent zinc.

Near Bathurst Inlet, Cominco completed its fifth season of drilling on the Bathurst Norsemines Ltd. property. To date, three main deposits and some additional mineralized zones, each carrying good silver, zinc, lead and copper values have been outlined. Bathurst Norsemines estimates that total drill-indicated reserves are in the order of 20 million tons, with good potential for increased tonnages.

On June 18, the Honourable Jean Chretien, Minister of Indian and Northern Affairs, announced that the government will invest $16.7 million towards the opening of the lead-zinc mine of Mineral Resources International Limited (MRI) on Strathcona Sound on Baffin Island at a total cost estimated at $55 million. The operating company, known as Nanisivik Mines Ltd., will be owned 59.5 per cent by Mineral Resources International, 18.0 per cent by the federal government and 11.25 per cent each by Metallgesellschaft Aktien Gesellschaft of Germany and Billiton N.V. of Holland. The latter two companies will buy the major part of zinc concentrates, while Texasgulf will take 20 per cent. The orebody is estimated to contain 6.9 million tons grading 14.1 per cent zinc, 1.4 per cent lead and 1.77 ounces of silver a ton, and will be mined at a rate of 1,500 tpd starting late in 1976 or early 1977.

Texasgulf has a 35 per cent carried interest as the original owner and will recover its $3 million exploration costs. Texasgulf also undertook to provide up to $10 million in capital costs overrun if necessary. Construction of surface facilities began on schedule, and progress with underground development was satisfactory during 1974.

Arvik Mines Ltd. (Cominco 75 per cent and Bankeno Mines Limited 25 per cent) has a 25-million-ton orebody grading, after dilution, 18.4 per cent combined zinc-lead (about 3.5 to 1 ratio) on Little Cornwallis Island northwest of Resolute. A decision on production may be made during 1975. Potentially it is a major project for startup somewhere between 1978 and 1982. No decision has been made public on the final mining rate.

Metal production. Production of refined zinc at the four Canadian plants in 1974 was 469,883 tons, 20 per cent lower than in 1973. Approximately 75 per cent of the Canadian zinc production is High Grade (HG – 99.9%) and Special High Grade (SHG – 99.996%) form, the rest in other grades. The production was distributed as follows:

	Production Refined Zinc	Rated Annual Capacity
Canadian Electrolytic Zinc Limited, (CEZ) Valleyfield, Quebec	134,800	145,000*
Cominco Ltd., Trail, B.C.	162,000	270,000**
Hudson Bay Mining and Smelting Co., Limited, Flin Flon, Manitoba	77,996	79,000
Ecstall Mining Limited, Hoyle, Ontario	107,900	120,000***

* Expansion to 225,000 tpy by 1975 is underway.
** Expansion to 300,000 tpy (1972-77) (including conversion of tank house) is underway.
*** Expansion to 180,000 tpy by 1976-77 was planned, but currently is in abeyance.

Production of refined zinc in 1974 was 78.6 per cent of rated capacity compared with 95 per cent in 1973.

Canadian Electrolytic Zinc Limited, which operated at 100 per cent capacity in 1973, lost some production at the Valleyfield plant, from April 20 to June 2, 1974 due to a 44-day strike. A three-year contract to June 1977 was signed. Production included 772,000 pounds of cadmium. The plant operated at about four per cent above rated capacity for the remainder of the year, after the strike. Production delays and equipment delivery problems have resulted in the expansion program completion date being set back several months to September 1975. Inflation has increased the estimated capital expenditure from $30 million to $56.5 million.

Hudson Bay Mining and Smelting Co., Limited produced 77,996 tons of zinc in 1974, some 5,000 tons less than in 1973. Production was reduced due to lack of oxides and to the necessary cutback so that the roasters could be connected to the new 825-ft stack. The company also lost several days of production with the breakdown of the zinc fuming furnace in late August. Approximately 53 per cent of the concentrates processed in the zinc plant are purchased and 47 per cent are from the company's mines in the Flin Flon — Snow Lake area.

Cominco had a four-month strike, at Trail, from July 1 to November 1 and full production after the settlement was not achieved until the end of the year. Losses in output for the year were approximately 95,000 tons in zinc and 70,000 tons in lead. Earlier in the year, Cominco curtailed operation for a few weeks following the electrical fire of November 30, 1974 and did not achieve full capacity until mid-January 1974. The company completed the modernization of part of its electrowinning plant in early 1974 by installing larger tanks and mechanical stripping equipment. Some problems were encountered during the startup period with this new section. The company considers this section of the plant to be a pilot project and current experience will form the basis for a proposal in 1975 to continue with, and complete, a conversion of the entire plant which should take about two years. When it is completed, Cominco's effective capacity will be 300,000 tons of zinc metal a year.

Ecstall Mining Limited, a subsidiary of Texasgulf Inc., produced 107,900 tons of zinc at its Hoyle plant near Timmins. At year-end the plant was operating at its design level of 120,000 tons a year. The company formerly announced that it will redesign and expand its capacity to 150,000 tpy but this is, as yet, in the planning stage. At mid-year the company lost about three weeks of production through a failure of a roaster. Substantial improvements in output were expected in 1975, but market conditions may necessitate production cutbacks.

New zinc plants are currently being considered for several locations in Canada, notably in the Yukon Territory, in conjunction with deposits of the Anvil district; in Newfoundland, based on the local resource base, imports of concentrates and availability of relatively "low" cost power by 1980; in Nova Scotia, in conjunction with industrial development of the Straits of Canso; and in New Brunswick, on account of the excellent and expanding resource base. It was reported that Brunswick Mining and Smelting Corporation Limited is actively reviewing the matter. Given local resources, a plant with an initial capacity of 100,000 to 140,000 tons a year would have to be considered.

Approximately 12,000 to 14,000 tons of zinc oxide is produced annually in Canada. Three companies are the main producers, namely Zochem Limited, Pigment and Chemical Company Limited, and G.H. Chemicals Ltd. Their total productive capacity is about 40,000 tons a year.

Table 7. Canada, producers' domestic shipments of refined zinc, 1972-74.

	1972	1973	1974*p*
		(short tons)	
1st Quarter	38,336	33,169	42,060
2nd Quarter	41,925	37,125	43,646
3rd Quarter	26,212	36,322	26,851
4th Quarter	31,226	41,920	35,617
Total	137,699	148,536	148,174

Source: Statistics Canada.

Metal consumption. Producers' domestic shipments, which are a measure of apparent consumption were 148,174 tons in 1974 compared to 148,536 tons in 1973. Buoyant domestic consumption which began in early 1972 continued throughout 1973 and 1974. Signs of a general easing in consumption only appeared in late 1974 and early 1975, which is later than in most other industrial countries. As shown in Table 1, Statistics Canada measures consumption at the reported consumer level and consistently reports primary consumption below levels of shipments. Some of the difference is due to incomplete coverage and some to direct re-exports of metal originally acquired for domestic consumption by companies which took advantage of higher prices overseas. Increases in galvanizing and die-casting uses accounted for the moderate increase. Consumption of secondary zinc which is just less than 5 per cent of the total, considerably below U.S. levels, is expected to increase over the next few years.

World industry

Mine production. World mine production of zinc (preliminary) in 1974 increased only slightly to 4,955,000 tons from 4,991,000 tons in 1973. Europe had a net increase of 69,000 tons but almost all of it was accounted for by Denmark, with its new Black Angel mine in Greenland that achieved full production in late 1973. In Africa, the Republic of South Africa recorded the largest increase while The Republic of Zaire and Zambia registered small increases. Mine output on the continent of America decreased by 5 per cent with Canada accounting for most of the drop while Peru and Mexico also recorded small decreases. The United States recorded a small increase. Overall zinc mine output from Asia remained static with a significant decrease in Japan offset by increases in other Asian countries. Australian production dropped for the second consecutive year.

New mining projects now under construction or planned for startup in 1975 and 1976 have a potential of adding some 400,000 tpy. Closures will offset this increase by at least 40,000 tpy. There are indications that some of these projects may be delayed and some indefinitely deferred. In Europe, new mines will be opened by Société Minière et Metallurgique de Penarroya, S.A. at Saint Salvy, France (23,000 tpy – 1976)*; by Hellenic Chemical at Olympias, Greece (20,000 tpy – 1976); by RMHK Trepca at Blagodat, (26,000 tpy – 1976) and Brskovo, Yugoslavia (23,000 tpy – 1976); by Real Cia. Austuriana de Minas S.A. at Huelva, Spain (7,000 tpy – 1975); and a main expansion by Bolaget Vieille Montagne at Ammeberg, Sweden (22,000 tpy – 1976). Small increases are expected in Norway and Austria. In Africa, Penarroya will open the Fedj Hassen mine in Tunisia (7,000 tpy – 1976). In America, Canada leads with new mines and expansions, with Sturgeon Lake Mines Limited in full production for the first year (38,000 tpy – 1975); Newfoundland Zinc Mines Limited (44,000 tpy – 1976); Soquem at the Louvem mine (15,000 tpy – 1975); Lemoine Mines Limited (13,000 tpy – 1976) and completion of expansion by Heath Steele Mines Limited at their Little River mine to about 44,000 tpy – 1976 from the current level of 38,000 tpy. Increased zinc mine production is expected in the U.S.A. in particular from the New Jersey Zinc Company, Elmwood mine (18,000 tpy – 1975) and reopened Anaconda-Asarco, Park City mine (18,000 tpy – 1976). A small new mine will be opened in Guatemala by Tormex Mining Developers Ltd. (11,000 tpy – 1976). In Mexico Cia. Fresnillo S.A. is opening a new mine at Zimapan (8,500 tpy – 1975) and Minmex is expanding its mine near Taxco (24,000 tpy – 1976). The Gran Bretana mine in Peru will be expanded (7,500 tpy – 1975) as well as three others in Madrigal, Milpo and Juinin by a total of 23,000 tpy by 1976. In Asia, Dowa Mining Co. Ltd. will open the new Fukazawa mine (21,000 tpy – 1975) and in Australia, EZ Industries Ltd. will open the Beltana mine (18,000 tpy – 1976.)

Firm mine development projects for the period from 1977 to 1978 include the large Navan project in Ireland where settlement of the industry – government dispute on taxation and ownership paved the way for a startup of production by 1977 with full capacity of some 190,000 tons of zinc a year reached in 1978; the Rubiales mine in Spain (73,000 tpy – 1978) brought to production by Exminesa, a company in which Cominco Ltd. has the principal interest; the Stekenjokk mine in Sweden (13,000 tpy – 1977), the Nanisivik mine in the Canadian Arctic expected to achieve initial production in early 1977 with full production for 1978 (66,000 tpy); the Huari-Huari mine in Bolivia (30,000 tpy – 1977); the expansion of the Santa Barbara mine of Rosario Resources Corporation in Honduras (by 5,500 tpy – 1978); the opening of two mines in the Zawar and Rajpura districts of India jointly adding up to 66,000 in 1977 from which some initial output is currently derived. In Brasil, Metais de Minas Gerais S/A will bring a new mine into production in the Paracatur district in 1978. Full capacity at approximately 35,000 tons a year will be reached in 1979. Iran plans to increase mine production by an unspecified amount (reported up to 100,000 tpy) by 1977 from three existing mines. This may be a high expectation. One of the Aggeneys deposits in South Africa (Phelps Dodge) should be brought into production by 1978. It could yield up to 60,000 tons of zinc a year if the capacity of the mill is finalized at, say, 10,000 tons a day.

For the later part of the 1970s and early 1980, several countries have large zinc deposits that may be developed under generally favourable economic conditions. These are: Canada – Arvik deposit, in the Arctic

* All dates are for reaching capacity, not start up.

Islands, two deposits in the Yukon Territory and one on Nova Scotia; U.S.A.–four deposits of which three from the Tennessee zinc district; South Africa–Gamsberg deposit; Mexico–deposits of the Zacatecas district; Australia–the Hilton, Lady Loretta, Mackintosh, Woodlawn; and Elura deposits that jointly have the potential to add more than 250,000 tons a year to world zinc mine output. In addition there is the very large McArthur River deposit with reserves estimated in excess of 220 million tons averaging approximately 9 per cent zinc at 4 per cent lead. Access and metallurgical problems in treating this predominantly fine-grained ore make it difficult to forecast a target date for production from this deposit.

Table 8. World[1] mine production of zinc, 1972-74

	1972	1973	1974^p
	(short tons)		
Canada	1,401,693	1,496,500	1,363,916
United States	525,581	526,243	542,998
Australia	518,306	483,363	470,907
Peru	352,739	454,152	426,594
Japan	309,859	291,010	265,546
Mexico	296,962	293,214	287,703
West Germany	153,001	155,426	148,371
Sweden	121,034	126,545	120,042
Spain	98,106	105,160	103,837
Republic of Zaire	110,231	97,003	99,208
Yugoslavia	81,902	82,343	95,901
Ireland	104,719	91,492	92,594
Zambia	77,713	80,689	90,720
Italy	113,097	86,642	84,327
Finland	55,005	64,595	65,367
Other countries	479,069	556,552	695,750
Total	4,799,017	4,990,929	4,953,781

Sources: International Lead and Zinc Study Group. For Canada, Statistics Canada.
[1] Total figures in respect to "other" countries exclude data relating to Bulgaria, China, Czechoslovakia, East Germany, Poland, Romania, North Korea and the U.S.S.R.
^{p} Preliminary.

Metal production. Noncommunist world metal production in 1974 totalled 4,719,000 tons compared with 4,664,000 tons in 1973. Actually, the 1974 figure may be slightly over-estimated, and actual production could have been about equal to that of 1973. Producers' stocks amounted to 243,600 tons at the beginning of the year and increased to 397,500 tons by the end of 1974; most of the increase took place in November and December. Zinc smelters and refineries operated near their capacities for the first three quarters of the year, but cutbacks in production took place in the fourth quarter, mainly in Japan. The world zinc smelting capacity in 1974 was estimated at 4,932,000 tons, and output amounted to 95.5% of capacity which is above levels that can be sustained on a long-term basis. Indeed, many smelters postponed routine maintenance operations until early 1975 which was fortuitous since it corresponded to a period of increasing over-supply.

Most of the industrialized countries except for Canada, Australia and the U.S.A., recorded increases in metal production in 1974. The substantial cutbacks in Canada and Australia were due mainly to strikes, whereas the decrease in the U.S.A. was a combination of labour problems, power supply problems and start-up difficulties in the rehabilitated Sauget smelter that replaced production from the Blackwell smelter closed during 1973 (both operated by AMAX).

Throughout 1972, 1973 and almost until the end of 1974 there was a prevailing anxiety about the low level of smelting capacity around the world. This fact was particularly underlined by the U.S. press against a background of consecutive closure of seven obsolete U.S. smelters within a period of four years. Several obsolete smelters were also closed in Europe and Japan but these were replaced by new facilities. By the end of 1974 it became evident that there was enough new smelter construction in progress or committed, to dispel any notion of a bottleneck in the metal producing sector. By contrast, there is a growing awareness that zinc mine concentrate supplies might present problems on a longer-term basis.

Following a typical cyclical pattern, there is evidence that there may be a surplus zinc smelting capacity for the next five years, at least. The expected increases in world capacity for 1975 to 1979 are shown in metric tons on Table 10. The rise from 4,927,000 metric tons in 1974 to 6,321,000 metric tons in 1979 corresponds to an annual growth rate of 5.1 per cent. Out of a total of 84 plants, 5 will probably close between 1975 and 1979; 9 new facilities are expected to achieve production and at least 17 other smelters will undergo expansion and modernization programs. The table is in a large measure self-explanatory. Attention is drawn on the more problematic issues. Asarco's Stephensport facility, initially projected for completion by 1977 at 162,000 metric tons a year has been postponed several times and it appears now that a plant of 90,000 metric tons will be completed by 1979 with a possibility of a future increase in capacity. However this is not yet a final corporate decision and a further postponement is possible if the company is not successful in negotiating long-term concentrate supply. Asarco's plant at Amarillo will definitely close in June 1975. Construction of the Clarksville zinc plant of New Jersey Zinc Company was also postponed and is now firmed up for completion by 1979, at a capacity of 81,000 metric tons. Belgian technology (Mechim) may be used. In both cases, uncertainties of future supplies of concentrates were major obstacles to higher capacities, although, in general, U.S. mine production is currently on the rise.

Further expansion of the Timmins, Ontario plant of Texasgulf Inc., originally expected for 1976, was postponed indefinitely and an increase will probably not occur much before 1979. The new Mexican plant, projected initially for 1976 – 77 at San Luis Potosi was also postponed. Startup may occur in 1978 with full capacity to be reached in 1979. The project will have Japanese capital and "know-how." Expansion of the two Brazilian plants to a combined capacity of about 80,000 tons by 1979 is planned to be in step with mine production increases.

The expansion of smelting capacity in India is most uncertain. Until recently, plans were made to double capacity at the existing smelters at Debari and the Kerala district and construct a small new smelter at Visak with East European technical help. The alternative plan, which may now prevail is to concentrate all efforts on one smelter of 100,000 tons capacity. Japanese plans have not changed much in the past year except that the small Mitsui, Miike smelter will not be closed in 1974 – 75, as originally announced. The new smelter for South Korea may be postponed beyond 1978 or may be of lower capacity; e.g., 50,000 tons instead of the originally announced objective of 80,000 tons. The Japanese were conducting negotiations, but there is no agreement to date.

In Europe, plans for the smelter in the United Kingdom at Teeside are in abeyance. It is believed now that if a decision is made to proceed with the project, full-capacity utilization would not be achieved before 1979. Spain's program to increase total capacity to about 245,000 tons by 1979 is well on schedule and is in step with a major expansion in mine supplies. However Spain may still have to import some 20 per cent of its zinc concentrates requirements in 1979. In Turkey, good progress is being made towards completion of the zinc plant in 1976; however, it is expected that full capacity utilization of 40,000 tons will not be achieved for a considerable length of time.

World consumption and trade

The preliminary estimate of world consumption of zinc in 1974 is 5,037.7 tons, a decrease from 5,389.1 tons in 1973. The consumption in the first half of 1974 was sustained at the same rate as in 1973 and the drop came in the last five months. The largest decrease, 9.1 per cent, was recorded in America whereas European consumption declined by 5.4 per cent and that of Japan by 5.9 per cent. These preliminary estimates are frequently subject to substantial revisions and the final total figures may be slightly lower.

The galvanizing and brass sectors remained strong almost to the end of 1974, but the diecasting and the zinc oxide sectors, largely dependent on the welfare of the automotive industry, were very weak. With the advent of 1975, all sectors were weak.

The major consuming areas in the world, excluding communist countries, are western Europe, the United States, and Japan which, between them, used 4.00 million tons of zinc in 1974 or 79.5 per cent of the total world consumption, compared with 82.0 per cent in 1973. By contrast, these areas produced only 1.71 million tons or 34.6 per cent of the world's mine output of zinc. The remaining requirement, approximately 2.29 million tons, was imported as either zinc in concentrates or as refined metal. Japan and western Europe imported mainly concentrates, whereas the United States imported 69.2 per cent of its requirements as metal and 30.8 per cent as concentrates. In 1974 the major consuming areas produced 3.08 million tons of refined metal, or 72.0 per cent of world production compared with 70.5 per cent in 1973. This

(text continued on page 598)

Table 9. World[1] production of refined zinc, 1972-74

	1972	1973	1974^p
	(short tons)		
Japan	887,139	929,137	936,743
United States	706,911	628,758	581,909
Canada	524,885	587,038	469,883
West Germany	395,399	435,412	440,483
Belgium	280,207	304,899	318,347
France	288,254	285,939	304,458
Australia	334,772	337,748	288,805
Italy	171,850	200,620	231,375
Mexico	92,374	79,366	148,812
Spain	119,049	119,601	140,765
Finland	89,397	88,075	100,641
United Kingdom	81,350	92,484	95,350
Netherlands	53,242	33,620	85,539
Norway	80,799	88,736	82,563
Peru	76,941	76,720	78,044
Republic of South Africa	52,029	58,753	72,091
Republic of Zaire	73,855	74,957	70,548
Other countries	228,434	242,341	272,633
Total	4,536,887	4,664,204	4,718,989

Sources: International Lead and Zinc Study Group. For Canada, Statistics Canada.
[1] Total figures in respect to "other countries" exclude data relating to Bulgaria, China, Czechoslovakia, Eastern Germany, Poland, Romania, North Korea and the U.S.S.R.
^{p} Preliminary.

Table 10. Forecast of world zinc plant capacity, 1973-1979 (thousands of metric tons)

		Zinc Plant[1]		Estimated Capacity			Expected Capacity				
Area or Country	Company	Location	Type	1972	1973	1974	1975e	1976e	1977e	1978e	1979e
North America				**1,300**	**1,272**	**1,378**	**1,419**	**1,482**	**1,511**	**1,524**	**1,772**
U.S.A.				**705**	**621**	**664**	**655**	**636**	**656**	**656**	**827**
	Anaconda	Great Falls, Mont.[2]	E	64	—	—	—	—	—	—	—
	Amax	Blackwell, Okla.[3]	HR	80	40	—	—	—	—	—	—
	Amax	Sauget, Ill.[4]	E	—	20	73	73	73	73	73	73
	Asarco	Amarillo, Tex.[5]	HR	50	50	50	21	—	—	—	—
	Asarco	Corpus Christi, Tex.	E	95	95	95	115	115	115	115	115
	Asarco	Stephensport, Kty.[6]	E	—	—	—	—	—	—	—	90
	Bunker Hill	Kellogg, Ida.	E	96	96	96	96	96	96	96	96
	National Zinc	Bartlesville, Okla.[7]	HR (E)	50	50	50	50	52	52	52	52
	New Jersey Zinc	Palmerton, Pa.[8]	VR	80	80	80	80	80	100	100	100
	New Jersey Zinc	Clarksville, Tenn.[9]	E	—	—	—	—	—	—	—	81
	St. Joe Minerals	Monaca, Pa.[10]	ET	190	190	220	220	220	220	220	220
Canada				**504**	**549**	**557**	**567**	**649**	**658**	**658**	**700**
	Cominco	Trail, B.C.[11]	E	244	244	244	254	264	273	273	273
	HBM & S	Flin Flon, Man.	E	73	73	73	73	73	73	73	73
	Noranda, Mattagami	Valleyfield, Que.[12]	E	132	132	132	132	204	204	204	204
	Texasgulf	Timmins, Ont.[13]	E	55	100	108	108	108	108	108	150
Mexico				**91**	**102**	**157**	**197**	**197**	**197**	**210**	**245**
	Industrial Minera Mexico	Rosita	HR	61	62	62	62	62	62	—	—
	Ind. Min. Mexico	San Luis Potosi[14]	E	—	—	—	—	—	—	75	110
	Zincamex	Saltillo	HR	30	30	30	30	30	30	30	30
	Penoles	Torreon[15]	E	—	10	65	105	105	105	105	105
South America				**129**	**137**	**137**	**137**	**154**	**154**	**310**	**330**
Argentina				**42**	**42**	**42**	**42**	**42**	**42**	**42**	**42**
	Sulfacid	Borghi	E	26	26	26	26	26	26	26	26
	Cie Metallurgica	Comodoro	ET	16	16	16	16	16	16	16	16
Bolivia	Machino	Altiplano[16]	E	—	—	—	—	—	—	30	50
Brazil				**19**	**22**	**22**	**22**	**39**	**39**	**75**	**75**
	Cia Industrial e Mercantil Inga	Itaguai	E	7	7	7	7	14	14	30	30
	Cia Mineira de Metais	Tres Marias[17]	E	12	15	15	15	25	25	45	45
Peru				**68**	**73**	**73**	**73**	**73**	**73**	**163**	**163**
	Cerro de Pasco	La Oroya	E	68	73	73	73	73	73	73	73
	Mitsui	Cajamarquilla[18]	E	—	—	—	—	—	—	90	90

Asia				**959**	**979**	**1,009**	**1,086**	**1,086**	**1,106**	**1,198**	**1,278**
India				**38**	**38**	**38**	**38**	**38**	**58**	**86**	**106**
	Hindustan Zinc	Debari[19]	E	18	18	18	18	18	18	36	36
	Hindustan Zinc	Visak[20]	E	—	—	—	—	—	20	30	30
	Cominco-Binani	Kerala[21]	E	20	20	20	20	20	20	20	40
Iran	Government	Northwest[22]	E	—	—	—	—	—	—	—	40
Japan				**906**	**926**	**956**	**1,022**	**1,022**	**1,022**	**1,022**	**1,022**
	Akita S. Co.	Iijima[23]	E	78	78	90	156	156	156	156	156
	Hachinohe S. Co.	Hachinohe	ISP	72	72	72	72	72	72	72	72
	Mitsubishi M. Corp.	Akita	E	90	90	90	90	90	90	90	90
	Mitsubishi M. Corp.	Hosukura	E	21	21	21	21	21	21	21	21
	Mitsui M. & S.	Hikoshima[24]	E	66	66	84	84	84	84	84	84
	Mitsui M. & S.	Hamioka	E	72	72	72	72	72	72	72	72
	Mitsui M. & S.	Miike[25]	E	22	22	22	22	22	22	22	22
	Mitsui M. & S.	Miike[26]	VR	100	120	120	120	120	120	120	120
	Nippon M. Co.	Mikkaichi	ET	120	120	120	120	120	120	120	120
	Nisso S. Co.	Aizu	E	31	31	31	31	31	31	31	31
	Sumiko ISP Co	Harima	ISP	60	60	60	60	60	60	60	60
	Toho Zinc Co.	Annaka[27]	E	174	174	174	174	174	174	174	174
Korea, South				**15**	**15**	**15**	**26**	**26**	**26**	**50**	**50**
	Eiho Shoji Co.	Sekiho	E	9	9	9	20	20	20	—	—
	Young Poong Mining	Onzan[28]	E	—	—	—	—	—	—	50	50
	Tong Shin Chemical	Seoul[29]	E	6	6	6	6	6	6	—	—
Thailand	Tahi Zinc	Mae Sod[30]	E	—	—	—	—	—	—	40	60
Australia				**310**	**315**	**315**	**315**	**335**	**335**	**335**	**335**
	Electrolytic Zinc	Risdon[31]	E	195	200	200	200	220	220	220	220
	Sulphide Corp.	Cockle Ck.[32]	ISP	70	70	70	70	70	70	70	70
	Broken Hill Assoc. Smelters	Port Pirie	E	45	45	45	45	45	45	45	45
Europe (EEC)				**1,291**	**1,348**	**1,473**	**1,516**	**1,581**	**1,581**	**1,581**	**1,681**
Belgium				**286**	**316**	**316**	**328**	**328**	**328**	**328**	**328**
	Metallurgie Hoboken	Overpelt[33]	VR(E)	88	88	88	100	100	100	100	100
	Vieille Montagne S.A.	Balen	E	168	168	168	168	168	168	168	168
	Soc Prayon	Ehein[34]	E	30	60	60	60	60	60	60	60
France				**288**	**288**	**288**	**289**	**299**	**299**	**299**	**299**
	Vieille Montagne S.A.	Viviez	E	94	94	94	94	94	94	94	94
	Vieille Montagne S.A.	Creil	HR	9	9	9	—	—	—	—	—
	Pennarroya S.A.	Noyelles	ISP	105	105	105	105	105	105	105	105
	Cie Royale Asturienne	Auby[35]	VR(E)	80	80	80	90	100	100	100	100
Germany, F.R.				**422**	**429**	**424**	**424**	**459**	**459**	**459**	**459**
	Preussag AG	Harlingerode	VR	94	94	94	94	94	94	94	94
	Preussag AG	Nordenham[36]	E	88	105	105	105	105	105	105	105

Table 10. (concl'd)

		Zinc Plant[1]		Estimated Capacity			Expected Capacity				
Area or Country	Company	Location	Type	1972	1973	1974	1975^e	1976^e	1977^e	1978^e	1979^e
Germany (cont'd)											
	Ruhr Zink-Metallges.	Datteln	E	130	130	130	130	165	165	165	165
	Berzelius-Metallges.	Duisburg	ISP	90	80	80	80	80	80	80	80
	Duisburger Kupf.	Duisburg	ES	20	20	15	15	15	15	15	15
Italy				**155**	**175**	**215**	**235**	**255**	**255**	**255**	**255**
	Pertusola	Crotone[37]	E	70	70	80	80	100	100	100	100
	AMMI	Bergano	E	35	35	35	35	35	35	35	35
	AMMI	Monteponi[38]	E	15	15	15	15	15	15	15	15
	AMMI	Porto Marghera	E	35	35	35	35	35	35	35	35
	AMMI	Portovesme[39]	ISP	—	20	50	70	70	70	70	70
Netherlands				**50**	**50**	**140**	**150**	**150**	**150**	**150**	**150**
	Kempenscне Zinc de la Campine	Budel[40]		50	50	20	—	—	—	—	—
	Budelco	Budel[40]	E	—	—	120	150	150	150	150	150
United Kingdom				**90**	**90**	**90**	**90**	**90**	**90**	**90**	**190**
	Commonwealth Smelting	Avonmouth[41]	ISP	90	90	90	90	90	90	90	90
	Cominco	Teeside[42]	E	—	—	—	—	—	—	—	100
Europe (Others)				**363**	**388**	**428**	**508**	**583**	**663**	**668**	**678**
Austria	Bleiberger Bergwerks	Gailitz	E	17	17	17	17	22	22	22	22
Finland	Outokumpu OY	Kokkola[43]		90	90	90	150	150	150	150	150
Norway	Det Norske	Eitrheim	E	85	85	85	85	85	100	100	100
Spain				**110**	**110**	**125**	**140**	**190**	**245**	**245**	**245**
	Asturiana de Zinc	San Jaun de Nieva[44]	E	80	80	95	110	135	190	190	190
	Espanol del Zinc	Cartagena[45]	E	30	30	30	30	55	55	55	55
Yugoslavia				**61**	**86**	**111**	**116**	**136**	**146**	**151**	**161**
	Hemijska Industrija Zorka	Sabac	E	25	25	25	25	25	30	30	30
	R.-M.-H. Komb. Trepca	Trepca	E	36	36	36	36	36	36	36	36
	Government	Titov Veles[46]	ISP	—	25	50	55	55	55	55	55
Turkey	Cinkur	Kayseri[47]	E	—	—	—	—	20	25	30	40

Africa				**182**	**187**	**187**	**227**	**247**	**247**	**247**	**247**
Algeria	Government	Ghazaouet[48]	E	—	—	—	20	40	40	40	40
Republic of South Africa	Zinc Corp. of South Africa	Vogelstuisbuilt[49]	E	50	55	55	75	75	75	75	75
Republic of Zaire	Soc. Metallurgique Katangese	Kolwezi	E	68	68	68	68	68	68	68	68
Zambia	Nchanga Cons. Copper	Broken Hill	ISP	34	34	34	34	34	34	34	34
	Broken Hill Div.	Kabwe	E	30	30	30	30	30	30	30	30
Total				**4,534**	**4,626**	**4,927**	**5,220**	**5,480**	**5,609**	**5,875**	**6,321**

[1] Type of zinc plant abbreviated as follows: HR – Horizontal Retort; VR – Vertical Retort; ET – Electrothermic Smelter; ISP – Imperial Smelting Process; E-Electrolytic. [2] Plant closed down August 1972 (147,000 mtpy capacity). [3] Plant closed down at the end of 1973 and production was replaced by E. St. Louis plant. (Sauget) [4] Initial production, September of 1973. [5] Plant is closing down in June 1975 because of pollution regulations. [6] A new electrolytic plant was to be built by 1977, deferred to 1979. [7] Replacement by a new electrolytic plant of approx 52,000 mtpy by 1976-77. [8] Replacement by a new electrolytic plant by 100,000 mtpy by 1977; plans in abeyance. [9] New plant, smaller capacity than originally planned, provision for increases. [10] A 30,000 mtpy expansion was completed. Capacity also added to zinc oxide plant. [11] Expansion of part of the plant was completed in 1972, giving an effective capacity of about 244,000 mtpy. Further expansion and modernization of facilities, e.g., tank house may be completed by 1977, raising effective capacity of all components of the plant to about 272,000 mtpy. [12] Present plant capacity of 131,500 mtpy will be expanded to 204,000 mtpy by the end of 1975. [13] The originally planned capacity of 108,000 mtpy was attained by the end of 1973. Expansion of capacity to 163,000 mtpy is in abeyance. [14] A feasibility study was completed on a 70,000 to 110,000-mtpy plant to be in operation by 1977; construction now delayed. [15] This 105,000-mtpy plant started up December 1973 and is expected to be at full capacity in 1974. [16] A new 50,000-mtpy electrolytic plant is expected to be completed in 1979. [17] Plans are to expand over next 3 years to a capacity of 45,000 mtpy. [18] This new electrolytic plant is expected to start operations at a capacity of 90,000 mtpy by 1977, with plans for further expansion. [19] A proposal to double the capacity by 1977-78 has not yet been approved. [20] A new 30,000-mtpy electrolytic plant should be commissioned by 1977 (constructed with assistance of Poland). Plant could be expanded. [21] Plans are to double capacity to 40,000 mtpy by 1978-79. [22] A plant of approximately 75,000 mtpy could be constructed by 1979 with technical assistance from Japan. [23] The plant commenced production in 1971 with a capacity of 71,000 mtpy and was increased to 91,000 mtpy by 1973. It will be expanded to 104,000 mtpy in mid-1975 and to a final capacity of 163,000 mtpy by 1977-1978. [24] Capacity was increased from 66,000 mtpy to 84,000 mtpy in January 1974. Plans called for an increase to 168,000 mtpy by 1977, but are in abeyance because of environmental and power supply considerations. [25] Plant output is less than half of rated capacity. Plant was scheduled to be closed in 1974, then in 1975, but a modernization and expansion program was substituted in early 1975. [26] There was an expansion of capacity in 1973. [27] Actual capacity is 174,000 mtpy, but this plant operates at a reduced capacity of 140,000 mtpy because of environmental considerations. [28] A new 50,000-mtpy plant was planned for 1978-79, possibly with Japanese capital and technical help. (Toho Zinc) [29] The operation of this plant was resumed in March 1973. [30] This smelter will be constructed with Australian technology suitable for oxide ores. [31] An expansion of capacity by 20,000 mtpy is expected by the end of 1975. [32] Full-capacity operation was attained at the end of 1972. [33] A new 100,000-mtpy electrolytic refinery replaced the old 88,000-mtpy plant in mid-1974. [34] The old plant was replaced with a new 60,000-mtpy electrolytic plant in mid-1972. [35] Will be replaced by a new electrolytic facility by the end of 1975. [36] The new electrolytic zinc plant commenced operations in 1972. Penarroya has 25 per cent. [37] Expansion of capacity from 60,000 to 80,000 mtpy was completed in September 1972. Further expansion is in progress. [38] Monteponi has an effective capacity of about 15,000 mtpy but plant was originally rated at 30,000 mtpy. [39] Construction at this new 70,000-mtpy plant was completed in mid-1973. [40] A new 150,000-mtpy electrolytic zinc plant replaced the old facility in early 1974, but tune up problems delayed full utilization to mid-1975. [41] Expansion from 100,000 mtpy to 150,000 mtpy by 1979-80 is possible. [42] Construction decision is in abeyance. Earliest possible completion may be 1979. [43] Expansion to 150,000 mtpy is to be completed in 1975. [44] A gradual expansion from 80,000 mtpy to 190,000 mtpy is to be phased in over a period of four years. [45] Operations to be expanded to 55,000 mtpy by 1976. [46] This new ISP plant should reach full capacity of 55,000 mtpy in 1975. [47] This new 40,000-mtpy electrolytic plant is expected to be operational in mid-1975. Progress to full capacity utilization will be slow. [48] Capacity of new electrolytic plant is expected to be 40,000 mtpy when operations commence in 1975 or 1976. [49] Expansion of the plant to a capacity of 75,000 mtpy originally expected by 1978 was put forward to 1975.

Source: Mineral Development Sector.

^{e} Estimated; — Nil.

illustrates the fact that most of the world's smelting and refining capacity is concentrated in industrialized countries which must depend largely on imported concentrates. This relationship is changing only very slowly.

The U.S.A. is the only major industrialized country that maintains tariffs for zinc in concentrates. In the fall of 1974 a bill suspending these tariffs to June 30, 1977 was passed by Congress and the Senate but was vetoed by President Ford on November 26, 1974 because of an undesirable tax rider. It is expected that the same legislation will be reintroduced in early 1975. The U.S.A., Japan and the EEC maintain tariffs on zinc metal. Until January 1, 1973 the United Kingdom had no tariffs for Commonwealth countries, and since then tariffs are being gradually increased to reach a common EEC level by 1977. At the same time United Kingdom tariffs on zinc metal imports from the other member countries of the EEC are being progressively phased out. The EEC has also proposed to change their common specific tariff on zinc to an ad valorem tariff by July 1, 1975. This would effectively double their current protection level.

Table 11. United States zinc consumption by end-use, 1973-74

	1973	1974p
	(short tons)	
Galvanizing	563,837	494,241
Brass products	197,650	177,078
Zinc-base alloy	610,606	430,455
Rolled zinc	40,763	38,648
Zinc oxide	61,734	66,115
Other uses	29,348	30,584
Estimated undistributed consumption	—	56,800
Total	1,503,938	1,293,921

Source: U.S. Bureau of Mines, Mineral Industry Surveys, Zinc Industry in December 1974.
p Preliminary; — Nil.

Outlook

The downturn in economic activity experienced in 1974, developed into a major recession necessitating substantial revisions in recently forecast zinc supply-demand conditions for the period 1975 to 1979.* Demand in 1975 is now estimated to be 3,700,000 metric tons, a decrease of 24 per cent from the peak demand of 1973. Mine production will decrease slightly, but not as much as metal production which will be down to about 3.8 million metric tons, or possibly lower, as producers instituted major cutbacks in production. For 1975, there is an apparent statistical surplus build-up by year-end of some 300,000 metric tons after allowing for no sales from the GSA stockpile and imports from socialist countries at normal levels. However, since consumers overstocked during 1974 and are expected to draw down their inventories by some 300,000 to 500,000 metric tons during 1975, the demand for primary metal will be only in the order of 3,500,000 metric tons (against the projected output of 3,800,000 metric tons). It is clear that, as 1976 begins, the marketable surplus is not going to be the 300,000-metric-tons balance indicated on Table 12, but a total of about 600,000 metric tons, since "excessive" stocks which are now in producers hands should be included. This surplus will cover deficits projected for 1976, 1977 and part of 1978. Some industry experts, however, are of the opinion that by late 1976 or early 1977 consumers again will begin to accumulate stocks and any departure from normal levels may swiftly give rise to a tight-market situation.

In any event, sometime in late 1978 or possibly earlier in the year if consumers read the developing situation properly, a period of supply shortages may develop. This supply shortage could be worsened by any or all of the following developments: major disruption in mine supply through strikes or transportation difficulties; continuation of the present diminishing rate of exploration and development in the zinc industry; and lack of governmental policies in the developed countries to offset the aforementioned trend. Thus, there should be no complacency concerning the longer-term sector of the zinc industry, steps should be taken now to stimulate investment and prevent future supply problems.

Zinc uses

Zinc is used to galvanize steel and to make castings, alloys, sheet, zinc oxide and other compounds.

In galvanizing, zinc is applied as an impervious, corrosion-resistant coating to iron and steel products to prevent rust. Galvanized sheet it used in industrial, agricultural and residential construction; for guard rails, culverts and signs in road construction; and for rocker panels and other vulnerable parts of automobiles. Galvanized reinforcing rods are used in the construction industry, and galvanized structural members in bridge construction to save on painting and maintenance costs. Wire, pipe and numerous other articles are galvanized where protection is required. In the automotive industry the usage of galvanized sheet has been relatively steady over the last several years, averaging 160 to 170 pounds (using 11 to 12 pounds of zinc) per vehicle, but has declined to approximately 100 to 120 pounds in the 1971–73 models. The gauge of zinc coating is also decreasing. Zinc is currently about 6

* Zinc in 1975 to 1979, *CIM Bulletin*, March 1975.

Table 12. World production and consumption of Zinc – 1973-1979

	1973	1974^e	1975^e	1976^e	1977^e	1978^e	1979^e
	(thousands of metric tons)						
Mine production (gross)	4506	4478	4400	4600	4800	5200	5600
Metal production	4232	4279	3800	4400	4500	4900	5300
Metal consumption[1]	4889	4567	3700	4600	5000	5300	5600
Balance of metal production/ consumption	–650	–288	+150	–200	–500	–400	–300
Net exports of socialist countries	139	107	100	100	100	100	100
Net sales from U.S. stockpile	242	240	0	60	60	0	0
Balance[2]	(–279)	+59	+300	(–40)	(–340)	(–300)	(–200)
Metal production capacity	4626	4927	5220	5480	5609	5875	6321
Capacity utilization (%)	91.5	86.8	76.6	82.1	80.2	83.4	83.8

[1] Actual consumption in 1973 and 1974 combined, was lower by some 300,000 tons, since excessive stocks were accumulated by consumers. Thus the consumption of 3,700,000 tons forecast for 1975 corresponds to 3,400,000 tons in new deliveries and about 300,000 tons of surplus consumer stocks, worked back into the system.
[2] Statistical balance (surplus) of 300,000 tons in 1975 does not indicate all of the marketable surplus, since in addition some 300,000 tons to 500,000 tons of excessive stocks will be accumulated by producers during 1975 (with total producer stocks forecast to peak at 800,000 tons).
^{e}Estimated.

per cent by weight and will go down to about 5 per cent over the next two or three years. Consumption of galvanized sheet per automobile may increase slightly due to the availability of one-side galvanized sheet which allows for a higher welding productivity.

Diecastings made of zinc-base alloys are used in the automotive industry for such parts as grilles, headlight and taillight assemblies, fender extensions, door and window hardware, carburettors and fuel pumps. On average, new models contain about 50 lbs of zinc in these parts. Zinc diecast components, especially in trimmings, may decrease considerably in 1976 automobiles.

Zinc-base diecastings are used as components in household appliances such as washing machines and refrigerators, and in plumbing and hardware supplies. The alloys most commonly used for diecastings are made of special high-grade zinc (99.99 per cent or higher) to which is added 4 per cent aluminum, 0.04 per cent magnesium and up to 1 per cent copper. A new application which holds great promise is superplastic zinc alloy (SPZ). It is a material containing 78 – 80 per cent zinc and 20 – 22 per cent aluminum, which behaves like a metal at normal temperatures and like a plastic when heated to just over 500°F for forming. It has excellent pressure-vacuum forming characteristics with excellent deep-drawing and elongation characteristics. It has very good electrical conductivity and is highly corrosion resistant. It will take electroplating or painting. Principally because of its ductility, it is called a superplastic alloy, and will be used to manufacture pressed parts for the automobile and appliance industry. Parts made of superplastic zinc can be vacuum formed from sheet, when hot, with minimal energy and using very low-cost molds.

Brass, a copper — zinc alloy containing as much as 40 per cent zinc, has many applications in the form of sheets and strips, tubes, wire, rods, castings and extruded shapes. Rolled zinc is used in Canada mainly for making dry-cell batteries in which zinc serves both as the negative pole of the cell and as the container. In Europe, rolled zinc is a popular roofing and roof-flashing material. Other uses of rolled zinc are terrazzo trip and anticorrosion plates for boilers, dock pilings and ships' hulls. Zinc, in the form of 0.2 to 0.3 micron-size particles of zinc oxide (83 per cent zinc content), is finding increasing use as the major constituent of the paper coating for coated paper electrostatic copies. Demand for this application is expected to grow at a faster rate than for any other in zinc over the next few years. Zinc oxide is also used in compounding rubber and in making rayon yarn, ceramic materials, inks, matches, and many other commodities.

Weather-resistant paints based on zinc oxide and zinc dust provide one of the most effective and durable protective coatings on outside surfaces, especially metallic. A new application is a two-coat paint system known as Zincrometal that can be hot-rolled on coiled steel. It is applied on a chromium base coating. This system is reported to have corrosion resistance similar to galvanized steel, and could replace it in some applications. It has, however, important limitations, since tests show that it gives little if any sacrificial protection on scratched surfaces or cut edges. Nevertheless, its use is forecast to expand in the automotive industry particularly because of its good weldability. However, it may not be as a substitution to galvanized sheet but as an addition to its use.

Zinc dust, which is a finely divided form of zinc metal, is used in the process of printing and dyeing textiles, in zinc-rich paints, in purifying fats and precipitating gold and silver from cyanide solutions. The more important industrial compounds of zinc are zinc sulphide, which in combination with barium sulphate forms the pigment lithopone; zinc sulphate, used in rayon fibre manufacture; and zinc chloride, a wood preservative.

The International Lead Zinc Research Organization, Inc. (ILZRO) is the main body assisting industry to find new uses for lead and zinc. Promotion and advertising of new zinc products and processes is carried on by the Zinc Institute, Inc. which opened a branch office in Toronto in 1968. The development of thin-walled diecastings and of improved zinc-based diecasting alloys has done much to expand the use of zinc as a diecasting metal in competition with alternative materials such as aluminum and plastics.

Prices

After a year (1973) of very high and volatile zinc prices on the "free" market and grossly exaggerated levels of producer prices principally due to price controls in the U.S.A., the market in January 1974 settled into some semblance of stability. In the aftermath of the price increases in the U.S.A. that followed price decontrol in December, some U.S. producers moved up their price in January 1974 to the then current European producers level of 32 cents a pound (£300 a metric ton) while others raised it to only 28 cents a pound. Canadian producers in North America sold zinc for an average of 31.0 cents a pound. LME quotes took a plunge following U.S. decontrol of prices, plummeting from £875 a metric ton (92.7 cents a pound) on December 5 to £514 (51.9 cents a pound) on January 14. Markets remained tight in February and March setting off a chain reaction in which Canadian and offshore zinc producers selling on the North America market raised prices repeatedly so that by the end of March prices in the United States ranged from 32 cents a pound to 39.5 cents a pound. The lowest prices being quoted by United States producers, middle by Canadian and highest by offshore producers. Only New Jersey Zinc quoted zinc at 35.0 cents a pound. In Europe, Outokumpu Oy, the Finnish producer led off on March 11 by increasing the price to £330 a metric ton. In April, producers worldwide, finished off the round of price increases initiated by European producers. The price then remained firm at £330 a metric ton until September while Canadian, Australian and U.S. producers adjusted prices very gradually to reach the equivalent level. Some offshore producers quoted premium prices in the U.S.A. market, such as Minero Peru which raised it to 45 cents a pound for SHG in May, followed by Indussa, agent for Outokumpu Oy and UZK of Zaire. The effect of strikes in the U.S.A. and Canada helped to keep prices firm. Meanwhile, the LME price reached a high for the year of £872 a metric ton on May 6; thereafter it declined steadily to £445 a metric ton by mid-year and to £417 a metric ton by the beginning of September. By September, merchant zinc became readily available and the LME continued on a gradual and systematic decline to £301 a metric ton on December 31, 1974.

In September, the European producers raised their price to £360 a metric ton mainly because inflationary pressures raised production costs appreciably. Some market experts felt that the amount of the increase was hampered by the softening on the LME; however, in retrospect it is clear that producers gauged the market correctly in anticipating a prolonged period of lower demand in which a longer-term maintenance of a higher price would have been impossible. Indeed, by late October producer support for the LME market was reinstituted as this market traded below producers quotes. Effective support of the LME cash prices was extended into the first few months of 1975.

On October 21, in response to falling LME quotes, Minero Peru became the first producer to lower its United States quote from 45.0 cents a pound to 41.5 cents a pound. Indussa which still quoted premium prices on the United States market in October lowered its price in November and by the end of December all other offshore producers including Penoles and the Australians lowered their quotes of SHG zinc to 39.5 cents a pound, on par with Canadian producers. Feeling the burden of worldwide market depression producers started taking steps to curtail production first in Japan, then in Europe and Australia and, in early 1975, in the U.S.A. and Canada.

Table 13. Monthly zinc average prices in 1974

	Canada	United States	Producer basis (outside North America)	London Metal Exchange
	cents/lb	cents/lb	£/metric ton	£/metric ton
Jan.	31.1	31.0	300.0	597.9
Feb.	31.0	31.8	300.0	666.7
Mar.	31.0	33.1	314.0	696.5
Apr.	32.7	34.8	330.0	728.8
May	34.0	34.8	330.0	732.4
June	34.0	35.3	330.0	589.8
July	34.0	37.0	330.0	458.9
Aug.	35.8	38.0	330.0	454.1
Sept.	37.0	38.9	342.9	393.5
Oct.	37.0	39.0	360.0	353.6
Nov.	37.0	39.0	360.0	341.5
Dec.	37.0	39.0	360.0	331.3
Year	34.3	35.2	332.2	528.7

Source: International Lead and Zinc Study Group Bulletin.

Canadian price of Prime Western zinc, fob Toronto and Montreal, during 1974.

		(¢/lb)
January 1	to March 31	31.00
April 1	to July 31	34.00
August 1	to December 31	37.00

United States price, Prime Western zinc, delivered U.S.A.

		(¢/lb)
January 1	to January 9	28.00 – 32.00
January 10	to January 15	31.00 – 32.00
January 16	to February 10	32.00
February 11	to March 14	31.50 – 32.00
March 15	to March 27	31.50 – 35.00
March 28	to June 2	34.50 – 35.00
June 3	to June 9	34.50 – 36.00
June 10	to July 15	34.50 – 40.00
July 16	to July 24	35.00 – 40.00
July 25	to September 4	36.00 – 40.00
September 5	to December 31	38.00 – 40.00

Tariffs

The following Canadian and United States tariffs apply for zinc in its various forms.

Canada

Item No.	(British preferential and most favoured nation — all free.)	General
32900-1	Zinc in ores and concentrates	free
34505-1	Zinc smelter, zinc and zinc alloys containing not more than 10% by weight of other metal or metals, in the form of pigs, slabs, dust or granules/lb	2¢
34500-1	Zinc dross and zinc scrap for remelting, or for processing into zinc dust	10%
35800-1	Zinc anodes	10%

United States

Item No.		(¢/lb)
602.20	Zinc ores and concentrates, on zinc content	
	Unwrought zinc	0.67
626.02	Other than alloys of zinc	0.7
626.10	Zinc waste and scrap	0.75
603.30	Zinc dross and skimmings	0.75
		(%)
626.04	Alloys of zinc	19
653.25	Zinc anodes	
	On and after Jan. 1, 1970	13
	1971	11
	1972	9.5

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Zirconium

MICHEL A. BOUCHER

Canada does not produce zirconium or hafnium-bearing minerals but has a few occurrences of zircon (ZrO_2 SiO_2) which is the principal mineral source of zirconium. Hafnium is associated with zirconium in zircon.

Canada imports zircon concentrates mainly for the foundry industry, ferrozirconium for the steel industry and zirconium alloys for the nuclear industry. In 1974 Canada imported 2,561 tons* of zircon concentrates from Australia (the largest producer) compared with 8,304 tons in 1973 and 15,300 tons in 1972. The decrease of imports was due to the price increase of zircon concentrates during the past two years. In 1972, zircon concentrates were selling at $70.00 a ton. The price was raised to $100.00 in 1973 and to $500.00 in 1974. For this reason the foundry industry used substitute materials such as friable chromite, olivine sand and mixtures of chromite, zircon and silica sand in order to lower its consumption of zircon. Fine-ground alumina and synthetic spinel base powders may also be used as a substitute for zircon. The spectacular price increase of zircon of more than 600 per cent in two years was due to the extremely rapid growth of a new refractory application to zircon adapted by the Japanese steel industry. In response to this new outlet, Japan increased its share of western world zircon consumption from about 15 per cent in 1969 to just over 30 per cent in 1974. In 1974, the Japanese used over 100,000 tons of standard grade zircon for the lining of steel ladles used in pouring molten steel into ingots.

Canada's imports of zirconium alloys were 490,538 tons in 1974 compared with 309,157 tons in 1973. Zirconium alloys used by the nuclear industry are high-value products; for this reason the price increase of zircon can be absorbed more easily. Ferrozirconium is used for specialty steels, and the price of zircon does not represent a high portion of the selling price.

World production, trade and consumption

By far, the largest producer and exporter of zircon is Australia. In 1974, Australia produced some 450,000 tons of zircon concentrates. About 98 per cent of the Australian production is exported, mainly to Japan, the European Economic Community (EEC) and the United States. The world's second largest producer of zircon is the United States whose current production is of the order of 100,000 tons a year. The bulk of the output is consumed in the United States. India, Malaysia and the Republic of South Africa are very small producers. Noncommunist world production is estimated at 525 – 575,000 tons of concentrates. In 1974, the two largest consumers of zircon, namely the United States and Japan, consumed 200,000 tons and 150,000 tons respectively.

Table 1. Australia, zircon production, 1964-73

	Zircon Concentrate	Zircon (ZrO_2 SiO_2 Content)
	(short tons)	
1964	206,172	204,035
1965	254,087	251,612
1966	263,927	260,851
1967	317,724	313,963
1968	329,498	325,829
1969	413,612	399,394
1970	435,800	430,226
1971	455,196	450,111
1972	393,187	389,255
1973	393,336	388,197

Source: *Australian Mineral Industry, Quarterly Review,* March 1975.

The consumption mix in 1973 in the United States was 55% foundry sands, 15% refractories, 18% ceramics and 12% to make zirconium metal used in alloys for nuclear applications and in chemical processing equipment. With the price increase of zircon in 1974, the consumption of zircon by the foundry industry has decreased.

* The short ton (2,000 pounds) is used throughout unless otherwise stated.

Table 2. World production of zircon concentrates 1972-74

	1972	1973	1974e
Australia	393,187	393,336	450,000
Other free world excluding U.S.A.	20,000	15,000	25,000

Sources: U.S. Bureau of Mines Commodity Data Summaries, January 1975; *Australian Mineral Industry, Quarterly Review*, March 1974.
e Estimated.

The total capacity for zirconium sponge production in the Western World is about 9,000,000 pounds a year which could be increased to 10 – 12,000,000 pounds with one-to two-years' notice. In 1974, production was estimated at 7,500,000 pounds. Europe, Japan and Canada have a capacity sufficient to meet their demands until the late 1970s. The minimum viable size of a zirconium sponge production plant is about 1,000 tons a year.

Producers tend to meet the demand in their own countries, and opportunities for export are limited because tariffs are high in consuming countries. The two major world producers, Wah Chang Albany, Division of Teledyne Corp. of the United States and Pechiney Ugine Kuhlman Development, Inc. of France have reciprocal licence agreements for parts of their processes. Wah Chang and Pechiney Ugine, with a combined capacity of about 70 per cent of the noncommunist world, effectively dominate the U.S. and European markets.

Table 3. Estimated zirconium sponge production capacity, 1972

Country	Company	Capacity (tons/year)
United States	Wah Chang Albany Corp. Amax Specialty Metals Inc.[1]	3,000
France	Pechiney Ugine Kuhlman	1,000
Japan	Mitsui Mining Co., Ltd. Nippon Mining Co. Ltd.	250
Canada	Eldorado Nuclear Limited[2]	300
India	Nuclear Fuel Complex, Hyderadad	80

Sources: *Australian Mineral Industry, Quarterly Review, Vol. 26, No. 1*, Sept. 1973 and EMR files.
[1] Closed its operation in late 1974. [2] Plant was partly dismantled in 1974; a larger plant is expected to be built.

Table 4 shows the main zircaloy tube producers. There is some uncertainty in assigning figures to production capacity because zircaloy tube production is often integrated with special steel tube production, and machines may be reallocated according to demand. Wolverine Tube Division U.O.P. Company Limited is the largest producer in the United States and Sandvik is the largest producer in Europe. The demand for tubes in the United States, Japan and Europe is reported to be doubling every five years. A minimum viable scale of operation for tube production is around 100 km a year.

Nuclear Assurance Corporation of the United States estimates the 1974 production of zircaloy fuel cladding in the U.S., Europe and Asia at 11 million feet and forecasts a production of 64 million feet in 1980.

Table 4. Zircaloy tube producers, 1972

Country	Company
U.S.A.	Wolverine General Electric Co. Westinghouse Electric Corporation Amax Specialty Metals Inc. Sandvik Special Metals Chase Brass & Copper Company
France	Vallomec Co. (Cefilac Division)
Sweden	Sandvik Universal Tube
Germany	Vereinigte Deutsche Metallwerke A.G. Mannesman Roehrenwerke GmbH
Japan	Sumitoma Metal Mining Co. Ltd. Kobe Steel Co.

Sources: *Australian Mineral Industry, Quarterly Review, Vol. 26, No. 1, Sept. 1973;* EMR files.

Zirconium inventory and replacement demands for the different types of reactors are as follows:

	Tons of Zirconium/MW	
Type of reactor	Initial core	Annual replacement
CANDU	0.091	0.010
PWR (Pressurized Water Reactor)	0.030	0.009
BWR (Boiling Water Reactor)	0.058	0.015

Using the above data and projecting the nuclear power capacity requirements to 1985, Alder & Wright of the United States estimated in 1971 the demand for zircaloy tubes as follows:

United States	20,000 km
Europe	8,000 km
Japan	3,000 km
Canada	1,600 km

Table 3 shows typical chemical specifications for nuclear grade zirconium sponge, and the zirconium alloy Zircaloy – 2, used in nuclear reactors.

Table 5. Maximum permissible concentration (ppm)

Impurity	Zr Sponge	Zircaloy – 2
Aluminum	75	75
Boron	0.5	0.5
Cadmium	0.5	0.5
Chloride	1,300	—
Chromium	200	—
Cobalt	20	20
Copper	30	50
Hafnium	150	200
Hydrogen	—	25
Iron	1,500	—
Manganese	50	50
Nickel	70	—
Nitrogen	50	80
Silicon	120	200
Titanium	50	50
Tungsten	50	100
Uranium	3	3.5

Source: *Australian Mineral Industry, Quarterly Review, Vol. 26, No. 1, Sept. 1973.*

Canadian production, consumption and developments

There is no production of zircon ore in Canada, however, zircon is known to occur in small quantities in Temiscamingue County, Quebec, Argenteuil County, Quebec and Haliburton County, Ontario. The best prospect for a commercial operation however lies in the exploitation of the Alberta tar sands which contain 0.05 per cent zirconium (Zr) and 0.21 per cent titanium (Ti). Recovery of heavy minerals including zircon is under study by the oil companies involved in mining the tar sands, and experimental work has shown that by using froth flotation, the grade of zirconium and titanium in the sand could be raised to 2 per cent and 4 per cent respectively.

Most of the zircon imported by Canada is used in the foundry industry. A small quantity is used as ferrozirconium by Dominion Foundries and Steel, Limited (Dofasco), Esco Ltd., The Steel Company of Canada, Limited (Stelco), and Black Clawson-Kennedy Ltd. Wrought zirconium represents a small tonnage but, in terms of value, it is the highest valued product of zircon imported.

In the late 1960s, Eldorado Nuclear Limited started producing zirconium alloys for the nuclear industry. The plant had a production capacity of 300 tons a year of direct-cast alloy ingots and billets. At that time the company expected to sell 170 tons a year in the Canadian market and to export 100–130 tons a year. Eldorado had to compete in the export market with Wah Chang of the United States, whose production capacity was about six times that of Eldorado, and with Pechiney of France. Eldorado relied heavily on its sales to Ontario Hydro. However, because lower prices were offered by other producers, the sales did not materialize and the plant suspended operations.

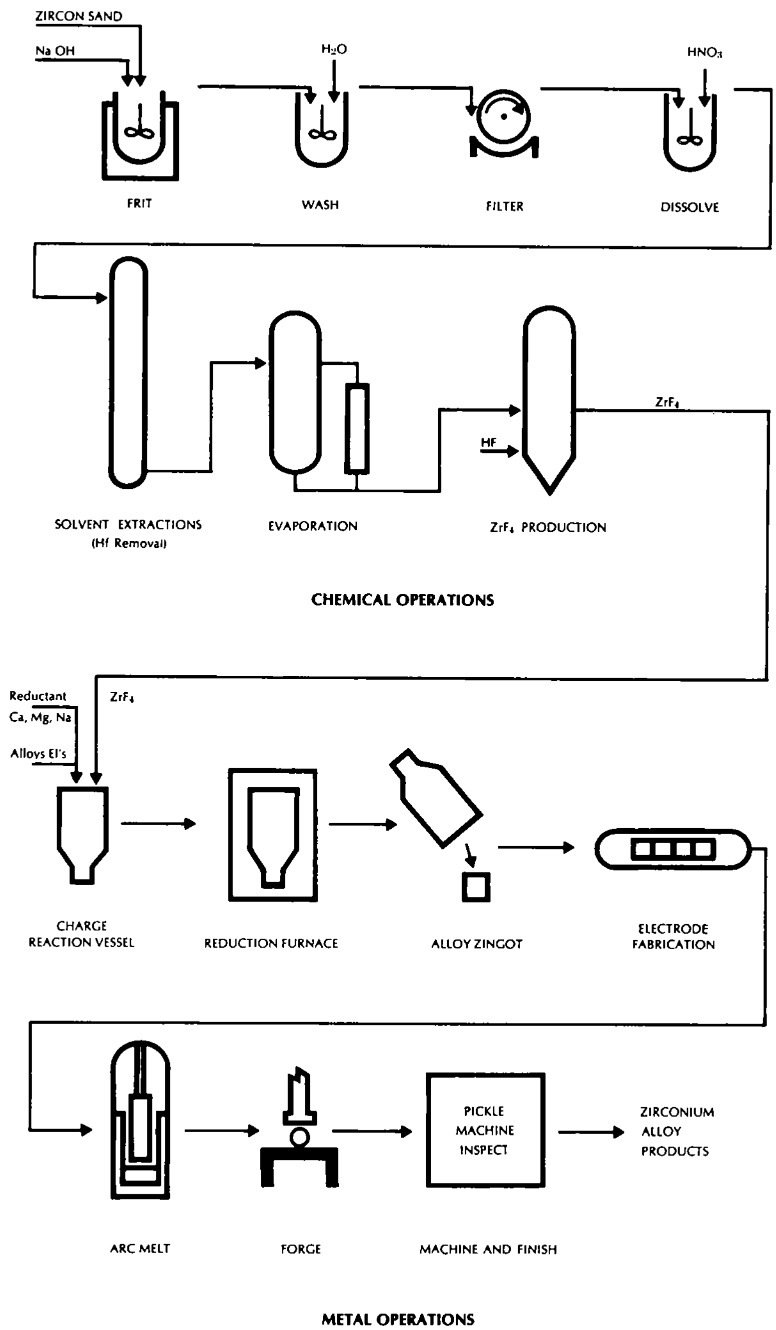
During 1974, Norco Industries Limited started construction of a tube mill at Arnprior. Construction is expected to be completed by the end of 1975. The plant is designed to produce zirconium alloy fuel sheathing

Table 6. Nominal compositions of zirconium alloys

Alloy	Alloying Additions – wt %					
	Sn	Fe	Cr	Ni	Cb	O
Zircaloy – 2	1.5	0.15	0.1	0.05	—	0.14
Zircaloy – 4	1.5	0.2	0.1	0.004	—	0.14
Zr – 2.5% Cb	—	—	—	—	2.5	0.14
Zr – 1% Cb	—	—	—	—	1.0	—
Zr – 3% Cb – 1% Sn	1.0	—	—	—	3.0	—
Ozhennite	0.2	0.1	—	0.1	0.1	0.09 – 0.12
Zr – 1% Cr – 0.1% Fe	—	0.1	1.2	—	—	—

Source: Canadian Nuclear Association Annual Conference, June 1969, Paper No. 69 – CNA – 537.

ELDORADO ZIRCONIUM PROCESS



and zirconium alloy pressure tubes and nickel alloy, specialty steel and titanium and titanium alloy steam generator, heat exchanger and condenser tubing.

The annual capacity of the plant will be 1,000,000 meters of zirconium alloy fuel sheathing, 2,000,000 to 3,000,000 meters of nuclear steam generator or heat exchanger tubing (Inconel and Incoloy) and about 1,000 zirconium alloy pressure tubes. Fuel sheathing capacity will be easily doubled or quadrupled if needed. The plant will have have a 3,500-ton-BLH-horizontal extrusion press, tube reducers (cold-pilgering mills), one vertical vacuum furnace over twenty feet long for heat treatment of zirconium alloy products, controlled atmosphere furnaces for heat treatment of the steam generator and heat exchanger alloy tubing and ultrasonic testing equipment. The standard range of products includes tubing with outside diameters from 10 mm to 115 mm and lengths up to 31 meters. Zirconium tubing will be used by the CANDU nuclear reactors in Ontario, Quebec and, eventually, New Brunswick. The company hopes to export an appreciable quantity of its production to the United States.

Chase Nuclear (Canada) Limited, a subsidiary of Chase Brass & Copper Co. Incorporated of the United States, operates a processing plant in Arnprior, Ontario that finishes and checks the tubes it receives from its parent company. Finishing includes straightening, drawing, grinding, grit blasting, cleaning and polishing. The tubes are also checked for roundness, wall thickness and defects. The company sells tubes to Ontario Hydro; however about half its production is exported, mainly to Europe. The company intends to extrude pressure tubes by 1978. There are two other production facilities in Ontario, namely Canadian General Electric Company at Peterborough, and Westinghouse Canada, Limited at Port Hope. Both companies produce and assemble fuel bundles.

Products and uses

The principal uses of zircon are in making sand moulds for steel and iron foundries, mould facings and cores and milled flour for moulds. It is used especially in steel foundry castings manufactured to stringent specifications. Silica sand, olivine and chromite are zircon's chief competitors in foundry use.

Zircon is used for other refractory applications as zircon sand and as zirconia (ZrO_2) in the manufacture of bricks and refractory shapes and ceramics. Milled zircon and zirconia are used as opacifiers in ceramic glazes and enamels, in electric insulators, pigments, abrasives and chemicals. The dioxide alone or mixed with other oxide carriers such as alumina, silica, magnesia, or clay is used as a catalyst in the production of gasoline and in the cracking stage of refining crude

Table 7. Ontario hydro requirements of zirconium tubing to 1983.

	1976	1977	1978	1979	1980	1981	1982	1983
				(000 pounds)				
		Pressure Tubing (Zr-Cb) and Calandria Tubing (Zircaloy – 2)						
Pickering B	71.8	143.5	71.8					
Bruce B			88.3	176.5	88.3			
Darlington				88.3	176.6	88.3		
E–16						88.3	176.6	88.3
E–17						88.3	176.6	88.3
Subtotal	71.8	143.5	160.1	264.9	264.9	264.9	353.2	176.6
		Fuel Sheathing (Zircaloy – 4)						
	151.3	174.4	194.4	248.7	324.3	381.2	426.0	476.5
Total	223.1	317.9	354.5	513.6	589.2	646.1	779.2	653.1
		Equivalent Ingot Weight						
Pressure calandria tubing	151.6	303.2	338.2	559.8	559.8	559.8	746.4	373.2
Fuel sheathing	275.1	317.1	353.5	452.2	589.6	693.1	774.5	866.4
Total	426.7	620.3	691.7	1,012.0	1,149.4	1,252.9	1,520.9	1,239.6

Source: Ontario Hydro.
The equivalent ingot weight figures have been calculated by using the following yield factors: Pressure tubes 45 per cent; calandria tubes 55 per cent; fuel sheathing 55 per cent.

Table 8. Canada, imports of zirconium alloys 1973-74

	1973		1974^p	
	(pounds)	($)	(pounds)	($)
United States	276,716	4,571,000	457,851	5,304,000
Sweden	30,137	828,000	27,685	646,000
West Germany	—	—	646	19,000
United Kingdom	1,800	3,000	4,200	9,000
Other countries	504	18,000	156	3,000
Total	309,157	5,420,000	490,538	5,981,000

Source: Statistics Canada.
^p Preliminary.

Table 9. Australia, exports of zirconium concentrates, 1971-73

	1971	1972	1973	1974^p
	(short tons)			
Japan	100,594	155,328	170,763	173,128
United States	78,076	59,346	97,518	52,463
Italy	26,005	35,487	45,551	41,429
Netherlands	29,895	36,419	42,358	31,428
United Kingdom	36,103	25,078	29,467	29,462
France	31,291	27,949	26,429	35,522
Belgium and Luxembourg	19,653	37,159	11,380	6,274
Canada	27,517	15,332	8,321	2,561
Other	54,361	32,960	43,626	56,013
Total	403,495	425,058	475,413	428,280
Value ($'000)		13,793	15,883	

Source: *Australian Mineral Industry, Quarterly Review*, March 1974.
^p Preliminary.

oils. Zirconium tetrachloride is the principal intermediate chemical compound used in the manufacture of other zirconium compounds.

Zirconium metal formed after the 1 to 5 per cent hafnium impurities occurring in zircon have been removed is called "reactor grade" and is used in nuclear power reactors. The important properties of zirconium in this application are its low neutron cross section (0.18 barns), good mechanical strength, high heat conduction and corrosion resistance. A 500,000-kilowatt unit of the CANDU-PHW (pressurized heavy water) type of power reactor installed at Pickering, Ontario, requires approximately 45–55 tons of zirconium in the installation and will require 6–8 tons a year for replacement fuel rods.

Unlike the United States, where enriched uranium is used in nuclear reactors, the Canadian reactors use natural uranium. Natural uranium releases less neutrons than enriched uranium, therefore, zirconium which has a low thermal neutrons absorption capacity is used in larger quantities in Canadian reactors than in American reactors.

Zirconium products used by the nuclear industry

Fuel sheathing or cladding (Zircaloy – 4). This is a hollow cylinder, 0.015 – 0.20" thick 0.5 – 0.6" diameter and about 20 inches long. One pound of alloy makes about 10 linear feet of fuel sheathing. The tubes last about one year in a nuclear reactor.

Pressure tube. This is a hollow cylinder, 0.15–0.20" thick, 4 inches inside diameter and 20 feet long. The pressure tubes used in Canada contain 2.5% Cb_2O_5 because they must resist corrosive fluids circulating inside of them at high pressures and temperatures. Each tube is placed concentrically inside a calandria tube. The tubes last 10 to 30 years. The average life is 15 years.

Calandria Tube (Zircaloy – 2). The calandria tubes consist of a hollow cylinder, 5 inches in diameter, 0.06" thick and 20 feet long; the tube is made from a sheet of zirconium. Its life expectancy is 20 years.

Hafnium, which is only recovered as a byproduct in the processing of zircon to reactor-grade zirconium, is used as a neutron control-rod material in nuclear power reactors. It is used in this application because of its high neutron absorption cross section (108 barns) which also makes necessary its removal from reactor-grade zirconium. Significant commercial use of hafnium outside the field of nuclear technology includes hafnium in the nickel-base superalloy component parts for gas turbine aircraft engines and the high-intensity photo-flash cube. Hafnium improves creep characteristics, ductility and working life of turbine parts. Hafnium metal as a shredded foil provides a photo-flash bulb or cube that gives a 50 per cent increase in light intensity and a colour that eliminates the need for a blue filter. Other uses, developed or proposed, are as incandescent filaments, as a "getter" in vacuum tubes to absorb traces of oxygen and nitrogen, as electrodes in X-ray tubes, in rectifiers, as a component of explosive detonating caps, as a surface coating on nickel and stainless steel by metallizing, and as a film for printed circuits.

Minerals and occurrences

Zirconium is widely distributed in nature and, although not one of the most abundant elements, it is estimated to form 0.22 per cent of the earth's crust. It is more abundant than zinc, nickel, copper or lead. The most important zirconium mineral is silicate, zircon (ZrO_2SiO_2). Because of its resistance to weathering, attrition and high specific gravity, it is found in beach deposits of heavy minerals in association with ilmenite, rutile and monazite. Oxide baddeleyite (ZrO_2), another important zirconium mineral, is found in the Republic of South Africa in the alkaline-carbonatite Phalaborwa complex. Zircon is theoretically 67.2 per cent ZrO_2 and 32.8 per cent SiO_2, but usually contains about 2 per cent hafnia (HfO_2). Baddeleyite is essentially pure zirconium oxide in crystalline form, but usually contains about 1 per cent hafnia. Certain altered varieties of zircon, such as alvite and cyrtolite, contain hafnia in amounts varying from 5 to 10 per cent.

Zircon is an accessory mineral in igneous, sedimentary and metamorphic rocks, but is rarely found in mineable concentrations except where weathering and reconcentration have occurred. It is a typical minor constituent of pegmatites and nepheline syenites, occasionally appearing as local patches of crystalline zircon and cyrtolite. It usually occurs as shiny, stout, brown crystals with low pyramids at the terminations.

Patches several square feet in area containing zircon crystals from one-tenth to one inch in diameter have been found in Haliburton County, Ontario. Occurrences of scattered crystals of zircon and cyrtolite have been found in Renfrew and Hastings counties and in Henry Township, Parry Sound district, Ontario. Rich zones of zircon crystals associated with titanite in a large body of pyroxenite have been found in Harrington Township, Argenteuil County, Quebec.

It is estimated that the Alberta tar sands contain some 56 million tons of zircon and 195 million tons of titanium dioxide, mostly in the form of leucoxene (which is an alteration production of ilmenite), rutile, and anatase.

The most important sources of zircon in Australia are in natural concentrations of heavy minerals found in beach sands on the east coast. Bulk concentrates of zircon-rutile-ilmenite sands range from 45 to 70 per cent zircon, 10 to 30 per cent rutile and 10 to 20 per cent ilmenite. Other constituents are monazite, garnet, cassiterite, tourmaline and spinel. Zircon will soon be available from the west coast of Australia where it is associated with rutile, ilmenite and monazite.

Zircon-bearing sands are also found in India, the Republic of South Africa, Ceylon, U.S.S.R., Sierra Leone and the United States.

Mining and concentration of mineral sands

Concentrations of mineral-bearing sands are mined by dredging to recover zircon, rutile and ilmenite. A fully floating plant has a capacity of 1,500 tons an hour. A small plant may have a capacity as low as 40 tons an hour. The mined material grading about 4 per cent heavy minerals by weight is fed into a wet-concentrating plant immediately behind or adjacent to each mining dredge, where the bulk of silica sand is removed and immediately returned to the mined-out area.

Prices

The price of zircon ore increased considerably in 1974, mainly because of a much stronger demand for zircon in Japan. The price of zirconium sponge, sheet and billets did not change. In 1975 the price should remain stable or decrease slightly, otherwise zircon will be replaced with other commodities.

Outlook

The current and future demand for zirconium metal alloys can be related directly to the growth of the nuclear industry. In the long-term, the nuclear industry is expected to grow faster than any of the base metal industries. In the short-term, the Canadian requirements will be determined by national energy policies and Canada's position on exports of nuclear reactors. The demand for zircon concentrates will continue to decrease in Canada unless the price decreases.

	Dec. 1974	Dec. 1973	Dec. 1972
	($ per short ton)		
Zirconium ore – Australia	560.00	95 – 100.00	65 – 70.00
– U.S.A.	138.00	54.00	54.00

	Dec. 1974	Dec. 1973
	($ per lb.)	
Billets/Bars – U.S.A.	8.00 – 11.00	8.00 – 11.00
Sheet/Strip – U.S.A.	12.00 – 17.00	12.00 – 17.00
Sponge – U.S.A.	5.50 – 7.00	5.50 – 7.00

Source: *Metals Week*, December 1974.

Tariffs

Canada

Item No.		British Preferential	Most Favoured Nation	General
34720-1	Sponge and sponge briquettes, ingots, blooms, slabs, billets and castings in the rough, of zirconium or zirconium alloys for use in Canadian manufacture (expires 28 February 1976)	free	free	25%
34730-1	Bars, rods, sheets, strip, wire, forgings, castings and tubes, seamless or welded, of zirconium or zirconium alloys for use in the manufacture of nuclear power reactors, including fuel components (expires 28 February 1976)	free	free	25%
33508-1	Zirconium oxide (effective 1-7-74)	free	5%	15%
92845-4	Zirconium silicate (effective 1-7-74)	free	free	free

United States

Item No.		
601.63	Zirconium ore (including zirconium sand)	free
629.60	Zirconium metal, unwrought, other than alloys, waste and scrap (duty on waste and scrap suspended on or before 30 June 1973)	6% ad val.
629.62	Zirconium, unwrought alloys	7.5% ad val.
629.65	Zirconium metal, wrought	9% ad val.
422.80	Zirconium oxide	5% ad val.
422.82	Other zirconium compounds	5% ad val.

Sources: For Canada, the Customs Tariff and Amendments, Department of National Revenue, Customs and Excise Division, Ottawa. For United States, Tariff Schedules of the United States Annotated (1975), TC Publication 706.

Statistical Summary

This chapter of the Yearbook is a statistical summary of Canadian mining and related activities. The statistical information is as comprehensive as possible given the availability of data.

The summary is divided into nine sections, each containing a number of statistical tables. The sections are preceded by a list of tables by section, number and title and by a table entitled Canada, general economic indicators, 1953-1974.

The sources of Canadian Mineral Industry statistics are Statistics Canada, other federal departments and agencies, provincial governments and company annual reports. International mineral statistics are derived from U.S. Bureau of Mines publications, *American Bureau of Metal Statistics, World Bureau of Metal Statistics, Metals Week, Engineering and Mining Journal,* United Nations and the Organization for Economic Cooperation and Development.

Where applicable, an explanation of a concept or a term is contained in the footnote to a statistical table. If further information is required, the source of the information should be consulted.

The statistical summary was prepared by J.T. Brennan and Staff, Statistics Section, Mineral Development Sector.

STATISTICAL TABLES

SECTION 6 EMPLOYMENT, SALARIES AND WAGES

SECTION 7 MINING, EXPLORATION AND DRILLING

SECTION 8 TRANSPORTATION

SECTION 9 INVESTMENT AND FINANCE

Canada, general economic

		1953	1954	1955	1956	1957	1958	1959	1960	1961
Gross National Product-current prices	$ millions	25,833	25,918	28,528	32,058	33,513	34,777	36,846	38,359	39,646
Gross National Product-1961 = 100	"	29,408	29,047	31,788	34,474	35,283	36,098	37,470	38,553	39,646
Value of manufacturing industry shipments	"	. .	. .	19,513	21,637	22,178	22,171	23,353	23,444	24,428
Value of mineral production	"	1,336	1,488	1,795	2,085	2,190	2,101	2,409	2,493	2,603
Merchandise exports	"	4,097	3,860	4,258	4,760	4,789	4,791	5,022	5,256	5,755
Merchandise imports	"	4,248	3,967	4,568	5,547	5,473	5,050	5,509	5,482	5,769
Balance of trade, current account	"	+443	+432	+698	+1,366	+1,455	+1,131	+1,504	−1,243	−982
Corporation profits before taxes	"	2,611	2,290	2,965	3,345	3,056	3,075	3,504	3,359	3,427
Capital investment, current prices	"	5,968	5,802	6,531	8,196	8,813	8,488	8,500	8,328	8,292
Capital investment, 1961 = 100	"	6,682	6,458	7,068	8,439	8,944	8,634	8,568	8,281	8,292
Population	000's	14,845	15,287	15,698	16,081	16,610	17,080	17,483	17,870	18,238
Labour	"	5,397	5,493	5,610	5,782	6,008	6,137	6,242	6,411	6,521
Employed	"	5,235	5,243	5,364	5,585	5,731	5,706	5,870	5,965	6,055
Unemployed	"	162	250	245	197	278	432	372	446	466
Unemployment rate	%	3.0	4.6	4.4	3.4	4.6	7.0	6.0	7.0	7.1
Employment index	1961 = 100	96.2	93.2	95.4	101.9	100.0	100.4	100.2	100.7	100.0
Labour income	$ millions	12,110	12,432	13,215	14,719	15,825	16,180	18,309	19,303	20,399
Index industrial production	1961 = 100	70.1	70.0	77.7	85.8	87.2	86.7	94.2	96.2	100.0
Index manufacturing production	"	76.6	74.9	82.2	89.9	89.7	88.0	94.5	96.1	100.0
Index mining production	"	50.6	56.1	66.4	77.1	84.6	86.0	97.3	97.4	100.0
Index real domestic product	"	75.5	74.3	82.1	89.1	89.5	91.0	95.7	98.0	100.0
General wholesale price index	1935-39=100	220.7	217.0	218.9	225.6	227.4	227.8	230.6	230.9	233.3
Consumer price index	1961 = 100	89.4	89.9	90.1	91.4	94.3	96.8	97.9	99.1	100.0

. . Not available [p]Preliminary; [r]Revised.

indicators, 1953-1974

1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974^p
42,927	45,978	50,280	55,364	61,828	66,409	72,586	79,815	85,685^r	93,462^r	103,952^r	120,438	140,880
42,349	44,531	47,519	50,685	54,207	56,016	59,292	62,448	64,014	67,585	71,515	76,345	79,199
26,713	28,741	31,560	33,889	37,303	38,955	41,997	45,110	45,991	50,274^r	56,246^r	65,710	80,292
2,881	3,027	3,365	3,715	3,981	4,381	4,722	4,734^r	5,722	5,963^r	6,405^r	8,365	11,625
6,179	6,799	8,094	8,525	10,071	11,112	13,270	14,498	16,401	17,397	19,661	24,719	31,191
6,258	6,558	7,487	8,633	9,866	11,075	12,366	14,130	13,952	15,618	18,669	23,303	31,527
−830	−521	−424	−1,130	−1,162	−499	−97^r	−917^r	+1,106^r	+442^r	−471^r	+18	−1,643
3,819	4,188	4,819	5,199	5,145	5,020	6,142	6,527	6,048	6,929	8,389^r	11,823	15,518
8,769	9,398	10,980	12,935	15,088	15,348	15,455	16,927	17,798	20,184	22,218^r	26,618	32,451
8,646	9,008	10,168	11,387	12,638	12,598	12,605	13,239	13,341	14,422	15,169^r	17,049	18,407
18,583	18,931	19,290	19,644	20,015	20,378^r	20,701	21,001^r	21,297^r	21,569	21,821^r	22,095	22,446
6,615	6,748	6,933	7,141	7,420	7,694	7,919	8,162^r	8,374	8,631	8,891	9,279	9,662
6,225	6,375	6,609	6,862	7,152	7,379	7,537	7,780	7,879	8,079	8,329	8,759	9,137
390	374	324	280	267	315	382	382	495	552	562	520	525
5.9	5.5	4.7	3.9	3.6	4.1	4.8	4.7	5.9	6.4	6.3	5.6	5.4
102.2	104.4	108.2	114.3	120.7	122.6	122.7	126.9	127.1	127.8	129.9	135.9	142.8
21,816	23,262	25,367	28,201	31,878	35,303	38,444	43,065	46,706	51,342	56,976	64,961	75,969
108.3	115.2	126.6	137.0	146.0	150.8	161.9	172.6	175.3	184.2	198.3	214.8	220.3
109.0	116.2	127.4	138.8	148.7	152.3	163.6	175.4	173.0	181.7	195.8	211.8	217.4
106.2	112.1	126.0	131.9	134.2	142.1	152.4	153.5	175.3	182.9	192.2	210.5	207.0
106.9	112.7	120.4	129.0	138.0	142.4	152.5	161.6	165.6	175.0	184.6	197.2	204.4
240.0	244.6	245.4	250.3	259.5	264.1	269.9	282.4	286.4	289.9	310.3	376.9	460.4
101.2	103.0	104.8	107.4	111.4	115.4	120.1	125.5	129.7	133.4	139.8	150.4	166.8

Table 1. Mineral production of Canada, 1973 and 1974 and average 1970-74

	Unit of Measure	1973		1974[p]		Average 1970-1974	
		Quantity	$ 000	Quantity	$ 000	Quantity	$ 000
Metals							
Antimony	000 lb	. .	3,807	. .	5,561	. .	2,391
Bismuth	000 lb	71	348	245	2,006	290	1,595
Cadmium	000 lb	4,197	15,276	3,917	15,527	4,151	12,964
Calcium	000 lb	652	490	1,018	897	588	478
Cobalt	000 lb	3,344	8,899	4,240	14,275	3,964	10,226
Columbium (Cb_2O_5)	000 lb	3,177	4,233	4,113	6,452	3,638	4,334
Copper	000 st	908	1,157,507	929	1,400,101	805	980,659
Gold	000 troy oz.	1,954	190,376	1,718	268,981	2,084	149,412
Iron ore	000 lt	46,748	606,106	46,621	719,036	44,096	591,585
Iron remelt	000 st	. .	48,971	. .	69,871	. .	44,560
Lead	000 st	377	121,676	336	139,105	375	121,479
Magnesium	000 lb	13,680	5,482	13,070	9,073	14,754	6,279
Molybdenum	000 lb	30,391	51,851	29,603	57,992	28,984	49,884
Nickel	000 st	275	813,101	300	977,681	287	827,700
Platinum group	000 troy oz.	354	41,994	360	65,776	415	45,161
Selenium	000 lb	521	4,763	591	9,309	615	6,299
Silver	000 troy oz.	47,488	119,953	43,765	201,965	45,264	110,077
Tantalum	000 lb	171	1,165	430	3,646	282	2,042
Tellurium	000 lb	92	560	54	314	55	332
Thorium	000 lb	. .	. .	—	—	. .	. .
Tin	000 lb	291	570	1,048	1,222	452	622
Tungsten (WO_3)	000 lb	4,640	. .	3,544	. .	4,196	. .
Uranium (U_3O_8)	000 lb	9,517	. .	9,402	. .	9,021	. .
Zinc	000 st	1,352	652,944	1,278	892,139	1,275	567,329
Total metals			3,850,072		4,860,929		3,535,409
Nonmetals							
Arsenious oxide	000 lb	—	—	—	—	48	5
Asbestos	000 st	1,863	234,323	1,824	310,680	1,734	232,648
Barite	000 st	102	1,052	86	1,300	107	1,121
Feldspar	000 st	—	—	—	—	7	148
Fluorspar	000 st	. .	4,620	. .	8,170	. .	5,127
Gemstones	000 lb	154	307	. .	310	. .	252
Gypsum	000 st	8,389	21,067	8,235	22,170	7,549	18,371
Magnesitic dolomite and brucite	000 st	. .	2,656	. .	3,000	. .	2,918
Nepheline syenite	000 st	569	7,860	607	8,510	548	6,856
Peat moss	000 st	359	15,376	391	15,358	357	13,264
Potash (K_2O)	000 st	4,909	176,876	6,072	303,490	4,451	171,906
Pyrite, pyrrhotite	000 st	26	173	49	376	176	773
Quartz	000 st	2,766	11,051	2,686	11,956	2,782	9,353
Salt	000 st	5,565	49,631	5,704	56,225	5,517	44,442
Soapstone, talc, pyrophyllite	000 st	81	1,778	93	2,207	79	1,530
Sodium sulphate	000 st	543	7,165	604	13,187	525	8,244
Sulphur in smelter gas	000 st	756	10,070	797	12,676	711	7,986
Sulphur elemental	000 st	4,594	23,816	5,253	66,242	4,036	31,860
Titanium dioxide	000 st	. .	46,620	. .	51,396	. .	42,506
Total nonmetals			614,441		887,253		599,310

Table 1 (concl'd)

	Unit of Measure	1973 Quantity	1973 $000	1974[p] Quantity	1974[p] $000	Average 1970-1974 Quantity	Average 1970-1974 $000
Fuels							
Coal	000 st	22,567	179,732	22,990	253,702	20,383	161,225
Natural gas	000 cf	3,119,618	451,853	3,083,378	686,614	2,778,502	438,660
Natural gas byproducts	000 bbl	116,251	348,865	113,055	629,009	100,271	316,423
Petroleum crude	000 bbl	655,853	2,246,692	616,238	3,585,090	557,597	1,982,801
Total fuels			3,227,142		5,154,415		2,899,109
Structural materials							
Clay products	000 $	. .	61,170	. .	68,490	. .	56,840
Cement	000 st	11,126	240,561	11,308	244,711	9,899	207,014
Lime	000 st	1,891	30,340	2,088	33,447	1,808	27,253
Sand and gravel	000 st	233,461	213,437	242,200	230,000	223,360	181,545
Stone	000 st	91,894	127,579	94,800	132,800	81,147	109,644
Total structural materials			673,087		709,448		582,296
Total all minerals			8,364,742		11,612,045		7,616,124

. . Not available or not applicable; — Nil; [p]Preliminary.

Notes:
1. Production statistics for the following are not available for publication: indium, mercury, helium, nitrogen, diatomite, thorium, yttrium.
2. Nil production for the following between 1970 and 1974; grindstone, iron oxide, lithia, mica.
3. Dollar values only available for publication for the following: antimony, iron remelt, fluorspar, magnesitic dolomite and brucite, titanium dioxide and clay products.
4. Quantities only available for publication for tungsten and uranium.

Table 2. Canada, value of mineral production, per capita value of mineral production and population, 1934-74

	Metallics $ millions	Industrial Minerals $ millions	Fuels $ millions	Total $ millions	Per Capita Value of Mineral Production $	Population of Canada 000
1934	194	30	54	278	25.91	10,741
1935	222	36	55	313	28.84	10,845
1936	260	43	60	363	33.11	10,950
1937	335	57	66	458	41.48	11,045
1938	324	54	65	443	39.71	11,152
1939	343	61	71	475	42.12	11,267
1940	382	69	79	530	46.55	11,381
1941	395	80	85	560	48.69	11,507
1942	392	83	92	567	48.63	11,654
1943	357	80	93	530	44.94	11,795
1944	308	81	97	486	40.67	11,946
1945	317	88	94	499	41.31	12,072
1946	290	110	103	503	40.91	12,292
1947	395	140	110	645	51.38	12,551
1948	488	172	160	820	63.97	12,823
1949	539	178	184	901	67.01	13,447
1950	617	227	201	1,045	76.24	13,712
1951	746	266	233	1,245	88.90	14,009
1952	728	293	264	1,285	88.90	14,459
1953	710	312	314	1,336	90.02	14,845
1954	802	333	353	1,488	97.36	15,287
1955	1,008	373	414	1,795	114.37	15,698
1956	1,146	420	519	2,085	129.65	16,081
1957	1,159	466	565	2,190	131.87	16,610
1958	1,130	460	511	2,101	122.99	17,080
1959	1,371	503	535	2,409	137.79	17,483
1960	1,407	520	566	2,493	139.48	17,870
1961	1,387	542	674	2,603	142.72	18,238
1962	1,496	574	811	2,881	155.05	18,583
1963	1,510	632	885	3,027	159.91	18,931
1964	1,702	690	973	3,365	174.45	19,290
1965	1,908	761	1,046	3,715	189.11	19,644
1966	1,985	844	1,152	3,981	198.88	20,015
1967	2,285	861	1,235	4,381	214.99[r]	20,378[r]
1968	2,493	886	1,343	4,722	228.10	20,701
1969	2,378	891[r]	1,465	4,734[r]	225.41[r]	21,001[r]
1970	3,073	931	1,718	5,722	268.68[r]	21,297[r]
1971	2,940	1,008	2,015[r]	5,963	276.46[r]	21,569
1972	2,952	1,085[r]	2,368	6,405[r]	293.51[r]	21,821[r]
1973	3,850	1,288	3,227	8,365	378.58	22,095
1974[p]	4,861	1,597	5,154	11,612	517.33	22,446

[p] Preliminary; [r] Revised.

Table 3. Canada, value of mineral production by provinces, territories and mineral classes, 1974p

	Metals		Industrial Minerals		Fuels		Total	
	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)
Alberta	—	—	126,259	7.9	4,287,093	83.1	4,413,352	38.0
Ontario	2,068,310	42.5	346,908	21.7	7,843	0.2	2,423,061	20.8
British Columbia	735,243	15.1	117,752	7.4	330,464	6.4	1,183,459	10.2
Quebec	671,190	13.8	486,599	30.5	28	. . .	1,157,817	10.0
Saskatchewan	22,955	0.5	337,708	21.2	466,726	9.1	827,389	7.1
Newfoundland	411,235	8.5	42,274	2.6	—	—	453,509	3.9
Manitoba	378,479	7.8	38,010	2.4	27,076	0.5	443,565	3.8
Northwest Territories	223,047	4.6	—	—	5,346	0.1	228,393	2.0
New Brunswick	187,515	3.9	27,338	1.7	5,363	0.1	220,216	1.9
Yukon	162,741	3.3	22,300	1.4	153	. . .	185,194	1.6
Nova Scotia	214	. . .	49,953	3.1	24,323	0.5	74,490	0.7
Prince Edward Island	—	—	1,600	0.1	—	—	1,600	. . .
Total	4,860,929	100.0	1,596,701	100.0	5,154,415	100.0	11,612,045	100.0

p Preliminary; — Nil; . . . Too small to be expressed.

Table 4. Canada, production of leading minerals

	Unit of measure	Nfld.	P.E.I.	N.S.	N.B.	Quebec	Ontario
Petroleum	000 bbl	—	—	—	8	—	743
	$000	—	—	—	11	—	4,715
Copper	st	8,100	—	—	11,282	157,962	319,742
	$000	12,623	—	—	17,580	246,105	498,220
Nickel	st	—	—	—	—	—	234,473
	$000	—	—	—	—	—	761,640
Zinc	st	21,208	—	—	174,774	137,667	465,259
	$000	14,803	—	—	121,992	96,091	324,751
Iron ore	000 st	24,767	—	—	—	14,104	11,817
	$000	372,424	—	—	—	161,180	172,188
Natural gas	000 mcf	—	—	—	83	185	6,952
	$000	—	—	—	31	28	3,128
Asbestos	000 st	81	—	—	—	1,545	17
	$000	17,880	—	—	—	242,175	1,771
Potash (K_2O)	000 st	—	—	—	—	—	—
	$000	—	—	—	—	—	—
Gold	000 oz	14	—	—	4	444	795
	$000	2,206	—	—	700	69,515	124,370
Coal	000 st	—	—	1,410	415	—	—
	$000	—	—	24,323	5,321	—	—
Cement	000 st	. .	—	. .	. .	3,332	4,438
	$000	3,539	—	5,912	5,672	62,342	90,535
Sand and gravel	000 st	6,500	1,300	11,800	9,100	53,200	84,500
	$000	8,500	1,600	13,200	10,500	35,500	80,100
Silver	000 oz	647	—	27	4,382	2,860	17,674
	$000	2,985	—	124	20,222	13,198	81,566
Lead	st	13,715	—	217	50,290	1,070	10,898
	$000	5,679	—	90	20,825	443	4,513
Stone	000 st	400	—	1,000	2,400	48,100	38,000
	$000	1,100	—	2,000	4,600	59,200	55,800
Iron remelt	st	—	—	—	—	. .	—
	$000	—	—	—	—	69,871	—
Clay products	$000	275	—	2,725	1,131	12,393	37,810
Sulphur, elemental	000 st	—	—	—	—	—	—
	$000	—	—	—	—	—	2
Platinum metals	000 oz	—	—	—	—	—	360
	$000	—	—	—	—	—	65,776
Molybdenum	000 lb	—	—	—	—	365	—
	$000	—	—	—	—	715	—
Salt	000 st	—	—	822	—	—	4,225
	$000	—	—	10,205	—	—	35,990
Titanium dioxide	st	—	—	—	—	. .	—
	$000	—	—	—	—	51,396	—
Lime	000 st	—	—	—	. .	407	1,354
	$000	—	—	—	1,000	5,899	21,665
Gypsum	000 st	552	—	6,100	91	—	825
	$000	1,883	—	14,518	300	—	2,760
Total leading minerals	$000	443,897	1,600	73,097	209,885	1,126,051	2,367,210
Total all minerals	$000	453,509	1,600	74,490	220,216	1,157,817	2,423,061
Leading minerals as % of all minerals		97.9	100.0	98.1	95.3	97.3	97.7

[p]Preliminary; — Nil; . . Not available.

by provinces and territories, 1974*p*

Manitoba	Sask.	Alberta	B.C.	Y.T.	N.W.T.	Total Canada
4,740	73,000	517,774	18,820	—	1,153	616,238
27,076	443,840	3,004,334	103,500	—	1,614	3,585,090
83,024	9,156	—	327,221	11,300	764	928,551
82,611	14,265	—	509,902	17,605	1,190	1,400,101
64,456	—	—	732	—	—	299,661
213,570	—	—	2,471	—	—	977,681
86,820	6,980	—	91,672	98,246	195,513	1,278,139
60,600	4,872	—	63,987	68,576	136,467	892,139
—	—	—	1,528	—	—	52,216
—	—	—	13,244	—	—	719,036
—	65,255	2,581,067	397,350	1,332	31,154	3,083,378
—	9,014	595,809	74,719	153	3,732	686,614
—	—	—	91	90	—	1,824
—	—	—	26,554	22,300	—	310,680
—	6,072	—	—	—	—	6,072
—	303,490	—	—	—	—	303,490
55	15	—	188	26	177	1,718
8,647	2,343	—	29,436	4,130	27,634	268,981
—	3,842	9,176	8,147	—	—	22,990
—	8,299	75,794	139,965	—	—	253,702
686	255	1,016	965	—	—	11,308
18,066	8,135	25,810	24,700	—	—	244,711
12,500	8,200	18,900	36,200	—	—	242,200
14,300	6,600	18,400	41,300	—	—	230,000
1,303	227	—	6,235	6,158	4,252	43,765
6,011	1,046	—	28,772	28,420	19,621	201,965
45	—	—	61,714	106,304	91,732	335,985
18	—	—	25,550	44,010	37,977	139,105
700	—	200	4,000	—	—	94,800
1,100	—	900	8,100	—	—	132,800
—	—	—	—	—	—	. .
—	—	—	—	—	—	69,871
753	2,188	5,688	5,527	—	—	68,490
17	17	5,160	59	—	—	5,253
54	190	65,200	796	—	—	66,242
—	—	—	—	—	—	360
—	—	—	—	—	—	65,776
—	—	—	29,238	—	—	29,603
—	—	—	57,277	—	—	57,992
32	275	350	—	—	—	5,704
150	5,180	4,790	—	—	—	56,225
—	—	—	—	—	—	. .
—	—	—	—	—	—	51,396
. .	—	155	44	—	—	2,088
1,125	—	2,931	827	—	—	33,447
218	—	—	449	—	—	8,235
657	—	—	2,052	—	—	22,170
434,738	809,462	3,799,656	1,158,679	185,194	228,235	10,837,704
443,565	827,389	4,413,352	1,183,459	185,194	228,393	11,612,045
98.0	97.8	86.1	97.3	100.0	99.9	93.3

Table 5. Canada, percentage contribution of leading minerals to total value of mineral production, 1965-74

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974[p]
Petroleum	19.4	19.8	19.8	19.9	21.4	20.2	22.7	24.5	26.9	30.9
Copper	10.3	11.4	13.3	12.8	12.4	13.6	12.7	12.6	13.8	12.0
Nickel	11.6	9.5	10.6	11.1	10.2	14.5	13.4	11.2	9.7	8.4
Zinc	6.7	7.3	7.3	6.9	7.8	7.0	7.0	7.4	7.8	7.7
Iron ore	11.1	10.8	10.7	11.2	9.6	10.3	9.3	7.6	7.2	6.2
Natural gas	4.3	4.4	4.5	4.8	5.5	5.5	5.7	6.2	5.4	5.9
Asbestos	3.9	4.1	3.7	4.0	4.1	3.6	3.4	3.2	2.8	2.7
Potash (K_2O)	1.5	1.6	1.5	1.8	1.5	1.9	2.3	2.1	2.1	2.6
Gold	3.6	3.1	2.5	2.1	2.0	1.5	1.3	1.9	2.3	2.3
Coal	2.1	2.1	1.3	1.1	1.1	1.5	2.0	2.4	2.1	2.2
Cement	3.8	3.9	3.3	3.1	3.4	2.7	3.2	3.3	2.9	2.1
Sand and gravel	3.6	3.8	3.3	2.7	2.6	2.3	2.6	2.8	2.5	2.0
Silver	1.2	1.2	1.4	2.2	1.8	1.4	1.2	1.2	1.4	1.7
Lead	2.4	2.3	2.0	1.9	2.0	2.2	1.8	1.8	1.5	1.2
Stone	2.6	2.7	2.3	2.0	1.9	1.5	1.6	1.6	1.5	1.1
Iron remelt	0.5	0.4	0.4	0.5	0.6	0.6	0.5	0.7	0.6	0.6
Clay products	1.2	1.1	1.0	1.0	1.1	0.7	0.8	0.8	0.7	0.6
Sulphur, elemental	0.7	1.0	1.6	1.7	1.3	0.5	0.4	0.3	0.3	0.6
Platinum metals	0.9	0.8	0.8	0.9	0.7	0.8	0.7	0.5	0.5	0.6
Molybdenum	0.5	0.9	0.9	0.8	1.1	1.0	0.6	0.7	0.6	0.5
Salt	0.6	0.6	0.6	0.7	0.6	0.6	0.7	0.6	0.6	0.5
Titanium dioxide	0.6	0.6	0.5	0.6	0.6	0.6	0.7	0.6	0.6	0.4
Lime	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3
Gypsum	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.2
Other minerals	6.1	5.8	6.0	5.5	6.0	4.9	4.7	5.3	5.5	6.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[p] Preliminary.

Table 6. Canada, value of mineral production by provinces and territories, 1965-74.

	1965	1966	1967	1968	1969	1970	9171	1972	1973	1974p
					($ millions)					
Alberta	762	849	974	1,092	1,205	1,396	1,641	1,979r	2,764	4,413
Ontario	994	958	1,195	1,356	1,223	1,593	1,555	1,532r	1,853	2,423
British Columbia	280	331	380	389	434	490	541	678	976	1,184
Quebec	716	771	741	725	717	803	766	786r	926	1,158
Saskatchewan	329	349	362	357	345	379	410	410	510	827
Newfoundland	208	244	266	310	257	353	343	291	375	454
Manitoba	182	179	185	210	246	332	330	323	419	444
Northwest Territories	77	111	118	116	119	105	116	120	165	228
New Brunswick	83	90	90	88	95	134	107	120	163	220
Yukon	13	12	15	21	35	77	93	107	151	185
Nova Scotia	71	86	53	57	59	59	60	58r	62	74
Prince Edward Island	—	1	2	1	1	1	1	1	2	2
Total	3,715	3,981	4,381	4,722	4,736	5,722	5,963	6,405r	8,366	11,612

pPreliminary; rRevised; — Nil.

Table 7. Canada, percentage contribution of provinces and territories to total value of mineral production, 1965-74.

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974p
Alberta	20.5	21.3	22.2	23.1	25.4	24.4	27.5	30.9	33.0	38.0
Ontario	26.8	24.1	27.3	28.7	25.8	27.8	26.0	23.9	22.2	20.9
British Columbia	7.5	8.3	8.7	8.2	9.2	8.6	9.1	10.6	11.7	10.2
Quebec	19.3r	19.4	16.9	15.4	15.2	14.0	12.9	12.3r	11.1	10.0
Saskatchewan	8.9	8.7	8.3	7.6	7.3	6.6	6.9	6.4	6.1	7.1
Newfoundland	5.6	6.1	6.1	6.6	5.4	6.2	5.8	4.5r	4.5	3.9
Manitoba	4.9	4.5	4.2	4.4	5.2	5.8	5.5	5.0	5.0	3.8
Northwest Territories	2.1	2.8	2.7	2.4	2.5	2.4	1.9	1.9	2.0	2.0
New Brunswick	2.2	2.3	2.1	1.9	2.0	1.8	1.8	1.9	1.9	1.9
Yukon	0.3	0.3	0.3	0.5	0.7	1.4	1.6	1.7	1.8	1.6
Nova Scotia	1.9	2.2	1.2	1.2	1.3	1.0	1.0	0.9	0.7	0.6
Prince Edward Island	0.02	0.02	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

pPreliminary; rRevised.

Table 8. Canada's world role as a producer of certain

	Year	World production
Nickel (mine production)	1973 st	645,927
	% of world total	
Zinc (mine production)	1973 st	6,031,659
	% of world total	
Asbestos	1973^p st	4,494,911
	% of world total	
Silver	1973 000 troy oz	291,479
	% of world total	
Titanium concentrate (Ilmenite)	1973^p st	3,886,582
	% of world total	
Potash K_2O (equivalent)	1973^p 000 st	24,689
	% of world total	
Molybdenum	1973 st	92,047
	% of world total	
Elemental sulphur	1973^p 000 st	31,771
	% of world total	
Gypsum	1973^p 000 st	67,105
	% of world total	
Uranium (U_3O_8 concentrates)	1973^p st	25,445
	% of world total	
Platinum group metals (mine production)	1973^p troy oz	5,239,781
	% of world total	
Gold (mine production)	1972 troy oz	44,082,419
	% of world total	
Copper (mine production)	1973 st	8,058,262
	% of world total	
Aluminum (primary metal)	1973 st	13,762,209
	% of world total	
Cadmium (smelter production)	1973^p 000 lb	39,797
	% of world total	
Lead (mine production)	1973 st	3,774,687
	% of world total	
Iron ore	1973 000 lt	821,284
	% of world total	

^{p}Preliminary; ^{e}Estimated

important minerals, 1973

Rank of Six Leading Countries With % of World Total					
1	2	3	4	5	6
Canada 274,527 42.5	U.S.S.R. 140,000[e] 21.7	New Caledonia 110,000 17.0	Australia 45,022 7.0	Cuba 40,000[e] 6.2	U.S.A. 17,000 2.6
Canada 1,352,074 22.4	U.S.S.R. 715,000[e] 11.9	Australia 478,900 7.9	U.S.A. 475,853 7.9	Peru 456,022 7.6	Mexico 299,134 5.0
Canada 1,862,976 41.5	U.S.S.R. 1,411,000[e] 31.4	Republic of South Africa 368,435 8.2	People's Republic of China 230,000[e] 5.1	Italy 164,525 3.7	U.S.A. 150,036 3.3
Canada 47,488 16.3	U.S.S.R. 41,000[e] 14.1	Mexico 38,788 13.3	Peru 38,400 13.2	U.S.A. 37,233 12.8	Australia 23,200 8.0
Canada 942,700 24.3	U.S.A. 804,355 20.7	Norway 803,610 20.7	Australia 781,493 20.1	Finland 175,267 4.5	Malaysia 167,800 4.3
U.S.S.R. 6,300 25.5	**Canada** 4,909 19.9	West Germany 3,300[e] 13.4	East Germany 2,910[e] 11.8	U.S.A. 2,603 10.5	France 2,494 10.1
U.S.A. 57,930 62.9	**Canada** 15,196 16.5	U.S.S.R. 9,350 10.2	Chile 6,487 7.1	People's Republic of China 1,650 1.8	Peru 796 0.9
U.S.A. 11,224 35.3	**Canada** 4,594 14.5	U.S.S.R. 4,575 14.4	Poland 3,903 12.3	Uruguay 2,706 8.5	France 1,988 6.3
U.S.A. 13,558 20.2	**Canada** 8,389 12.5	France 6,790 10.1	U.S.S.R. 5,200[e] 7.8	Spain 4,520[e] 6.7	United Kingdom 4,066 6.1
U.S.A. 13,235 52.0	**Canada** 4,759 18.7	South Africa 3,411 13.4	France 1,950[e] 7.7	Niger 1,045 4.1	Gabon 712 2.8
U.S.S.R. 2,450,000[e] 46.8	Republic of South Africa 2,362,800[e] 45.1	**Canada** 354,223 6.8	Colombia 26,358 0.5	U.S.A. 19,980 0.4	Japan 16,841 0.3
Republic of South Africa 29,245,310 66.3	U.S.S.R. 6,900,000[e] 15.7	**Canada** 2,078,567 4.7	U.S.A. 1,449,776 3.3	Australia 754,932 1.7	Ghana 724,051 1.6
U.S.A. 1,726,934 21.4	U.S.S.R. 1,150,000[e] 14.3	**Canada** 908,241 11.3	Chile 800,200 9.9	Zambia 791,451 9.8	Zaire 538,307 6.7
U.S.A. 4,530,000 32.9	U.S.S.R. 1,980,000[e] 14.4	Japan 1,215,000 8.8	**Canada** 1,037,859 7.5	Norway 683,828 5.0	West Germany 587,427 4.3
U.S.A. 7,428 18.7	Japan 6,834[e] 17.2	U.S.S.R. 5,500[e] 13.8	**Canada** 4,197 10.6	Belgium 3,180[e] 8.0	West Germany 2,640[e] 6.6
U.S.S.R. 610,000[e] 16.2	U.S.A. 600,257 15.9	Australia 437,000 11.6	**Canada** 376,939 10.0	Peru 218,900 5.8	Mexico 197,638 5.2
U.S.S.R. 212,692 25.9	U.S.A. 87,669 10.7	Australia 82,248 10.0	France 53,889 6.6	**Canada** 46,748 5.7	People's Republic of China 44,289 5.4

Table 9. Canada, census value added, commodity-producing industries, 1966-72

	1966	1967	1968	1969	1970	1971	1972^p
				($ millions)			
Primary industries							
Agriculture	3,298	2,693	2,870	3,032	2,775	3,035	3,442
Forestry	596	615	644	734	683	686	814
Fishing	176	164	186	184	204	205	237
Trapping	14	10	12	16	13	11	17
Mining[1]	2,613	2,918	3,176	3,342	3,805	3,810	4,267
Electric power	1,132	1,234	1,360	1,511	1,707	1,856	2,051
Total	7,829	7,634	8,248	8,819	9,187	9,603	10,828
Secondary industries							
Manufacturing	16,352	17,006	18,332	20,134	20,048	21,737	24,292
Construction	4,844	5,148	5,269	5,794	6,167	7,581	8,244
Total	21,196	22,154	23,601	25,928	26,215	29,318	32,536
Grand total	29,025	29,788	31,849	34,747	35,402	38,921	43,364

[1]Excludes cement, lime and clay and clay products (from domestic clays) manufacturers. These industries in the above tables are included under manufacturing.

^{p}Preliminary.

Table 10. Canada, census value added, mining and mineral manufacturing industries, 1968-72

	1968	1969	1970	1971	1972^p
			($ 000)		
Mining					
Metallic					
Placer gold	264	155	120	92	110
Gold quartz	78,032	74,993	63,902	59,516	74,938
Copper-gold-silver	377,800	465,309	432,678	378,384	446,120
Silver-cobalt	7,645	6,088	4,184	2,874	3,587
Silver-lead-zinc	150,565	171,239	171,603	156,050	175,301
Nickel-copper	437,372	386,383	634,644	448,779	521,009
Iron	339,402	315,378	367,599	345,900	281,757
Misc. metal mines	72,306	104,433	101,824	90,705	95,392
Total	1,463,386	1,523,978	1,776,554	1,482,300	1,598,214
Industrial minerals					
Asbestos	143,591	157,855	168,612	165,018	160,859
Feldspar, quartz and nepheline syenite	7,368	9,065	8,939	9,473	11,086
Gypsum	9,277	11,496	10,756	11,608	14,609
Peat	8,857	8,066	9,432	11,227	10,706
Salt	23,484	22,238	28,124	29,842	31,879
Sand and gravel	40,286	44,329	42,059	51,454	51,400
Stone	44,339	45,153	47,165	50,827	57,442
Talc and soapstone	824	785	784	897	1,174
Misc. nonmetals	60,450	62,005	97,850	117,497	123,800
Total	338,476	360,992	413,721	447,843	462,955
Fuels					
Coal	66,088	64,321	74,035	103,918	130,144
Petroleum and natural gas	1,307,995	1,392,994	1,540,581	1,775,798	2,075,454
Total	1,374,083	1,457,315	1,614,616	1,879,716	2,205,598
Total mining industry	3,175,945	3,342,285	3,804,891	3,809,859	4,266,767
Mineral manufacturing					
Primary metal industries					
Iron and steel mills	684,684	708,727	835,956	866,948	909,369
Steel pipe and tube mills	73,844	75,525	76,558	86,564	113,801
Iron foundries	106,610	123,331	119,721	120,039	135,431
Smelting and refining	477,763	513,806	552,540	545,192	530,569
Aluminum rolling, casting and extruding	66,496	82,837	80,163	87,491	98,265
Copper and alloy rolling, casting and extruding	59,105	61,054	52,319	55,780	67,253
Metal rolling, casting and extruding, nes	46,365	55,867	51,831	50,144	62,630
Total	1,514,867	1,621,147	1,769,088	1,812,158	1,917,318
Nonmetallic mineral products industries					
Cement manufacturers	107,088	117,521	115,175	131,404	155,968
Lime manufacturers	8,573	10,368	11,248	11,937	12,605
Gypsum products manufacturers	32,079	36,877	31,874	40,395	*
Concrete products manufacturers	122,789	126,965	125,170	160,480	175,927
Ready-mix concrete manufacturers	106,314	109,951	108,467	133,290	156,206

Table 10. (concl'd)

	1968	1969	1970	1971	1972^p
			($ 000)		
Clay products (domestic clay)	33,996	37,270	32,553	37,514	39,572
Clay products (imported clay)	24,652	22,399	21,947	22,791	26,546
Refractories manufacturers	16,924	19,759	23,212	20,741	19,375
Stone products manufacturers	6,278	6,630	5,960	10,622	9,330
Mineral wool manufacturers	21,808	24,748	24,692	29,535	*
Asbestos products manufacturers	29,359	31,135	31,600	37,269	*
Glass manufacturers	93,692	100,230	104,955	123,390	143,531
Glass products manufacturers	43,396	50,784	44,434	55,878	58,248
Abrasive manufacturers	29,198	33,228	31,037	27,944	32,713
Other nonmetallic mineral products industries	9,895	11,074	11,415	12,497	143,197
Total	686,041	738,939	723,739	855,687	973,218
Petroleum and coal products industries					
Petroleum refining	307,298	293,416	331,965	401,032	431,301
Manufacturers of lubricating oils and greases	13,635	15,486	15,908	17,495	19,529
Other petroleum and coal products industries	8,484	8,266	8,355	10,629	11,735
Total	329,417	317,168	356,228	429,156	462,565
Total mineral manufacturing	2,530,325	2,677,254	2,849,055	3,097,001	3,353,101
Total mining and mineral manufacturing	5,706,270	6,019,539	6,653,946	6,906,860	7,619,868

* Included in other nonmetallic mineral products industries.
nes-Not elsewhere specified; ^p Preliminary.

Table 11. Canada, indexes of physical volume of total industrial production, mining and mineral manufacturing, 1959-74. (1961 = 100)

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974p
Total industrial production	94.2	96.2	100.0	108.3	115.2	126.6	137.0	146.0	150.8	161.9	172.6	175.3	184.2	198.3	214.8	220.3
Total mining	97.3	97.4	100.0	106.2	112.1	126.0	131.9	134.2	142.1	152.4	153.5	175.3	182.9	192.2	210.5	207.0
Metals																
All metals	110.0	107.3	100.0	102.2	104.1	120.2	122.8	121.1	129.3	135.7	127.4	152.1	153.3	143.3	158.4	155.5
Placer gold and gold quartz mines	102.2	104.4	100.0	95.1	91.4	90.1	87.4	82.2	73.6	66.8	64.9	57.7	55.5	50.6	44.9	38.9
Iron mines	105.2	103.6	100.0	139.3	170.4	208.6	224.8	241.5	260.7	313.8	274.8	347.0	338.7	279.2	362.5	360.0
Miscellaneous metal mines, nes	. .	. .	100.0	97.5	95.7	111.4	112.7	108.6	117.9	119.2	114.7	137.2	140.5	137.6	145.3	142.9
Fuels																
All fuels	84.1	87.1	100.0	114.3	123.0	133.0	142.0	152.4	166.1	181.1	199.0	229.6	249.0	304.0	331.8	317.3
Coal	103.8	107.0	100.0	97.9	104.5	109.8	111.9	103.7	103.1	100.2	99.6	128.2	149.0	205.5	219.5	221.4
Crude petroleum and natural gas	. .	. .	100.0	117.3	126.3	137.2	147.4	161.2	177.5	195.7	217.0	247.9	267.1	321.8	352.2	334.7
Nonmetals																
All nonmetals	92.0	91.5	100.0	108.7	121.4	139.2	151.5	164.2	173.6	191.9	202.3	211.0	219.6	213.8	233.7	257.3
Asbestos	86.4	90.3	100.0	103.2	109.0	121.9	118.2	127.7	125.6	135.9	133.0	146.5	146.3	147.4	157.3	153.7
Mineral manufacturing																
Primary metals	. .	. .	100.0	105.5	114.3	128 4.	140.4	146.1	141.1	158.2	164.8	171.0	172.6	177.1	190.6	200.1
Nonmetallic mineral products	99.0	95.8	100.0	115.0	116.7	128.0	139.3	144.9	135.4	147.2	154.3	145.9	157.4	177.5	196.3	204.3
Petroleum and coal products	90.2	94.1	100.0	108.7	117.2	118.5	124.4	129.1	130.5	144.3	150.2	153.2	165.2	188.1	206.4	215.8

p Preliminary; . . Not available; nes Not elsewhere stated.

Table 12. Indexes of real domestic product by industries, 1965-74. (1961 = 100)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974p
Real domestic product, all industries	129.0	138.0	142.4	152.5	161.6	165.6	175.0	184.6	197.2	204.4
Agriculture	127.6	145.9	118.6	126.0	133.3	131.4	152.7	140.8	142.3	132.3
Forestry	122.5	132.7	130.3	131.2	139.5	136.8	135.0	129.0	158.0	158.0
Fishing and trapping	106.6	118.2	112.1	127.1	112.8	115.5	107.9	102.4	102.6	86.6
Mining (including milling) quarries and oil wells	131.9	134.2	142.1	152.4	153.5	175.3	182.9	192.2	210.5	207.0
Electric power, gas and water utilities	129.9	141.4	151.2	162.8	177.7	194.3	207.6	229.4	247.2	265.5
Manufacturing	138.8	148.7	152.3	163.6	175.4	173.0	181.7	195.8	211.8	217.4
Construction	131.6	141.7	141.2	147.4	152.1	150.6	165.6	166.5	178.0	177.8
Transportation, storage and communication	127.6	138.0	145.3	154.7	165.5	174.0	182.7	198.8	216.7	232.5
Trade	129.4	137.6	144.7	150.6	158.3	160.0	170.6	182.6	192.5	201.3
Community, business and personal service	128.8	140.4	150.4	160.5	172.0	179.4	187.0	194.8	202.7	213.2
Finance, insurance and real estate	120.8	125.6	131.4	152.8	162.1	170.0	179.3	186.0	197.4	208.0
Public administration and defence	108.3	112.2	118.2	120.1	122.7	127.0	132.4	138.9	148.9	156.6

p Preliminary.

Table 13. Canada, value of exports of crude minerals and fabricated mineral products, by main groups, 1970-74.

	1970	1971	1972	1973	1974[p]
			($ millions)		
Ferrous					
Crude material	508.9	431.8	371.8	497.7	573.9
Fabricated material	487.3	463.6	485.9	598.7	913.1
Total	996.2	895.4	857.7	1,096.4	1,487.0
Nonferrous[1]					
Crude material	993.8	954.8	1,014.1	1,501.8	1,799.3
Fabricated material	1,689.7	1,389.7	1,388.9	1,897.8	2,089.3
Total	2,683.5	2,344.5	2,403.0	3,399.6	3,888.6
Nonmetals					
Crude material	453.2	456.9	475.5	595.5	792.5
Fabricated material	99.8	100.6	133.2	166.2	174.8
Total	553.0	557.5	608.7	761.7	967.3
Mineral fuels					
Crude material	884.6	1,124.6	1,420.9	1,998.4	4,219.6
Fabricated material	85.1	117.0	209.5	311.6	615.1
Total	969.7	1,241.6	1,630.4	2,310.0	4,834.7
Total minerals and products					
Crude material	2,840.5	2,968.1	3,282.3	4,593.4	7,385.3
Fabricated material	2,361.9	2,070.9	2,217.5	2,974.3	3,792.3
Total	5,202.4	5,039.0	5,499.8	7,567.7	11,177.6

[1]Includes gold, refined and unrefined.
[p]Preliminary.

Table 14. Canada, value of imports of crude minerals and fabricated mineral products, by main groups, 1970-74.

	1970	1971	1972	1973	1974[p]
			($ millions)		
Ferrous					
Crude material	54.4	50.9	53.1	75.3	94.6
Fabricated material	718.4	805.0	850.4	1,022.1	1,759.8
Total	772.8	855.9	903.5	1,097.4	1,854.4
Nonferrous[1]					
Crude material	188.9	192.0	185.8	255.1	302.7
Fabricated material	277.5	301.4	343.7	474.0	816.2
Total	466.4	493.4	529.5	729.1	1,118.9
Nonmetals					
Crude material	63.7	73.1	71.6	89.0	120.7
Fabricated material	165.9	180.3	198.7	243.1	326.1
Total	229.6	253.4	270.3	332.1	446.8
Mineral fuels					
Crude material	571.4	700.0	867.6	1,116.1	2,955.5
Fabricated material	205.7	213.4	209.2	214.5	373.6
Total	777.1	913.4	1,076.8	1,330.6	3,329.1
Total minerals and products					
Crude material	878.4	1,016.0	1,178.1	1,535.5	3,473.5
Fabricated material	1,367.5	1,500.1	1,602.0	1,953.7	3,275.7
Total	2,245.9	2,516.1	2,780.1	3,489.2	6,749.2

[1]Includes gold, refined and unrefined.
[p]Preliminary.

ʲle 15. Canada, value of exports of crude minerals and fabricated mineral products in relation to total export trade, ʲ70-74.

	1970		1971		1972		1973		1974p	
	$ millions	% of Total	$ millions	% of Total	$ millions	% of Total	$ millions	% of Total	$ millions	% of Total
Crude material	2,840.5	17.3	2,968.1	17.1	3,282.3	16.7	4,593.4	18.5	7,385.3	23.5
Fabricated material	2,361.9	14.4	2,070.9	11.9	2,217.5	11.3	2,974.3	12.0	3,792.3	12.1
Total	5,202.4	31.7	5,039.0	29.0	5,499.8	28.0	7,567.7	30.5	11,177.6	35.6
Total exports[1] all products	16,401.1	100.0	17,396.6	100.0	19,670.8r	100.0	24,836.9	100.0	31,411.9	100.0

[1]Includes gold, refined and unrefined.
rRevised; pPreliminary.

Table 16. Canada, value of imports of crude minerals and fabricated mineral products in relation to total import trade, 1970-74.

	1970		1971		1972		1973		1974p	
	$ millions	% of Total	$ millions	% of Total	$ millions	% of Total	$ millions	% of Total	$ millions	% of Total
Crude material	878.4	6.3	1,016.0	6.5	1,178.1	6.3	1,535.5	6.6	3,473.5	11.0
Fabricated material	1,367.5	9.8	1,500.1	9.6	1,602.0	8.6	1,953.7	8.4	3,275.7	10.3
Total	2,245.9	16.1	2,516.1	16.1	2,780.1	14.9	3,489.2	15.0	6,749.2	21.3
Total imports[1] all products	13,951.9	100.0	15,618.1	100.0	18,669.4	100.0	23,323.5	100.0	31,639.4	100.0

[1]Includes gold, refined and unrefined.
pPreliminary.

Table 17. Canada, value of exports of crude minerals and fabricated mineral products by main groups and destination, 1974^p

	United Kingdom	United States	Other Countries	Total
	($ millions)			
Ferrous materials and products	79.4	1,082.6	325.0	1,487.0
Nonferrous[1] materials and products	573.0	1,514.6	1,801.0	3,888.6
Nonmetallic mineral materials and products	37.4	539.6	390.3	967.3
Mineral fuels, materials and products	19.3	4,332.1	483.3	4,834.7
Total	709.1	7,468.9	2,999.6	11,177.6
Percentage	6.3	66.8	26.9	100.0

[1]Includes gold, refined and unrefined.
^{p}Preliminary.

Table 18. Canada, value of imports of crude minerals and fabricated mineral products, by main groups and country of origin, 1974^p

	United Kingdom	United States	Other Countries	Total
	($ millions)			
Ferrous materials and products	102.7	1,081.6	670.1	1,854.4
Nonferrous[1] materials and products	61.4	695.8	361.7	1,118.9
Nonmetallic mineral materials and products	17.8	318.1	110.9	446.8
Mineral fuels, materials and products	7.3	454.1	2,867.7	3,329.1
Total	189.2	2,549.6	4,010.4	6,749.2
Percentage	2.8	37.8	59.4	100.0

[1]Includes gold, refined and unrefined
^{p}Preliminary.

Table 19. Canada, value of exports of crude minerals and fabricated mineral products, by commodity and destination, 1974p

	U.S.A.	United Kingdom	E.F.T.A.[1]	E.E.C.[2]	Japan	Other Countries	Total
				($000)			
Aluminum	300,242	56,546	5,995	48,322	49,764	80,988	541,857
Asbestos	123,504	24,970	6,286	73,910	24,472	99,444	352,586
Copper	307,711	176,487	87,915	141,334	499,221	84,858	1,297,526
Fuels	4,332,151	19,307	45,422	53,256	251,335	133,193	4,834,664
Iron ore	345,134	55,641	1,958	92,453	35,775	11,591	542,552
Lead	23,110	18,204	135	13,315	40,074	9,965	104,803
Molybdenum	393	4,883	2,164	27,109	16,655	4,031	55,235
Nickel	375,639	187,565	141,909	29,331	42,908	97,627	874,979
Primary ferrous metals	112,298	7,311	180	23,300	4,497	15,327	162,913
Uranium	27,973	22,121	—	1,215	—	—	51,309
Zinc	241,112	31,679	4,443	157,915	75,441	34,607	545,197
All other minerals[3]	1,279,642	104,380	11,581	83,736	71,396	263,209	1,813,944
Grand total	7,468,909	709,094	307,988	745,196	1,111,538	834,840	11,177,565

[1]Includes: Austria, Norway, Portugal, Sweden, Switzerland, Finland, Iceland.
[2]Includes: Belgium and Luxembourg, France, Italy, Netherlands, West Germany, Denmark, Ireland.
[3]Includes: gold, refined and unrefined.
— Nil; pPreliminary.

Table 20. Canada, reported consumption of minerals

	Unit of Measure	1971 Consumption	1971 Production	1971 Consumption as % of Production	1972 Consumption	1972 Production	1972 Consumption as % of Production
Metals							
Aluminum	st	322,081	1,104,644	29.2	333,550	999,940	33.4
Antimony	lb	1,481,522	323,525	457.9	2,026,300	. .	. .
Bismuth	lb	36,236	271,196	13.4	37,892	275,029	13.8
Cadmium	lb	117,395	4,063,805	2.9	123,395	4,267,987	2.9
Chromium (chromite)	st	61,313	—	. .	62,712	—	. .
Cobalt	lb	220,994	4,323,318	5.1	381,260	3,351,108	11.4
Copper	st	221,053[1]	721,430	30.6	228,907[1]	793,303	28.9
Lead	st	94,961[r2]	405,510	23.4	116,234[r2]	369,425	31.5
Magnesium	st	6,276	7,234	86.8	5,924	5,924	100.0
Manganese ore	st	174,761	110,885	157.6	183,175	—	. .
Mercury	lb	193,968	1,406,000	13.8	114,636	1,112,412	10.3
Molybdenum (Mo content)	lb	1,814,586	22,662,732	8.0	2,708,059	28,493,007	9.5
Nickel	st	8,583	294,341	2.9	10,187	258,987	3.9
Selenium	lb	15,868	718,440	2.2	20,677	582,060	3.6
Silver	oz	7,050,956	46,023,570	15.3	8,424,314	44,792,209	18.8
Tellurium	lb	1,178	24,488	4.8	1,419	45,649	3.1
Tin	lt	3,911	142	2,754.2	4,685	157	2,984.1
Tungsten (WO_3 content)	lb	639,765	4,624,208	13.8	1,176,564	4,447,316	26.5
Zinc	st	120,571[r2]	1,249,734	9.6	134,187[2]	1,244,142	10.8
Nonmetals							
Barite	st	58,200	120,765	48.2	78,900	77,261	102.1
Feldspar	st	8,854	10,774	82.2	9,651	11,684	82.6
Fluorspar	st	197,449	85,000[e]	232.3	232,128	180,000[e]	129.0
Mica	lb	7,216,000	—	. .	—	. .	. .
Nepheline syenite	st	83,091	517,190	16.1	96,112	559,483	17.2
Phosphate rock	st	2,031,289	—	. .	2,362,010	—	. .
Potash K_2O[3]	st	203,193	3,999,511	5.1	274,397	3,852,120	7.1
Sodium sulphate	st	401,908	481,919	83.4	429,080	507,275	84.6
Sulphur elemental	st	804,656	3,149,280	25.6	948,590	3,635,631	26.1
Talc etc.	st	38,650	65,562	59.0	36,253	80,946	44.8
Fuels							
Coal	st	28,249,835	18,432,199	153.3	28,393,096	20,709,316	137.1
Natural gas	mcf	1,001,328,624[4]	2,499,023,600	40.1	1,145,797,145[4]	2,913,537,215	39.3
Petroleum crude	bbl	507,463,990[5]	492,739,049	103.0	561,992,407[5]	561,976,934	100.0

Notes: Unless otherwise stated, consumption refers to reported consumption of refined metals or nonmetallic minerals by consumers. Production of metals, in most cases, refers to production in all forms, and includes the recoverable metal content of ores, concentrates, matte, etc., and the metal content of primary products recoverable at domestic smelters and refineries. Production of nonmetals refers to producers' shipments. For fuels, production is equivalent to actual output less waste.
[1]Producers' domestic shipments of refined metal; [2]Includes primary and secondary refined metal; [3]Production and consumption for year ended June 30; [4]Domestic sales; [5]Refinery receipts.
[p]Preliminary; [r]Revised; [e]Estimated.
— Nil; . . Not available or not applicable.

and relation to production, 1971-74.

1973			1974[p]		
Consumption	Production	Consumption as % of Production	Consumption	Production	Consumption as % of Production
335,100	1,037,859	32.3	. .	1,125,329	. .
979,566	. .	. .	2,168,876	. .	. .
56,852	70,684	80.4	64,547	245,000	26.3
120,958	4,196,594	2.9	105,548	3,917,000	2.7
38,030	—	. .	66,658	—	. .
431,420	3,344,352	12.9	408,829	4,240,000	9.6
254,613[1]	908,241	28.0	273,357[1]	928,551	29.4
119,082[2]	376,939	31.6	116,070[2]	335,985	34.5
7,292	6,840	106.6	6,853	6,535	104.9
188,072	—	. .	232,142	—	. .
72,663	950,000	7.6	83,304	. .	. .
4,434,714	30,391,463	14.6	3,688,655	29,603,000	12.5
11,862	274,527	4.3	. .	299,661	. .
22,435	521,110	4.3	30,479	591,000	5.2
16,870,929	47,487,589	35.5	10,671,283	43,765,000	24.4
1,222	92,284	1.3	981	54,000	1.8
5,152	130	3,963.1	5,339	468	1,140.8
1,019,706	4,640,000	22.0	1,179,381	3,544,000	33.3
133,079[2]	1,352,074	9.8	129,654[2]	1,278,139	10.1
83,148	101,580	81.9	. .	86,000	. .
6,978	—	. .	. .	—	. .
215,737	151,000[e]	142.9	. .	180,000[e]	. .
. .	—	. .	. .	—	. .
96,677	569,403	17.0	103,009	607,000	17.0
2,430,364	—	. .	. .	—	. .
210,220	4,909,438	4.3	. .	6,072,000	. .
300,080	543,354	55.2	. .	604,000	. .
999,705	4,593,855	21.8	1,019,200	5,253,000	19.4
42,287	81,495	51.9	. .	93,000	. .
. .	22,567,349	. .	. .	22,990,000	. .
1,229,409,641[4]	3,119,460,755	39.4	. .	3,083,378,000	. .
611,416,074[5]	655,853,110	93.2	. .	616,238,000	. .

Table 21. Canada, apparent consumption[1] of some minerals

		1971			1972		
	Unit of Measure	Apparent Consumption	Production	Consumption as a % of Production	Apparent Consumption	Production	Consumption as a % of Production
Asbestos	st	68,755	1,634,579	4.2	94,956	1,687,051	5.6
Cement	st	8,234,943[r]	9,075,915[r]	90.7[r]	8,782,660	10,038,617	87.5
Gypsum	st	1,772,909	6,702,100	26.5	2,198,890	8,099,480	27.2
Iron ore	lt	10,016,147	42,278,733	23.7	11,036,181	38,123,627	29.0
Lime	st	1,386,285[r]	1,643,758[r]	84.3[r]	1,476,699	1,744,156[r]	84.7
Quartz (silica)	st	3,873,498	2,553,884	151.7	3,895,112	2,663,836	146.2
Salt	st	5,312,000[e]	5,541,901	95.8	3,931,080[e]	5,416,925	72.6

[1]Apparent consumption — production plus imports less exports. [2]Production-producers' shipments.
[e]Estimated; [r]Revised; [p]Preliminary.

and relation to production[2], 1971-74.

	Unit of Measure	1973 Apparent Consumption	1973 Production	1973 Consumption as a % of Production	1974[p] Apparent Consumption	1974[p] Production	1974[p] Consumption as a % of Production
Asbestos	st	13,614	1,862,976	0.7	55,338	1,824,000	3.0
Cement	st	9,844,806	11,125,738	88.5	10,319,125	11,308,000	91.3
Gypsum	st	2,138,655	8,389,172	25.5	2,551,286	8,235,000	31.0
Iron ore	lt	12,322,529	46,748,314	26.4	12,060,907	46,621,000	25.9
Lime	st	1,533,756	1,890,590	77.7	1,684,966	2,088,000	80.7
Quartz (silica)	st	3,739,259	2,765,944	135.2	3,581,211	2,686,000	133.3
Salt	st	4,051,300[e]	5,564,627	72.8	4,568,055[e]	5,704,000	80.1

Table 22. Canada, domestic consumption of principal refined metals in relation to refinery production[1], 1965-74

	Unit of Measure or Percentage	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974[p]
Copper											
Domestic consumption[2]	st	224,684	262,557	219,680	250,104	226,281	237,916	221,053	228,907	254,613	273,357
Production	st	434,133	433,004	499,846	524,474	449,232	543,727	526,403	546,685	548,488	616,329
Consumption of production	%	51.8	60.6	43.9	47.7	50.4	43.8	42.0	41.9	46.4	44.4
Zinc											
Domestic consumption[3]	st	97,345	110,481	110,487	118,581	121,417[r]	108,364	120,571[r]	134,187	133,079	129,654
Production	st	358,498	382,605	405,136	426,728	466,357	455,471	410,643	524,885	587,038	469,883
Consumption of production	%	27.2	28.9	27.3	27.8	26.0	23.8	29.4	25.6	22.7	27.6
Lead											
Domestic consumption[3]	st	90,168	96,683	93,953	94,660	105,915	94,094[r]	92,961[r]	116,234[r]	119,082	116,070
Production	st	186,484	184,871	193,235	202,100	187,143	204,630	185,554	205,978	206,012	139,398
Consumption of production	%	48.4	52.3	48.6	46.8	56.6	45.9	50.1	56.4	57.8	83.3
Aluminum											
Domestic consumption[3]	st	213,094	243,301	217,484	242,390	269,027	275,743	322,081	333,550	335,100	. .
Production	st	830,505	889,915	963,343	979,172	1,078,717	1,061,020	1,104,644	999,940	1,037,859	1,125,329
Consumption of production	%	25.7	27.3	22.6	24.8	24.9	26.0	28.7	33.0	32.3	. .

[1]Production of refined metal from all sources, including metal derived from secondary materials at primary refineries.

[2]Producer's domestic shipments of refined metal.
[3]Consumption primary and secondary refined metal, reported by consumers.
[p]Preliminary; . . Not available; [r]Revised.

Table 23. Annual averages of prices of main metals[1], 1970-74.

	Unit of Measure	1970	1971	1972	1973	1974
Aluminum ingots, 99.5%	cents/lb	28.716	29.000	26.409	25.000	34.133
Antimony, RMM, fob Laredo, Texas	cents/lb	141.640	69.300	57.000	66.498	207.458
Bismuth, ton lots, delivered	$/lb	6.000	5.260	3.625	4.928	8.407
Cadmium	cents/lb	362.452	197.262	255.600	364.000	407.800
Calcium, ton lots, crowns	$/lb	0.95	0.95	0.95	0.95	1.07
Chromium, U.S. metal, 9% carbon	$/lb	1.15	1.15	1.56	1.50	2.45
Cobalt metal, 500 lb. lots	$/lb	2.20	2.20	2.450	3.007	3.474
Columbium metallurgical powder	$/lb	11-22	11-22	11-22	11-22	12-23
Copper, U.S. domestic, fob refinery	cents/lb	57.700	51.433	50.617	58.865	76.589
Gold, Royal Canadian						
Mint buying price	$ Cdn/t. oz	36.56	35.34	36.58	38.86	41.18
London free market[2]	$ Cdn/t. oz	37.51	41.20	57.54	97.25	155.67
Iridium	$/t. oz	154-159	150-155	150-178	224.58-232.92	150.00-290.00
Iron ore, 51.5% Fe, lower lake ports						
Bessemer						
Mesabi	$/lt	10.55-10.95	11.25	11.32	12.01	13.99
Old Range	$/lt	10.95-11.20	11.51	11.57	12.26	14.24
Non-Bessemer						
Mesabi	$/lt	10.55-10.80	11.11	11.17	11.86	14.00
Old Range	$/lt	10.80-11.05	11.36	11.42	12.44	14.26
Lead, common, New York	cents/lb	15.619	13.800	15.029	16.285	22.533
Manganese	cents/lb	27.25	29.10	33.25	33.25	41.771
Magnesium, ingot	cents/lb	35.250	36.250	37.250	38.250	60.548
Mercury	$ flask(76 lb)	407.769	292.413	218.279	286.227	288.833
Molybdenum red carbon powder	$/lb	4.00	4.00	4.00	. .	. .
Molybdenite, 95% MoS_2, contained Mo	$/lb	1.73	1.72	1.72	1.72	2.06
Nickel, fob Port Colborne (duty free)	cents/lb	129.080	133.000	139.700	153.000	173.500
Osmium	$/t. oz.	200-225	200-225	200-225	200-225	200-225
Palladium	$/t. oz	36.416	37.000	41.644	77.679	133.583
Platinum	$/t. oz	130.000	120.524	120.779	150.036	183.333
Rhenium — producer powder	$/lb	. .	1,400.00	975.-1,400.00	825.-1,050.00	625.00
Rhodium	$/t. oz	211-217	198-208	195-200	225.83-230.83	285-360
Ruthenium	$/t. oz	50-55	50-55	50-55	59.17-64.17	60-65
Selenium	$/lb	8.25	9.00	9.00	9.17-10.33	16.33
Silver, New York	cents/t. oz	177.082	154.564	168.455	255.756	470.798
Tantalum	$/lb	36-50	35.38-49.04	36-50	30-40	30-54
Tellurium, 100 lb powder	$/lb	6.00	6.00	6.00	6.00	8.33
Tin, Straits, New York	cents/lb	174.205	167.348	177.474	227.558	393.772
Titanium metal sponge, 500 lb lots, 99.3%	$/lb	1.32	1.32	1.32	1.42-1.43	2.25
Titanium slag, 70% TiO_2	$/lt	45.00	48.00	50.00	75.00	60.00
Tungsten hydrogen red metal	$/st	5.43-6.36	5.43-6.94	5.43-6.94	4.97-6.74	9.64-11.34
Zinc, prime western, delivered	cents/lb	15.319	16.128	17.753	20.658	35.945

[1]These prices except for gold are in United States currency, and are from *Metals Week*.
[2]Average of A.M. and P.M. fixings of the London Gold Market, converted to Canadian dollars.
. . Not available or applicable.

Table 24. Canada, wholesale price indexes of minerals and mineral products, 1971-74. (1935-39 = 100)

	1971	1972	1973	1974[p]
Iron and products	316.4	325.0	354.3	447.6
Pig iron	313.5	317.2	342.7	475.5
Rolling mill products	306.7	315.9	338.8	431.1
Pipe and tubing	321.4	331.8	358.9	452.4
Wire	368.3	382.8	416.3	507.1
Scrap iron and steel	284.2	268.1	388.8	742.1
Tinplate and galvanized steel	282.5	295.0	311.3	357.4
Nonferrous metal and products				
Total (including gold)	260.1	262.9	326.5	417.7
Total (excluding gold)	387.6	388.4	478.5	607.5
Copper and products	440.3	428.0	579.4	706.5
Lead and products	282.9	322.7	366.5	500.1
Silver	405.6	430.6	663.3	1,180.8
Tin	324.2	338.8	435.6	764.4
Zinc and products	365.9	419.1	536.8	785.4
Nonmetallic minerals and products	225.8	233.6	254.1	331.2
Clay and clay products	280.3	289.8	308.2	384.2
Pottery	313.9	351.2	439.2	476.0
Coke	413.4	. .	. .	. .
Petroleum products	182.6	187.3	226.7	342.0
Asphalt	225.2	229.2	243.9	432.5
Asphalt shingles	144.0	138.1	152.8	189.7
Plaster	185.0	198.0	213.3	247.6
Lime	299.4	347.1	394.5	497.0
Cement	216.4	229.7	233.5	271.6
Sand and gravel	187.8	216.6	234.7	273.1
Crushed stone	180.2	186.5	203.7	236.5
Building stone	282.6	298.3	314.0	336.1
Asbestos	383.2	397.4	414.4	550.8
General wholesale price index (all products)	289.9	310.3	376.9	460.4

[p] Preliminary; . . Not available.

Table 25. Canada, general wholesale price index and wholesale price indexes of mineral and nonmineral products, 1950-74.
(1935-39 = 100)

	Mineral products			Nonmineral products					
	Iron Products	Nonferrous Metal Products	Nonmetallic Mineral Products	Vegetable Products	Animal Products	Textile Products	Wood Products	Chemical Products	General Wholesale Price Index
1950	183.6	159.5	164.8	202.0	251.3	246.7	258.3	157.8	211.2
1951	208.7	180.6	169.8	218.6	297.7	295.9	295.9	187.3	240.2
1952	219.0	172.9	173.9	210.3	248.2	251.5	291.0	180.1	226.0
1953	221.4	168.6	176.9	199.0	241.7	239.0	288.6	175.7	220.7
1954	213.4	167.5	177.0	196.8	236.0	231.1	286.8	176.4	217.0
1955	221.4	187.6	175.2	195.1	226.0	226.2	295.7	177.0	218.9
1956	239.8	199.2	180.8	197.3	227.7	230.2	303.7	180.1	225.6
1957	252.7	176.0	189.3	197.0	238.4	236.0	299.4	182.3	227.4
1958	252.6	167.3	188.5	198.1	250.7	229.0	298.5	183.0	227.8
1959	255.7	174.6	186.5	199.5	254.3	228.0	304.0	187.0	230.6
1960	256.2	177.8	185.6	203.0	247.6	229.8	303.8	188.2	230.9
1961	258.1	181.6	185.2	203.1	254.7	234.5	305.1	188.7	233.3
1962	256.2	192.1	189.1	211.6	262.5	241.2	315.9	190.5	240.0
1963	253.6	197.5	189.5	227.8	255.6	248.0	323.4	189.3	244.6
1964	256.4	205.9	190.9	223.3	250.8	248.4	330.9	191.2	245.4
1965	264.5	217.6	191.6	218.4	270.7	246.4	334.0	200.2	250.3
1966	268.0	229.9	193.7	225.9	296.2	251.5	337.8	207.1	259.5
1967	274.4	240.2	199.2	230.9	293.1	252.7	346.3	212.6	264.1
1968	276.8	250.8	206.0	230.8	294.6	256.5	367.9	213.7	269.9
1969	285.8	264.0	210.0	237.9	322.4	256.7	389.4	219.7	282.4
1970	305.1	281.0	215.7	238.4	326.0	257.0	377.5	225.7	286.4
1971	316.4	260.1	225.8	237.1	326.0	261.9	394.4	237.8	289.9
1972	325.0	262.9	233.6	249.2	371.8	278.3	436.0	245.5	310.3
1973	354.3	326.5	254.1	354.9	455.3	337.7	504.1	263.3	376.9
1974[p]	447.6	417.7	331.2	485.2	492.8	423.0	563.2	324.2	460.4

[p] Preliminary.

Table 24. Canada, wholesale price indexes of minerals and mineral products, 1971-74. (1935-39 = 100)

	1971	1972	1973	1974[p]
Iron and products				
Pig iron	316.4	325.0	354.3	447.6
Rolling mill products	313.5	317.2	342.7	475.5
Pipe and tubing	306.7	315.9	338.8	431.1
Wire	321.4	[illegible]	[illegible]	

Table 26. Canada, mineral products industries, selling prices indexes, 1971-74. (1961 = 100)

	1971	1972	1973	1974[p]
Iron and steel products industries				
Agriculture implements industry	125.5	130.2	136.8	156.5
Hardware, tool and cutlery manufacturers	130.9	137.0	143.2	167.9
Heating equipment manufacturers	113.5	116.8	119.4	134.5
Primary metal industries	132.3	134.7	155.0	192.6
Iron and steel mills	118.0	121.9	130.6	166.1
Steel pipe and tube mills	103.0	106.9	117.0	142.4
Iron foundries	131.4	136.3	143.1	185.9
Wire and wire products manufacturers	124.5	129.6	142.2	173.1
Nonferrous metal products industries				
Aluminum rolling, casting and extruding	109.8	109.4	109.7	139.8
Copper and alloy, rolling, casting, and extruding	169.4	167.1	208.9	260.5
Jewellery and silverware manufacturers	145.5	155.6	198.9	269.8
Metal rolling, casting and extruding nes	151.0	156.6	187.1	264.5
Nonmetallic mineral products industries				
Abrasive manufacturers	110.9	111.3	116.2	128.3
Cement manufacturers	130.3	138.7	140.4	160.0
Clay products manufacturers from imported clay	121.2	124.5	129.6	153.4
Glass manufacturers	130.6	139.7	145.5	164.1
Lime manufacturers	138.3	149.4	161.9	206.7
Gypsum products manufacturers	119.5	127.1	134.6	153.9
Concrete products manufacturers	127.5	130.8	140.3	168.7
Clay products from domestic clay	124.6	129.9	140.2	164.4
Petroleum and coal products industries	113.9	115.7	132.4	178.3
Petroleum refining	113.7	116.7	133.1	178.6
Lubricating oils and greases	128.4	133.4	143.1	167.9
Manufacturers of mixed fertilizers	112.8	117.6	133.8	194.7

Note: Industry selling price indexes reflect wholesale price trends of products or groups of products sold by the industries listed.
nes Not elsewhere specified; [p]Preliminary.

Table 27. Canada, principal statistics of the mining industry, 1972.

	Mining Activity								Total Activity		
	Production and Related Workers										
	Establishments	Employees	Man-hours Paid	Wages	Cost of Fuel and Electricity	Cost of Materials and Supplies	Value of Production	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Metals											
Placer gold	15	4	5	16	12	43	164	110	4	16	113
Gold quartz	23	4,659	9,663	32,886	4,838	23,548	103,324	74,938	5,575	41,022	75,055
Copper-gold-silver	49	12,449	26,203	115,684	24,238	304,266	774,624	446,121	16,698	161,650	449,533
Silver-cobalt	4	125	261	964	126	827	4,541	3,587	165	1,291	3,626
Silver-lead-zinc	16	4,391	8,775	38,490	9,782	154,757	339,840	175,301	5,892	56,006	176,263
Nickel-copper	11	15,310	29,270	146,519	14,422	330,034	865,464	521,009	19,314	202,301	529,445
Iron	17	6,693	14,029	70,695	39,656	144,045	465,457	281,757	10,842	123,671	279,610
Misc. metal mines	14	2,626	5,535	25,317	5,535	25,317	126,244	95,392	3,504	34,631	96,114
Total	149	46,257	93,760	430,919	98,608	982,835	2,679,657	1,598,214	61,994	620,588	1,609,759
Nonmetals											
Asbestos	12	6,266	14,157	56,681	15,681	48,215	224,756	160,859	7,843	74,408	161,736
Feldspar, quartz and nepheline syenite	13	356	803	2,740	759	2,637	14,482	11,086	451	3,542	11,069
Gypsum	10	567	1,317	4,280	874	3,521	19,003	14,609	670	5,193	14,512
Peat	57	999	2,061	4,668	538	4,082	15,326	10,706	1,114	5,624	11,500
Salt	9	878	1,854	7,597	1,987	7,809	41,675	31,879	1,332	11,949	32,376
Sand and gravel	157	1,817	4,198	14,347	4,102	13,426	68,928	51,400	2,351	20,171	54,864
Stone	122	2,364	5,556	18,321	5,250	21,569	84,261	57,442	2,803	22,484	57,898
Talc and soapstone	4	65	148	353	102	326	1,603	1,174	91	553	1,162
Misc. nonmetallics	22	2,599	5,436	22,385	11,065	20,183	155,048	123,800	3,365	30,478	123,508
Total	406	15,911	35,530	131,372	40,358	121,768	625,082	462,955	20,020	174,402	468,625
Fuels											
Coal	35	6,552	12,283	58,000	9,202	46,029	185,376	130,144	8,704	77,873	130,615
Petroleum and natural gas	1,126	4,324	9,356	46,214	27,394	59,813	2,162,660	2,075,454	16,604	195,920	2,083,466
Total	1,161	10,876	21,639	104,214	36,596	105,842	2,348,036	2,205,598	25,308	273,793	2,214,081
Total Mining Industry	1,716	73,044	150,929	666,505	175,562	1,210,445	5,652,775	4,266,767	107,322	1,068,783	4,292,465

Note: Total activity in this table and also in Tables 28, 29 and 30 includes sales and head offices.

Table 28. Canada, principal statistics of the mineral manufacturing industries, 1972.

	Mineral Manufacturing Activity									Total Activity		
		Production and Related Workers										
	Establishments	Employees	Man-hours Paid	Wages	Cost of Fuel and Electricity	Cost of Materials and Supplies	Value of Production	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Primary metal industries											
Iron and steel mills	48	38,378	80,841	369,891	74,534	923,729	1,900,799	909,369	49,758	508,216	921,737
Steel pipe and tube mills	28	5,114	11,181	46,720	5,310	225,114	340,408	113,801	6,268	60,746	112,947
Iron foundries	115	8,446	18,362	68,818	7,469	93,156	233,487	135,431	9,948	84,981	138,758
Smelting and refining	26	23,509	48,839	210,030	88,289	359,104	977,961	530,569	33,829	334,757	556,918
Aluminum rolling, casting and extruding	68	4,585	9,861	37,873	4,699	188,450	293,755	98,265	6,200	55,333	98,186
Copper and copper alloy, rolling, casting and extruding	49	3,009	6,648	26,315	3,076	215,113	285,216	67,253	3,740	33,849	67,075
Metal rolling, casting and extruding	79	3,294	6,905	21,562	2,920	97,432	161,794	62,630	4,215	30,925	64,972
Total primary metal industries	413	86,335	182,637	781,209	186,297	2,102,098	4,193,420	1,917,318	113,958	1,108,807	1,960,593
Nonmetallic mineral products industries											
Cement manufactures	26	2,742	5,938	26,377	32,359	34,314	221,353	155,968	4,732	48,010	154,787
Lime manufactures	12	500	1,067	3,964	6,075	5,707	24,344	12,605	651	5,469	12,584
Gypsum products manufactures	..	..	..	..	..	..	..	..	..	..	..
Concrete products manufactures	465	8,459	18,626	64,931	7,341	108,863	290,591	175,927	10,817	88,957	182,476
Ready-mix concrete manufactures	340	6,323	13,827	54,500	8,883	193,933	358,927	156,206	8,240	74,042	163,640
Clay products manufactures											
domestic	70	2,233	4,864	16,233	6,182	10,333	55,611	39,572	2,758	21,211	39,974
imported	37	1,581	3,353	10,788	1,499	11,766	39,411	26,546	1,937	13,761	27,039
Refractories manufactures	17	717	1,520	5,643	1,611	18,750	39,694	19,375	1,150	10,112	22,815
Stone products manufactures	91	665	1,391	3,861	491	5,648	15,586	9,330	895	5,738	9,363

Table 28. (concl'd)

	Mineral Manufacturing Activity								Total Activity		
		Production and Related Workers									
	Esta-blish-ments	Em-ployees	Man-hours Paid	Wages	Cost of Fuel and Elec-tricity	Cost of Materials and Supplies	Value of Production	Value Added	Em-ployees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Glass manufactures	18	7,155	14,892	55,009	11,876	52,533	200,932	143,531	8,932	72,801	150,110
Glass products manufactures	85	2,367	5,195	20,142	1,984	55,219	115,336	58,248	3,113	28,917	59,107
Mineral wool manufactures	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Asbestos products manufactures	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Abrasive manufactures	23	1,763	3,829	14,710	8,113	30,201	72,206	32,713	2,367	21,049	33,063
Other nonmetallic mineral products industries	84	4,654	10,410	39,875	8,119	82,872	231,464	143,197	7,495	68,159	155,188
Total nonmetallic minerals	1,268	39,159	84,912	316,033	94,533	610,139	1,665,455	973,218	53,087	458,226	1,010,146
Petroleum and coal products industries											
Petroleum refining industry	41	5,870	13,250	69,977	22,428	1,908,001	2,361,709	431,301	14,376	176,984	430,520
Manufacture of lubricating oils and greases	18	281	578	2,391	388	31,842	50,672	19,529	478	4,392	21,156
Other petroleum and coal products industries	43	432	930	3,367	1,059	15,739	28,683	11,735	555	4,660	13,843
Total petroleum and coal products industries	102	6,583	14,758	75,735	23,875	1,955,582	2,441,064	462,565	15,409	186,036	465,519
Total mineral manufacturing industries	1,783	132,077	282,307	1,172,977	304,705	4,667,819	8,299,939	3,353,101	182,454	1,753,069	3,437,258

. . Not available separately, included in other nonmetallic mineral products industries.

Table 29. Canada, principal statistics of the mining industry[1], 1967-72

	Mining Activity								Total Activity		
		Production and Related Workers									
	Establishments	Employees	Man-hours Paid	Wages	Cost of Fuel and Electricity	Cost of Materials and Supplies	Value of Production	Value Added	Employees	Salaries and Wages	Value Added
	(Number)	(Number)	(000)	($000)	($000)	($000)	($000)	($000)	(Number)	($000)	($000)
1967	1,478	74,230	159,182	465,489	107,563	806,577	3,831,808	2,917,669	102,678	700,678	2,943,224
1968	1,548	75,066	160,346	510,003	119,640	900,344	4,195,930	3,175,945	104,916	772,453	3,189,271
1969	1,686	71,368	151,072	513,708	126,999	931,354	4,400,637	3,342,285	102,088	804,839	3,355,312
1970	1,636	77,208	164,835	614,084	146,049	1,167,456	5,118,396	3,804,891	110,094	994,014	3,830,364
1971	1,662	76,701	158,835	646,900	164,332	1,223,982	5,198,173	3,809,859	110,410	1,015,661	3,826,264
1972	1,716	73,044	150,929	666,505	175,562	1,210,445	5,652,775	4,266,767	107,322	1,068,783	4,292,465

[1]Excludes cement manufacturing, lime manufacturers, clay and clay products (domestic clays). These industries are included with the Mineral Manufacturing Industries. Industry coverage is the same as in Tables 27, 31 and 32.

Table 30. Canada, principal statistics of the mineral manufacturing industries[1], 1967-72.

	Mineral Manufacturing Activity								Total Activity		
		Production and Related Workers									
	Establishments	Workers	Man-Hours Paid	Wages	Cost of Fuel and Electricity	Cost of Materials and Supplies	Value of Production	Value Added	Employees	Salaries and Wages	Value Added
	(Number)	(Number)	(000)	($000)	($000)	($000)	($000)	($000)	(Number)	($000)	($000)
1967	1,797	131,090	282,982	801,636	210,519	3,241,716	5,692,956	2,291,709	169,441	1,095,187	2,342,764
1968	1,760	130,909	279,988^r	850,059	227,679	3,537,700	6,264,424^r	2,530,325	180,324^r	1,267,968^r	2,580,192^r
1969	1,802	128,263	272,947^r	890,911	232,861	3,689,337	6,581,618	2,677,454^r	178,474^r	1,348,463^r	2,757,052^r
1970	1,781	131,570	278,547	989,725	263,827	3,954,629	7,002,306	2,849,055	181,620	1,480,524	2,920,381
1971	1,813	131,044	276,629	1,063,861	288,016	4,192,544	7,551,951	3,097,001	181,122	1,595,437	3,166,347
1972	1,783	132,077	282,307	1,172,977	304,705	4,667,819	8,299,939	3,353,101	182,454	1,753,069	3,437,258

[1]Industry coverage in this table is the same as in Tables 28, 33 and 34.
^r Revised.

Table 31. Canada, consumption of fuel and electricity in the mining industry[1], 1972

	Unit	Metals	Nonmetals	Fuels	Total
Coal and coke	000 st	45	20	. . .	65
	$000	880	188	4	1,072
Gasoline	000 gal	5,004	9,934	2,182	17,120
	$000	2,045	4,029	663	6,737
Fuel oil, kerosene, coal oil	000 gal	191,520	72,648	9,550	273,718
	$000	29,682	15,404	2,059	47,145
Liquified petroleum gas	000 gal	8,925	1,265	898	11,088
	$000	1,589	288	98	1,975
Natural gas	000 mcf	13,105	19,047	3,151	35,303
	$000	5,880	5,368	1,279	12,527
Other fuels[2]	$000	416	–	–	416
Total fuels	$000	40,492	25,277	4,103	69,872
Electricity purchased	million kwh	8,807	1,642	2,154	12,603
	$000	58,104	15,080	32,494	105,678
Total value of fuels and electricity purchased	$000	98,596	40,357	36,597	175,550
Value of fuels and electricity of small establishments[3]	$000	12	–	–	12
Total value of fuels and electricity purchased, all reporting companies	$000	98,608	40,357	36,597	175,562
Electricity generated by industry for own use	million kwh	409	194	–	603
Electricity generated by industry for sale	million kwh	37	–	–	37

[1]Excludes cement and lime manufacturing and manufacture of clay products (from domestic clays). These industries are included under mineral manufacturing, Tables 33 and 34. Industry coverage is same as in Tables 27, 29 and 32.
[2]Includes wood, manufactured gas, steam purchased and other miscellaneous fuels. [3]Value of fuels and electricity used by small establishments which have reported in total only, without commodity detail.
. . . Less than 1,000 short tons; – Nil.

Table 32. Canada, cost of fuel and electricity used in the mining industry[1], 1965-72.

	Unit	1965	1966	1967	1968	1969	1970	1971	1972
Metals									
Fuel	$000	19,854	22,038	26,116	29,340	27,070	33,370	39,887	40,492
Electricity purchased	million kwh	5,533	5,511	6,300	7,020	7,073	7,995	8,692	8,807
	$000	34,517	35,248	38,342	42,340	46,002	52,257	56,847	58,104
Value of fuel and electricity used by small establishments[2]	$000	57	51	24	21	22	21	10	12
Total cost of fuel and electricity	$000	54,428	57,337	64,482	71,701	73,094	85,648	96,744	98,608
Electricity generated for own use and for sale	million kwh	483	473	510	466	476	459	359	446
Nonmetals[3]									
Fuel	$000	14,623	15,410	16,180	18,448	19,793	20,029	22,951	25,277
Electricity purchased	million kwh	939	1,022	1,127	1,291	1,473	1,468	1,584	1,642
	$000	8,711	8,867	9,537	10,809	12,728	13,980	14,474	15,080
Value of fuel and electricity used by small establishments[2]	$000	740	735	548	342	401	—	—	—
Total cost of fuel and electricity	$000	24,074	25,012	26,265	29,599	32,922	34,009	37,425	40,357
Electricity generated for own use and for sale	million kwh	41	123	151	156	173	161	178	194
Fuels									
Fuels	$000	827	720	690	678	739	2,072	2,635	4,103
Electricity purchased	million kwh	888	955	989	1,101	1,265	1,540	1,763	2,154
	$000	17,064	15,798	16,126	17,662	20,244	24,320	27,528	32,494
Value of fuel and electricity used by small establishments[2]	$000	—	—	—	—	—	—	—	—
Total cost of fuel and electricity	$000	17,891	16,518	16,816	18,340	20,983	26,392	30,163	36,597
Electricity generated for own use and for sale	million kwh	34	37	—	—	—	—	—	—
Total mining industry									
Fuel	$000	35,304	38,168	42,986	48,466	47,602	55,470	65,473	69,872
Electricity purchased	million kwh	7,360	7,488	8,416	9,412	9,811	11,003	12,039	12,603
	$000	60,292	59,913	64,005	70,811	78,974	90,558	98,849	105,678
Value of fuel and electricity used by small establishments[2]	$000	797	786	572	363	423	21	10	12
Total cost of fuel and electricity	$000	96,393	98,867	107,563	119,640	126,999	146,049	164,332	175,562
Electricity generated for own use and for sale	million kwh	558	633	661	622	649	620	537	640

[1]See footnote Table 31. Industry coverage is the same as in Tables 27, 29 and 31.
[2]Value of fuel and electricity used b[illegible] which have reported in total only, without commodity detail.
[3]Nonmetals includes structural [illegible]

Table 33. Canada, consumption of fuel and electricity in the mineral manufacturing industries[1], 1972.

	Unit	Primary Metals Industries	Nonmetallic Mineral Products Industries	Petroleum and Coal Products Industries	Total
Coal and coke	000 st	1,068	230	5	1,303
	$000	22,080	3,655	7	25,742
Gasoline	000 gal	3,902	16,564	630	21,096
	$000	1,394	6,624	255	8,273
Fuel oil, kerosene, coal oil	000 gal	302,891	242,782	4,584	550,257
	$000	31,584	26,018	651	58,253
Liquefied petroleum gas	000 gal	10,557	2,977	5	13,539
	$000	1,484	722	2	2,208
Natural gas	000 mcf	68,209	57,200	16,560	141,969
	$000	32,991	27,496	4,977	65,464
Other fuels	$000	1,317	651	539	2,507
Total fuels	$000	90,850	65,166	6,431	162,447
Electricity purchased	million kwh	15,678	2,280	2,475	20,433
	$000	95,447	29,367	17,444	142,258
Total value, fuels and electricity purchased	$000	186,297	94,533	23,875	304,705
Value of purchased fuels and electricity of small establishments[2]	$000	—	—	—	—
Total value of fuels and electricity purchased, all reporting companies	$000	186,297	94,533	23,875	304,705

[1]Industry coverage is the same as in Tables 28, 30 and 34.
[2]Value of fuels and electricity used by small establishments which have reported in total only, without commodity detail.
— Nil.

Table 34. Canada, cost of fuel and electricity used in the mineral manufacturing industries[1], 1965-72

	Unit	1965	1966	1967	1968	1969	1970	1971	1972
Primary metals									
Fuel	$000	67,121	71,129	71,133	73,938	69,185	83,034	92,903	90,850
Electricity purchased	million kwh	11,326	12,531	13,118	14,363	15,370	14,539	15,028	15,678
	$000	52,388	56,774	60,624	68,834	73,114	87,656	90,512	95,447
Cost of fuel and electricity for small establishments[2]	$000	384	326	199	171	202	–	–	–
Total cost of fuel and electricity	$000	119,893	128,229	131,956	142,943	142,501	170,690	183,415	186,297
Nonmetallic mineral products									
Fuel	$000	42,925	45,479	44,055	45,237	47,310	49,451	57,249	65,166
Electricity purchased	million kwh	2,885	3,265	2,987	3,118	3,182	3,270	3,279	2,280
	$000	18,397	20,791	19,962	21,566	23,297	24,507	25,932	29,367
Cost of fuel and electricity for small establishemnts[2]	$000	1,104	1,122	852	1,165	1,231	–	–	–
Total cost of fuel and electricity	$000	62,426	67,392	64,869	67,968	71,838	73,958	83,181	94,533
Petroleum and coal products									
Fuel	$000	2,738	3,213	2,980	5,294	5,450	4,749	5,346	6,431
Electricity purchased	million kwh	1,518	1,586	1,659	1,818	1,980	2,171	2,326	2,475
	$000	9,820	10,177	10,699	11,467	13,059	14,430	16,074	17,444
Cost of fuel and electricity for small establishments[2]	$000	18	9	15	7	13	–	–	–
Total cost of fuel and electricity	$000	12,576	13,399	13,694	16,768	18,522	19,179	21,420	23,875
Total mineral manufacturing industries									
Fuel	$000	112,784	119,821	118,168	124,469	121,945	137,234	155,498	162,447
Electricity purchased	million kwh	15,729	17,832	17,764	19,299	20,532	19,980	20,633	20,433
	$000	80,605	87,742	91,285	101,867	109,470	126,593	132,518	142,258
Cost of fuel and electricity for small establishments[2]	$000	1,506	1,457	1,066	1,343	1,446	–	–	–
Total cost of fuel and electricity	$000	194,895	209,020	210,519	227,679	232,861	263,827	288,016	304,705

[1]Industry coverage is the same as in Tables 28, 30 and 33.
[2]Total cost of fuel and electricity purchased by small establishments; No commodity detail reported.
– Nil.

Table 35. Canada, employment, salaries and wages in the mining industry[1], 1965-72.

	Unit	1965	1966	1967	1968	1969	1970	1971	1972
Metals									
Production and related workers	Number	49,050	48,276	48,262	49,238	46,023	51,102	50,121	46,257
Salaries and wages	$000	269,457	284,477	317,978	350,321	341,495	421,893	434,222	430,919
Annual average salary and wage	$	5,494	5,893	6,589	7,115	7,420	8,256	8,663	9,316
Administrative and office workers	Number	11,892	13,394	13,466	14,131	14,527	15,488	15,891	15,737
Salaries and wages	$000	87,398	100,666	111,405	124,451	137,756	158,653	178,640	189,669
Annual average salary and wage	$	7,349	7,516	8,273	8,807	9,482	10,244	11,242	12,052
Total, metals									
Employees	Number	60,942	61,670	61,728	63,369	60,550	66,590	66,012	61,994
Salaries and wages	$000	356,855	385,143	429,383	474,772	479,251	580,546	612,862	620,588
Annual average salary and wage	$	5,856	6,245	6,956	7,492	7,915	8,718	9,284	10,010
Nonmetals									
Production and related workers	Number	14,688	14,916	15,049	15,458	15,933	16,245	16,155	15,911
Salaries and wages	$000	72,352	77,984	84,755	94,850	107,622	114,345	122,355	131,372
Annual average salary and wage	$	4,926	5,228	5,632	6,135	6,754	7,039	7,574	8,257
Administrative and office workers	Number	3,676	3,818	3,807	4,051	4,081	4,415	4,278	4,109
Salaries and wages	$000	24,239	26,049	28,397	32,836	34,980	39,533	40,222	43,030
Annual average salary and wage	$	6,594	6,823	7,459	8,106	8,573	8,954	9,402	10,472
Total, nonmetals									
Employees	Number	18,364	18,734	18,856	19,509	20,014	20,660	20,433	20,020
Salaries and wages	$000	96,591	104,033	113,152	127,686	142,602	153,878	162,577	174,402
Annual average salary and wage	$	5,260	5,553	6,000	6,545	7,125	7,448	7,957	8,711
Fuels									
Production and related workers	Number	11,308	11,003	10,919	10,370	9,412	9,861	10,425	10,876
Salaries and wages	$000	54,922	57,035	62,756	64,832	64,591	77,846	90,324	104,214
Annual average salary and wage	$	4,857	5,184	5,747	6,252	6,862	7,894	8,664	9,582
Administrative and office workers	Number	10,206	10,656	11,175	11,668	12,112	12,983	13,540	14,432
Salaries and wages	$000	73,733	83,021	95,387	105,163	118,395	131,744	149,898	169,579
Annual average salary and wage	$	7,224	7,791	8,536	9,013	9,775	10,147	11,070	11,750
Total fuels									
Employees	Number	21,514	21,659	22,094	22,038	21,524	22,844	23,965	25,308
Salaries and wages	$000	128,655	140,056	158,143	169,995	182,986	209,590	240,222	273,793
Annual average salary and wage	$	5,980	6,466	7,158	7,714	8,501	9,175	10,024	10,818

Table 35. (concl'd)

	Unit	1965	1966	1967	1968	1969	1970	1971	1972
Total mining									
Production and related workers	Number	75,046	74,195	74,230	75,066	71,368	77,208	76,701	73,044
Salaries and wages	$000	396,731	419,496	465,489	510,003	513,708	614,084	646,900	666,505
Annual average salary and wage	$	5,286	5,654	6,271	6,794	7,198	7,954	8,434	9,125
Administrative and office workers	Number	25,774	27,868	28,448	29,850	30,720	32,886	33,709	34,278
Salaries and wages	$000	185,370	209,736	235,189	262,450	291,131	329,930	368,760	402,278
Annual average salary and wage	$	7,192	7,526	8,267	8,792	9,477	10,033	10,940	11,736
Total mining									
Employees	Number	100,820	102,063	102,678	104,916	102,088	110,094	110,410	107,322
Salaries and wages	$000	582,101	629,232	700,678	772,453	804,839	944,014	1,015,661	1,068,783
Annual average salary and wage	$	5,774	6,165	6,824	7,363	7,883	8,575	9,199	9,959

[1] According to the 1970 Standard Industrial Classification. Does not include cement and lime manufacturing and clay products (domestic clays) manufacturing. These industries are included in Table 36 under nonmetallic mineral products industries. See Table 27 for detail of industries covered.

Table 36. Canada, employment, salaries and wages in the mineral manufacturing industries, 1965-72

	Unit	1965	1966	1967	1968r	1969r	1970	1971	1972
Primary metal industries									
Production and related workers	Number	83,443	87,748	86,784	86,237	83,564	88,839	86,452	86,335
Salaries and wages	$000	478,482	518,347	541,970	570,183	583,498	680,779	714,600	781,209
Annual average salary and wage	$	5,734	5,907	6,245	6,612	6,982	7,663	8,266	11,051
Administrative and office workers	Number	21,189	22,555	23,294	26,786	27,389	27,706	27,862	27,623
Salaries and wages	$000	148,752	169,686	185,800	233,273	255,548	277,728	303,113	327,598
Average annual salary and wage	$	7,020	7,523	7,976	8,709	9,330	10,024	10,879	11,860
Total primary metal industries									
Employees	Number	104,632	110,303	110,078	113,023	110,953	116,545	114,314	113,958
Salaries and wages	$000	627,234	688,033	727,770	803,456	839,046	958,507	1,017,713	1,108,807
Annual average salary and wage	$	5,995	6,238	6,611	7,109	7,562	8,224	8,903	9,730
Nonmetallic mineral products industries									
Production and related workers	Number	38,246	39,561	37,467	37,796	38,107	36,045	38,035	39,159
Salaries and wages	$000	188,351	206,120	207,204	223,173	246,196	244,201	281,046	316,033
Annual average salary and wage	$	4,925	5,210	5,569	5,919	6,461	6,775	7,389	8,071

Table 36. (concl'd)

	Unit	1965	1966	1967	1968[r]	1969[r]	1970	1971	1972
Administrative and office workers	Number	11,044	11,583	11,793	13,874	13,781	13,383	13,256	13,928
Salaries and wages	$000	66,970	73,851	79,464	102,869	111,568	117,163	124,085	142,193
Annual average salary and wage	$	6,064	6,376	6,738	7,415	8,096	8,754	9,361	10,209
Total nonmetallic mineral products									
Employees	Number	49,290	51,144	49,260	51,670	51,888	49,428	51,291	53,087
Salaries and wages	$000	255,321	279,971	286,668	326,042	357,764	361,364	405,131	458,226
Annual average salary and wage	$	5,180	5,474	5,819	6,310	6,895	7,311	7,899	8,632
Petroleum and coal products industries									
Production and related workers	Number	6,825	6,832	6,839	6,876	6,590	6,686	6,557	6,583
Salaries and wages	$000	43,387	48,780	52,462	56,703	61,217	64,745	68,215	75,735
Annual average salary and wage	$	6,357	7,140	7,671	8,247	9,289	9,684	10,403	11,505
Administrative and office workers	Number	3,090	3,173	3,264	8,755	9,043	8,961	8,960	8,826
Salaries and wages	$000	25,472	26,540	28,287	81,767	90,436	95,908	104,378	110,301
Annual average salary and wage	$	8,243	8,364	8,666	9,339	10,001	10,703	11,649	12,497
Total petroleum and coal products									
Employees	Number	9,915	10,005	10,103	15,631	15,633	15,647	15,517	15,409
Salaries and wages	$000	68,859	75,320	80,749	138,470	151,653	160,653	172,593	186,036
Annual average salary and wage	$	6,945	7,528	7,993	8,859	9,701	10,267	11,123	12,073
Total mineral manufacturing industries									
Production and related workers	Number	128,514	134,141	131,090	130,909	128,263	131,570	131,044	132,077
Salaries and wages	$000	710,220	773,247	801,636	850,059	890,911	989,725	1,063,861	1,172,977
Annual average salary and wage	$	5,526	5,764	6,115	6,494	6,945	7,522	8,118	8,881
Administrative and office workers	Number	35,323	37,311	38,351	49,415	50,211	50,050	50,078	50,377
Salaries and wages	$000	241,194	270,077	293,551	417,909	457,552	490,799	531,576	580,092
Annual average salary and wage	$	6,828	7,239	7,654	8,457	9,113	9,806	10,615	11,515
Total mineral manufacturing industries									
Employees	Number	163,837	171,452	169,441	180,324	178,474	181,620	181,122	182,454
Salaries and wages	$000	951,414	1,043,324	1,095,187	1,267,968	1,348,463	1,480,524	1,595,437	1,753,069
Annual average salary and wage	$	5,807	6,085	6,464	7,032	7,556	8,151	8,809	9,608

Note: See Footnote Table 35.
See Table 28 for detail of industries covered.
[r] Revised.

Table 37. Canada, number of wage earners (surface, underground and mill) mining industry,[1] 1969-72.

	1969	1970	1971	1972
Metals				
Surface	13,269	14,724	14,316	13,171
Underground	22,996	25,317	24,907	22,177
Mill	9,758	11,061	10,898	10,909
Total	46,023	51,102	50,121	46,257
Nonmetals				
Surface	7,381	7,515	7,650	6,952
Underground	1,817	1,954	1,733	1,792
Mill	6,735	6,776	6,772	7,167
Total	15,933	16,245	16,155	15,911
Fuels				
Surface	4,292	5,091	5,798	7,576
Underground	5,120	4,770	4,627	3,300
Total	9,412	9,861	10,425	10,876
Total mining industry				
Surface	24,942	27,330	27,764	27,699
Underground	29,933	32,041	31,267	27,269
Mill	16,493	17,837	17,670	18,076
Total	71,368	77,208	76,701	73,044

[1]See Table 27 for coverage.

Table 38. Canada, labour costs in relation to tons mined, metal mines, 1970-72.

Type of Metal Mine	Number of Wage Earners	Total Wages	Average Annual Wage	Tons of Ore Mined	Average Annual Tons Mined Per Wage Earner	Wage Cost Per Ton Mined
		($000)	($)	(000 st)	(st)	($)
1972						
Auriferous quartz	4,663	32,903	7,056	6,713	1,440	4.90
Copper-gold-silver	12,449	115,684	9,293	73,422	5,898	1.58
Nickel-copper	15,310	146,519	9,570	25,459	1,663	5.75
Silver-cobalt	125	964	7,712	135	1,080	7.14
Silver-lead-zinc	4,391	38,490	8,766	15,603	3,553	2.47
Iron Ore	6,693	70,695	10,563	91,747	13,708	0.77
Miscellaneous metals	2,626	25,664	9,773	13,965	5,318	1.84
Total	46,257	430,919	9,316	227,044	4,908	1.90
1971						
Auriferous quartz	5,138	32,571	6,339	7,338	1,428	4.44
Copper-gold-silver	11,868	100,358	8,456	47,837	4,301	2.10
Nickel-copper	17,664	159,779	9,045	34,484	1,952	4.63
Silver-cobalt	228	1,637	7,180	165	724	9.92
Silver-lead-zinc	4,640	39,224	8,453	16,186	3,488	2.42
Iron Ore	7,493	72,172	9,632	107,222	14,310	0.67
Miscellaneous metals	3,090	28,481	9,217	19,876	6,432	1.43
Total	50,121	434,222	8,663[r]	233,108	4,651	1.86
1970						
Auriferous quartz	5,990	36,235	6,049	7,781	1,299	4.66
Copper-gold-silver	11,826	90,980	7,693	43,067	3,642	2.11
Nickel-copper	16,691	149,303	8,945	34,492	2,067	4.33
Silver-cobalt	339	2,203	6,499	230	678[r]	9.58
Silver-lead-zinc	4,987	39,235	7,868	15,839	3,176	2.48
Iron Ore	7,609	74,031	9,729	108,260	14,228	0.68
Miscellaneous metals	3,660	29,906	8,171	25,200	6,885	1.19
Total	51,102	421,893	8,256	234,869	4,596	1.80

[r] Revised.

Table 39. Canada, man-hours paid, in relation to tonnage mined and quarried, 1966-72

	Unit	1966	1967	1968	1969	1970	1971	1972
Metal mines[1]								
Ore mined	million st	162.8	186.5	206.1	189.6	234.9	233.1	227.0
Man-hours paid[2]	million	101.4	103.8	105.2	95.8	108.2	102.1	93.8
Man-hours paid per ton mined	number	0.62	0.56	0.51	0.51	0.46	0.44	0.41
Tons mined per man-hour paid	st	1.61	1.80	1.96	1.98	2.17	2.28	2.42
Nonmetallic mineral operations[3]								
Ore mined and rock quarried	million st	171.3	177.9	173.4	179.9	178.0	182.9	191.2
Man-hours paid[2]	million	24.7	25.3	25.9	28.4	28.6	27.5[r]	27.4
Man-hours paid per ton mined	number	0.14	0.14	0.15	0.16	0.16	0.15	0.14
Tons mined per man-hour paid	st	6.93	7.04	6.69	6.33	6.22	6.65[r]	6.98

[1]Excludes placer mining; [2]Man-hours paid for production and related workers only; [3]Excludes salt, cement, clay products, stone for cement and lime manufacture, and peat.
[r] Revised.

Table 40. Canada, basic wage rates per hour in metal mining industry on Oct. 1, 1974

	Gold Mines[2]	Iron Mines[3]	Other Metal Mines[4]
	($)	($)	($)
Underground workers			
Cageman	5.14	. .	4.61
Car dropper	. .	. .	4.44
Dinkey-engine operator	. .	. .	4.41
Grizzly worker	. .	. .	4.64
Hoist operator	5.18	. .	5.04
Labourer	5.06	. .	4.34
Mechanical shovel operator	5.10	. .	4.76
Miner	4.79	. .	4.60
Miner's helper	. .	. .	4.34
Timber and steel-prop setter	5.11	. .	4.60
Track repairman	. .	. .	4.27
Open-pit workers			
Blaster	. .	5.21	. .
Bulldozer operator	. .	5.03	. .
Driller machine operator	. .	5.23	. .
Dumptruck driver	. .	5.37	. .
Oiler and greaser	. .	4.50	. .
Shovel operator (power)	. .	5.60	. .
Surface and mill workers			
Bit-sharpener tender	5.07	. .	4.66
Blacksmith	. .	. .	5.20
Carpenter, maintenance	4.77	5.51	5.36
Crusher tender	4.99	5.02	4.47
Diesel mechanic	. .	5.76	3.70
Electrical repairman	4.85	5.88	5.54
Filtering attendant	. .	. .	4.41
Flotation-cell tender	. .	. .	4.74
Grinder and classifier tender	. .	5.40	4.68
Labourer	4.20	4.20	4.43
Maintenance machinist	4.90	5.85	5.63
Maintenance-man helper	. .	4.91	. .
Millman[1]	5.10	. .	. .
Millwright	. .	5.75	5.47
Pipefitter, maintenance	4.58	5.17	5.45
Truckdriver, light and heavy	4.65	4.88	4.98
Welder, maintenance	4.84	5.66	5.29

[1]Includes filtering attendant, grinder and classifier and leaching operator. [2]Figures from Provinces of Quebec and Ontario only. [3]Figures from Provinces of Nfld., Ontario, Quebec and British Columbia. [4]Figures from Provinces of Quebec, Ontario and British Columbia

. . Not available or not applicable.

Note: Due to changes in survey methods, data for 1974 not comparable with former years.

Table 41. Canada, average weekly wages and hours of hourly-rated employees in mining, manufacturing and construction industries, 1967-74

	1967	1968	1969	1970	1971	1972	1973	1974[p]
Mining								
Average hours per week	41.9	41.8	41.4	41.0	40.4	40.3	40.9	40.4
Average weekly wage	119.09	128.28	135.94	152.10	163.22	174.94	196.89	222.25
Metals								
Average hours per week	41.3	41.2	40.7	40.3	39.3	39.0	39.6	39.4
Average weekly wage	112.79	131.55	137.68	154.68	164.27	174.69	195.89	222.78
Mineral fuels								
Average hours per week	42.5	41.9	41.9	42.0	41.4	41.0	41.0	40.6
Average weekly wage	101.24	109.96	122.88	146.68	161.46	176.36	198.08	231.00
Nonmetals								
Average hours per week	42.3	42.4	41.9	41.3	41.4	41.3	41.3	41.1
Average weekly wage	112.35	121.24	129.05	139.21	151.52	158.30	173.10	190.95
Manufacturing								
Average hours per week	40.3	40.3	40.0	40.0	39.7[r]	40.0[r]	39.6	38.9
Average weekly wage	96.84	104.00	111.69	119.69	130.22	141.53	152.77	169.91
Construction								
Average hours per week	41.3	40.5	39.8	39.2	39.2	40.1	39.5	38.9
Average weekly wage	128.76	134.84	146.90	165.04	186.20	206.43	223.86	250.28

[p]Preliminary; [r]Revised.

Table 42. Canada, average weekly wages of hourly-rated employees in mining industry in current and 1949 dollars, 1967-74

	1967	1968	1969	1970	1971	1972	1973	1974^{p}
Current dollars								
All mining	119.09	128.28	135.94	152.10	163.22	174.94^{r}	196.89	222.25
Metals	122.79	131.55	137.68	154.68	164.27	174.69	195.89	222.78
Gold	95.72	101.26	107.69	113.72	124.61	131.92	151.73	192.18
Mineral fuels	101.24	109.96	122.88	146.68	161.46	176.36	198.08	231.00
Coal	90.63	97.41	108.58	130.37	144.26	158.18	181.29	212.59
Nonmetals except fuel	112.35	121.24	129.05	139.21	151.52	158.30	173.10	190.95
1949 dollars								
All mining	79.92	82.65	83.86	90.81	94.73	96.87^{r}	101.33	103.13
Metals	82.40	84.76	84.94	92.35	95.34	96.73	100.82	103.38
Gold	64.24	65.24	66.43	67.89	72.32	73.05	78.09	89.18
Mineral fuels	67.94	70.85	75.81	87.57	93.71	97.65	101.95	107.19
Coal	60.83	62.76	66.98	77.83	83.73	87.59	93.30	98.65
Industrial minerals	75.40	78.12	79.61	83.11	87.94	87.65	89.09	88.61

^{p}Preliminary; ^{r}Revised.

Table 43. Canada, industrial fatalities per thousand workers, by industry groups, 1972-74

	Fatalities number			Number of Workers 000's			Rate per 1,000 Workers		
	1972	1973	1974^{p}	1972	1973	1974^{p}	1972	1973	1974^{p}
Agriculture	30	25	36	481	467	473	0.06	0.06	0.08
Forestry	76	94	85	71	80	82	1.07	1.18	1.04
Fishing	10	15	11	22	25	24	0.45	0.60	0.45
Mining	171	166	204	124	123	126	1.38	1.35	1.62
Manufacturing	247	234	303	1,857	1,968	2,024	0.13	0.12	0.15
Construction	208	201	250	501	549	598	0.42	0.37	0.42
Transportation	225	241	257	730	773	790	0.31	0.31	0.33
Trade	70	78	128	1,410	1,498	1,575	0.05	0.05	0.08
Finance	6	6	6	385	410	446	0.02	0.02	0.01
Service	109	78	118	2,194	2,284	2,386	0.05	0.03	0.05
Public administration	63	89	67	553	582	613	0.11	0.15	0.11
Total	1,215	1,227	1,465	8,328	8,759	9,137	0.15	0.14	0.16

See footnotes to Table 44.
^{p}Preliminary.

Table 44. Canada, industrial fatalities per thousand workers, by industry groups, 1964-74

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974[p]
Agriculture	0.11	0.08	0.10	0.05	0.05	0.06	0.03	0.04	0.06	0.06	0.08
Forestry	1.89	1.40	1.45	1.25	1.28	1.10	1.31	1.29	1.07	1.18	1.04
Fishing[1]	1.42	1.74	1.42	1.32	0.79	0.86	1.25	0.50	0.45	0.60	0.45
Mining[2]	1.85	1.31	1.21	1.61	1.15	1.40	1.20	1.26	1.38	1.35	1.62
Manufacturing	0.14	0.14	0.13	0.11	0.10	0.11	0.10	0.10	0.13	0.12	0.15
Construction	0.61	0.60	0.59	0.43	0.46	0.49	0.41	0.45	0.42	0.37	0.42
Transportation[3]	0.40	0.47	0.40	0.34	0.26	0.30	0.27	0.29	0.31	0.31	0.33
Trade	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.08
Finance[4]	0.01	0.01	0.00	0.02	0.00	0.01	0.01	0.01	0.02	0.02	0.01
Service[5]	0.04	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.05	0.03	0.05
Public administration	0.14	0.13	0.07	0.08	0.14	0.14	0.16	0.13	0.11	0.15	0.11
Total	0.20	0.19	0.17	0.15	0.13	0.14	0.13	0.14	0.15	0.14	0.16

[1]Includes trapping and hunting; [2] Includes quarrying and oil wells; [3]Includes storage, communication, electric power and water utilities; [4]Includes insurance and real estate; [5]Includes community, business and personal service.
[p]Preliminary.

Table 45. Canada, number of strikes and lockouts, by industries, 1973-74

	1973			1974p		
	Strikes and Lockouts	Workers Involved	Duration in Man-days	Strikes and Lockouts	Workers Involved	Duration in Man-days
Agriculture	—	—	—	1	503	2,450
Forestry	23	6,181	17,490	16	16,065	204,770
Fishing and trapping	3	8,000	55,950	7	5,114	102,220
Mines	33	11,560	220,570	61	30,735	515,250
Manufacturing	384	148,857	3,376,000	685	232,436	4,814,560
Construction	62	26,104	519,300	72	154,856	2,409,980
Transportation and utilities	74	91,424	1,086,870	127	73,352	700,020
Trade	71	12,657	166,430	77	9,634	118,970
Finance, insurance and real estate	2	17	260	6	107	2,010
Service	49	39,338	234,190	104	32,619	272,060
Public administration	23	4,332	99,020	60	36,799	112,830
All industries	724	348,470	5,776,080	1,216	592,220	9,255,120

— Nil; pPreliminary.

Table 46. Canada, ore mined and rock quarried in the mining industry, 1970-72.

	1970	1971	1972
	(short tons)		
Metals			
Gold quartz	7,781,571	7,337,407	6,712,618
Copper-gold-silver	43,067,354	47,837,400	73,422,266
Silver-cobalt	229,704	164,690	134,814
Silver-lead-zinc	15,838,543	16,185,964	15,602,662
Nickel-copper	34,492,189	34,484,304	25,459,441
Iron	108,259,551	107,221,930	91,746,947
Miscellaneous metals	25,199,823	19,876,406	13,964,991
Total	234,868,735	233,108,101	227,043,739
Nonmetals			
Asbestos	90,531,936	84,475,059	79,179,897
Feldspar, nepheline syenite	626,833	706,240	686,562
Quartz (exclusive of sand)	1,368,952	1,495,943	1,325,357
Gypsum	5,892,699	6,735,651	8,042,115
Talc soapstone	67,021	73,851	86,654
Rock salt	4,368,015	4,581,429	4,622,532
Other nonmetallics	14,304,219	15,893,105	17,159,472
Total	117,159,675	113,961,278	111,102,589
Structural materials			
Stone, all kinds quarried	65,322,840	73,514,842	80,202,524
Stone used to make cement	11,774,537	14,367,599	14,650,285
Stone used to make lime	3,118,403	2,973,392	3,219,070
Total	80,215,780	90,855,833	98,071,879
Total ore mined and rock quarried	432,244,190	437,925,212	436,218,207

Table 47. Canada, ore mined and rock quarried in the mining industry, 1938-72.

	Metals	Nonmetals[1]	Total
		(million short tons)	
1938	31.4	14.9	46.3
1939	35.9	16.5	52.4
1940	39.6	20.3	59.9
1941	43.0	21.6	64.6
1942	42.5	21.7	64.2
1943	38.7	20.7	59.4
1944	35.3	19.3	54.6
1945	31.3	20.6	51.9
1946	28.9	24.8	53.7
1947	33.3	30.4	63.7
1948	36.9	33.5	70.4
1949	43.3	32.9	76.2
1950	45.9	41.8	87.7
1951	48.8	43.8	92.6
1952	52.3	44.2	96.5
1953	54.4	47.2	101.6
1954	59.0	61.5	120.5
1955	69.2	63.5	132.7
1956	77.4	73.0	150.4
1957	84.3	82.2	166.5
1958	78.8	78.5	157.3
1959	99.1	90.7	189.8
1960	101.6	97.8	199.4
1961	99.4	106.7	206.1
1962	114.3	114.5	228.8
1963	124.3	132.8	257.1
1964	141.1	147.8	288.9
1965	166.5	161.5	328.0
1966	162.8	189.4	352.2
1967	186.5	195.7	382.2
1968	206.1	190.3	396.4
1969	189.6	197.1	386.7
1970	234.9	197.3	432.2
1971	233.1	204.8	437.9
1972	227.0	209.2	436.2

[1]Includes nonmetallic mineral mining and all stone quarried, including stone used to make cement and lime. Excludes coal. Coverage is the same as in Table 46.

Table 48. Canada, exploration and capital expenditures in the mining industry[1], by provinces and territories 1972-74

		Capital						Repair						
		Construction				Machinery and Equipment	Total Capital	Construction	Machinery and Equipment	Total Repair	Total Capital and Repair	Outside or General Exploration	Land and Mining Rights	Total all Expenditures
		On-Property Exploration	On-Property Development	Structures	Total									
		(millions of dollars)												
Atlantic Provinces	1972	1.6	10.4	10.9	22.9	71.5	94.4	6.2	48.3	54.5	148.9	2.7	0.1	151.7
	1973	2.0	11.6	26.1	39.7	58.9	98.6	10.1	66.1	76.2	174.8	4.5	0.2	179.5
	1974^p	1.6	19.6	26.7	47.9	30.1	78.0	16.7	97.1	113.8	191.8	9.4	. .	. .
Quebec	1972	3.2	29.2	123.6	156.0	159.6	315.6	6.4	74.5	80.9	396.5	9.9	2.0	408.4
	1973	3.1	45.1	130.6	178.8	151.0	329.8	7.7	102.7	110.4	440.2	13.4	. .	. .
	1974^p	7.2	60.3	125.6	193.1	65.9	259.0	10.3	137.8	148.1	407.1	18.2	2.1	427.4
Ontario	1972	5.9	55.7	24.9	86.5	79.0	165.5	8.0	122.4	130.4	295.9	15.3	1.7	312.9
	1973	6.9	70.6	13.3	90.8	45.8	136.6	19.2	115.6	134.8	271.4	18.5	2.5	292.4
	1974^p	6.8	75.3	43.3	125.4	70.4	195.8	17.3	122.1	139.4	335.2	19.3	2.8	357.3
Manitoba	1972	. .	. .	. .	31.1	15.6	46.7	2.4	13.2	15.6	62.3	5.6	—	67.9
	1973	. .	. .	. .	26.1	9.3	35.4	2.4	21.1	23.5	58.9	5.9	. .	. .
	1974^p	. .	. .	. .	15.7	7.8	23.5	2.7	26.6	29.3	52.8	7.1	0.1	60.0
Saskatchewan	1972	. .	. .	. .	9.1	12.7	21.8	1.9	21.7	23.6	45.4	3.7	. .	. .
	1973	. .	. .	. .	12.2	14.7	26.9	1.3	26.7	28.0	54.9	6.3	. .	. .
	1974^p	. .	. .	. .	30.3	23.8	54.1	7.0	33.4	40.4	94.5	5.9	—	100.4
Alberta	1972	. .	. .	. .	7.4	5.0	12.4	0.3	5.5	5.8	18.2	1.8	. .	. .
	1973	. .	. .	. .	12.3	3.4	15.7	0.4	6.1	6.5	22.2	2.5	. .	. .
	1974^p	. .	. .	. .	18.7	20.6	39.3	0.4	9.2	9.6	48.9	3.9	1.2	54.0
British Columbia	1972	2.2	22.9	46.9	72.0	48.0	120.0	6.4	59.4	65.8	185.8	27.2	. .	. .
	1973	5.6	20.2	16.1	41.9	32.1	74.0	10.9	80.7	91.6	165.6	27.0	1.4	194.0
	1974^p	3.4	37.8	30.7	71.9	53.9	125.8	12.7	106.0	118.7	244.5	22.4	1.0	267.9
Yukon and Northwest Territories	1972	2.8	16.2	1.5	20.5	2.9	23.4	1.0	13.8	14.8	38.2	6.3	. .	. .
	1973	2.0	14.1	6.7	22.8	5.8	28.6	2.5	15.9	18.4	47.0	9.0	0.4	56.4
	1974^p	2.5	13.5	7.1	23.1	9.2	32.3	5.0	16.2	21.2	53.5	18.8	. .	. .
Canada	1972	16.6	157.9	231.0	405.5	394.3	799.8	32.6	358.8	391.4	1,191.2	72.5	12.7	1,276.4
	1973	23.2	184.6	216.8	424.6	321.0	745.6	54.5	434.9	489.4	1,235.0	87.1	9.1	1,331.2
	1974^p	27.8	231.5	266.8	526.1	281.7	807.8	72.1	548.4	620.5	1,428.3	105.0	18.8	1,552.1

[1]Excludes the petroleum and natural gas industries and the smelting and refining industries. Industry coverage is the same as in Table 49.
. . Not available for publication because of confidentiality, included in total.
^p Preliminary; — Nil.

Table 49. Canada, exploration and capital expenditures[1] in the mining industry by type of mining, 1972-74.

		Capital						Repair						
		Construction												
		On-Property Exploration	On-Property Development	Structures	Total	Machinery and Equipment	Total Capital	Construction	Machinery and Equipment	Total Repair	Total Capital and Repair	Outside or General Exploration	Land and Mining Rights	Total all Expenditures
		(millions of dollars)												
Metal mining														
Gold	1972	0.6	8.4	0.3	9.3	1.6	10.9	0.4	4.8	5.2	16.1	1.0	—	17.1
	1973	1.0	10.7	1.8	13.5	3.4	16.9	0.4	4.6	5.0	21.9	1.0	0.1	23.0
	1974^p	1.9	19.4	1.7	23.0	5.6	28.6	1.1	8.3	9.4	38.0	1.7	0.2	39.9
Copper-gold-silver	1972	4.0	43.7	73.9	121.6	105.2	226.8	7.5	51.6	59.1	285.9	7.2	0.5	293.6
	1973	6.2	45.9	26.1	78.2	64.9	143.1	12.9	83.0	95.9	239.0	6.2	0.2	245.4
	1974^p	6.6	53.0	39.7	99.3	66.3	165.6	14.3	108.5	122.8	288.4	3.1	. .	. .
Silver-lead-zinc	1972	3.4	12.4	3.2	19.0	7.0	26.0	1.8	16.2	18.0	44.0	1.3	0.4	45.7
	1973	2.9	14.5	8.5	25.9	13.9	39.8	3.0	17.4	20.4	60.2	1.3	—	61.5
	1974^p	3.2	17.8	17.5	38.5	13.7	52.2	5.9	19.0	24.9	77.1	3.9	. .	. .
Iron[2]	1972	. .	. .	. .	127.6	. .	. .	9.1	82.8	91.9	. .	0.7	—	. .
	1973	. .	. .	. .	170.1	136.8	306.9	14.4	117.9	132.3	439.2	1.5	—	440.7
	1974^p	. .	. .	. .	158.9	40.7	199.6	21.5	171.9	193.4	393.0	1.8	0.1	394.9
Other metal mining	1972	. .	. .	. .	65.2	. .	. .	7.6	86.9	94.5	. .	7.4	0.3	. .
	1973	. .	. .	. .	66.3	21.1	87.4	17.3	76.6	93.9	181.3	5.7	0.1	187.1
	1974^p	. .	. .	. .	86.2	30.4	116.6	16.1	74.7	90.8	207.4	7.8	—	215.2
Total metal mining	1972	14.1	122.9	205.7	342.7	312.4	655.1	26.4	242.3	268.7	923.8	17.6	1.2	942.6
	1973	17.9	146.8	189.3	354.0	240.1	594.1	48.0	299.5	347.5	941.6	15.7	0.4	957.7
	1974^p	21.8	175.1	209.0	405.9	156.7	562.6	58.9	382.4	441.3	1,003.9	18.3	. .	. .
Nonmetal mining														
Asbestos	1972	0.3	19.4	9.7	29.4	27.9	57.3	2.5	32.8	35.3	92.6	0.2	. .	. .
	1973	0.2	20.9	7.1	28.2	21.5	49.7	2.8	39.8	42.6	92.3	0.1	. .	. .
	1974^p	0.4	27.4	17.5	45.3	28.9	74.2	2.4	50.7	53.1	127.3	0.2	. .	. .
Other non-metal mining	1972	0.5	14.5	15.4	30.4	53.4	83.8	3.7	83.6	87.3	171.1	0.8	. .	. .
	1973	4.0	15.1	20.2	39.3	58.2	97.5	3.7	95.4	99.1	196.6	1.5	. .	. .
	1974^p	2.3	28.2	40.0	70.5	95.0	165.5	10.8	115.2	126.0	291.5	2.6	5.0	299.1

Table 49. (concl'd)

		Capital						Repair						
		Construction												
		On-Property Exploration	On-Property Development	Structures	Total	Machinery and Equipment	Total Capital	Construction	Machinery and Equipment	Total Repair	Total Capital and Repair	Outside or General Exploration	Land and Mining Rights	Total all Expenditures
		(millions of dollars)												
Nonmetal mining (cont'd)														
Total non-metal	1972	0.8	33.9	25.1	59.8	81.3	141.1	6.2	116.4	122.6	263.7	1.0	9.0	273.7
	1973	4.2	36.0	27.3	67.5	79.7	147.2	6.5	135.2	141.7	288.9	1.6	6.6	297.1
	1974ᵖ	2.7	55.6	57.5	115.8	123.9	239.7	13.2	165.9	179.1	418.8	2.8	. .	. .
Metal and nonmetal mining exploration	1972	1.7	1.1	0.2	3.0	0.6	3.6	—	0.1	0.1	3.7	53.9	2.5	60.1
	1973	1.1	1.8	0.2	3.1	1.2	4.3	—	0.2	0.2	4.5	69.8	2.1	71.9
	1974ᵖ	3.3	0.8	0.3	4.4	1.1	5.5	—	0.1	0.1	5.6	83.9	4.2	93.7
Total mining	1972	16.6	157.9	231.0	405.5	394.3	799.8	32.6	358.8	391.4	1,191.2	72.5	12.7	1,276.4
	1973	23.2	184.6	216.8	424.6	321.0	745.6	54.5	434.9	489.4	1,235.0	87.1	9.1	1,331.2
	1974ᵖ	27.8	231.5	266.8	526.1	281.7	807.8	72.1	548.4	620.5	1,428.3	105.0	18.8	1,552.1

[1]Excludes expenditures in the petroleum and natural gas industries. [2]Not completely available for iron mining in 1972, 1973, 1974. Confidential figures are included under "total metal mining".
. . Not available for publication due to confidentiality; ᵖPreliminary; — Nil.

Table 50. Canada, diamond drilling in the mining industry by mining companies with own equipment and by drilling contractors, 1971-72

		1971			1972		
		Exploration	Other	Total	Exploration	Other	Total
		(footage)					
Metal mining							
Gold quartz	own equipment	118,594	93,487	212,081	110,143	60,125	170,268
	contractors	361,432	60,645	422,077	501,491	82,084	583,575
	Total	480,026	154,132	634,158	611,634	142,209	753,843
Copper-gold-silver	own equipment	16,699	119,716	136,415	104,312	191,684	295,996
	contractors	1,456,478	174,678	1,631,156	1,281,915	35,801	1,317,716
	Total	1,473,177	294,394	1,767,571	1,386,227	227,485	1,613,712
Nickel-copper	own equipment	88,660	321,458	410,118	519,405	427,363	946,768
	contractors	860,068	535,417	1,395,485	584,218	29,974	614,192
	Total	948,728	856,875	1,805,603	1,103,623	457,337	1,560,960
Silver-lead-zinc and silver-cobalt	own equipment	25,921	436,357	462,278	51,278	319,921	371,199
	contractors	550,841	—	550,841	279,318	137,523	416,841
	Total	576,762	436,357	1,013,119	330,596	457,444	788,040
Molybdenum	own equipment	—	—	—	—	—	—
	contractors	20,789	—	20,789	3,896	3,896	7,792
	Total	20,789	—	20,789	3,896	3,896	7,792
Iron mines	own equipment	1,047	—	1,047	—	—	—
	contractors	99,908	13,084	112,992	28,255	12,244	40,499
	Total	100,955	13,084	114,039	28,255	12,244	40,499
Miscellaneous metal mining	own equipment	33,981	—	33,981	40,489	—	40,489
	contractors	106,294	—	106,294	76,002	—	76,002
	Total	140,275	—	140,275	116,491	—	116,491
Total metal mining	own equipment	284,902	971,018	1,255,920	825,627	999,093	1,824,720
	contractors	3,455,810	783,824	4,239,634	2,755,095	301,522	3,056,617
	Total	3,740,712	1,754,842	5,495,554	3,580,722	1,300,615	4,881,337

Table 50. (concl'd)

		1971			1972		
		Exploration	Other	Total	Exploration	Other	Total
				(footage)			
Nonmetal mining							
Asbestos	own equipment	—	—	—	—	—	—
	contractors	95,091	—	95,091	47,435	17,580	65,015
	Total	95,091	—	95,091	47,435	17,580	65,015
Feldspar and quartz	own equipment	—	—	—	—	—	—
	contractors	2,500	—	2,500	6,952	—	6,952
	Total	2,500	—	2,500	6,952	—	6,952
Gypsum	own equipment	—	—	—	—	—	—
	contractors	10,945	—	10,945	8,669	—	8,669
	Total	10,945	—	10,945	8,669	—	8,669
Salt	own equipment	2,000	—	2,000	4,700	—	4,700
	contractors	—	—	—	—	—	—
	Total	2,000	—	2,000	4,700	—	4,700
Miscellaneous nonmetal mining	own equipment	6,932	—	6,932	5,181	—	5,181
	contractors	10,710	—	10,710	15,262	—	15,262
	Total	17,642	—	17,642	20,443	—	20,443
Total nonmetal mining	own equipment	8,932	—	8,932	9,881	—	9,881
	contractors	119,246	—	119,246	78,318	17,580	95,898
	Total	128,178	—	128,178	88,199	17,580	105,779
Total mining industry	own equipment	293,834	971,018	1,264,852	835,508	999,093	1,834,601
	contractors	3,575,056	783,824	4,358,880	2,833,413	319,102	3,152,515
	Total	3,868,890	1,754,842	5,623,732	3,668,921	1,318,195	4,987,116

— Nil.

Table 51. Canada, total diamond drilling on metal deposits by mining companies with own equipment and by drilling contractors, 1960-72

	Gold-Quartz Deposits	Copper Gold-Silver and Nickel-Copper Deposits	Silver-Lead-Zinc and Silver-Cobalt Deposits	Other Metal Bearing Deposits[1]	Total Metal Deposits
			(footage)		
1960	2,060,419	4,159,424	741,557	1,033,686	7,995,086
1961	1,952,693	3,701,085	836,945	725,325	7,216,048
1962	2,960,265	3,363,019	1,148,886	1,176,768	8,648,938
1963	1,738,710	3,206,225	945,553	487,872	6,378,360
1964	1,505,686	2,328,045	1,315,944	343,631	5,493,306
1965	1,443,637	2,557,535	1,086,923	905,241	5,993,336
1966	1,451,598	2,392,220	958,737	538,891	5,341,446
1967	1,283,947	3,110,090	755,193	394,851	5,544,081
1968	1,231,179	3,069,935	649,731	186,288	5,137,133
1969	900,297	3,029,700	648,525	359,557	4,938,079
1970	704,455	3,716,915	1,230,380	326,027	5,977,777
1971	634,158	3,573,174	1,013,119	275,103	5,495,554
1972	753,843	3,174,672	788,040	164,782	4,881,337

[1]Includes iron, titanium, uranium, molybdenum and other metal deposits.
Note: Non-producing companies are not included since 1964.

Table 52. Canada, exploration diamond drilling, metal deposits, 1960-72

	By Mining Companies with Own Personnel and Equipment	By Diamond Drill Contractors	Total
		(footage)	
1960	880,515	4,624,067	5,504,582
1961	993,099	4,387,051	5,380,150
1962	548,603	5,734,983	6,283,586
1963	1,184,977	3,836,262	5,021,239
1964	469,205	3,520,293	3,989,498
1965	685,704	3,861,537	4,547,241
1966	536,022	3,428,021	3,964,043
1967	305,657	3,684,833	3,990,490
1968	522,775	3,250,298	3,773,073
1969	443,936	3,518,138	3,962,074
1970	203,896	4,029,074	4,232,970
1971	284,902	3,455,810	3,740,712
1972	825,627	2,755,095	3,580,722

Note: Non-producing companies are not included since 1964.
See footnote to Table 53.

Table 53. Canada, diamond drilling, other than for exploration, on metal deposits, by companies with own equipment and by drilling contractors, 1960-72.

	By Mining Companies with Own Personnel and Equipment	By Diamond Drill Contractors	Total
		(footage)	
1960	1,477,185	1,013,319	2,490,504
1961	1,261,262	574,636	1,835,898
1962	1,734,581	630,771	2,365,352
1963	1,273,714	83,407	1,357,121
1964	1,265,636	238,172	1,503,808
1965	1,292,479	153,616	1,446,095[r]
1966	747,929	629,474	1,377,403
1967	611,755	941,836	1,553,591
1968	403,056	961,004	1,364,060
1969	287,247	688,758	976,005
1970	952,637	792,170	1,744,807
1971	971,018	783,824	1,754,842
1972	999,093	301,522	1,300,615

Note: Non-producing companies are not included since 1964. The total footage drilled shown in Tables 52 and 53 equals the total footage drilled reported in Table 50.

[r] Revised.

Table 54. Canada, total contract diamond drilling operations[1], 1960-73

	Footage Drilled	Income from Drilling	Average No. of Employees	Total Salaries and Wages
	(feet)	($ millions)		($ millions)
1960	5,521,211	17.1	1,912	8.0
1961	5,290,813	16.2	2,025	7.8
1962	5,549,733	17.9	1,926	8.0
1963	5,702,168	20.1	2,201	9.0
1964	6,479,096	23.7	2,401	11.2
1965	7,404,834	30.7	2,776	14.1
1966	7,466,264	33.7	2,887	15.1
1967	6,957,269	31.3	2,669	14.9
1968	7,615,175	38.7	2,985	18.8
1969	7.766,957	44.8	3,109	21.3
1970	7,627,493	53.2	3,207	24.3
1971	6,195,715	38.1	2,514	18.9
1972	5,177,882	35.9	2,083	16.6
1973	5,239,396	39.1	2,123	18.7

[1] Includes contract diamond drilling in mining and in other industries.

Table 55. Canada, contract drilling for oil and gas, 1960-73

	Footage Drilled				Gross Income from Drilling	No. of Employees	Total Salaries and Wages
	Rotary	Cable	Diamond	Total	($ million)	Number	($ million)
1960	13,538,783	231,748	–	13,770,531	75.2	4,860	23.2
1961	12,616,950	170,098	–	12,787,048	68.6	4,144	21.7
1962	12,459,736	252,467	–	12,712,203	62.2	3,800	20.8
1963	14,783,110	361,979	–	15,145,089	75.9	4,179	22.9
1964	14,803,776	229,726	6,230	15,039,732	81.9	4,158	25.2
1965	15,997,276	340,345	–	16,337,621	100.2	4,648	31.7
1966	13,394,413	210,104	–	13,604,517	95.8	4,428	33.9
1967	12,717,419	168,035	–	12,885,454	94.7	4,249	32.9
1968	13,300,766	230,443	–	13,531,209	109.5	4,434	36.9
1969	13,038,137	280,323	–	13,318,460	115.5	4,821	39.5
1970	11,500,845	165,042	–	11,665,887	112.6	4,267	37.9
1971	11,650,353	134,522	–	11,784,875	109.5	4,093	38.0
1972	14,213,386	138,983	–	14,352,369	154.6	4,817	53.5
1973	16,015,530	78,890	–	16,094,420	213.3	5,680	75.5

– Nil.

Table 56. Canada, crude minerals transported by Canadian railways, 1972-73

	1972	1973
	(000 short tons)	
Metallic Minerals		
Alumina and bauxite	2,774	2,606
Copper ores and concentrates	2,749	2,910
Iron ores and concentrates	37,850	57,728
Iron pyrite	133	23
Lead ores and concentrates	725	798
Lead-zinc ores and concentrates	111	97
Manganese ores	11	29
Nickel-copper ores and concentrates	2,856	2,670
Nickel ores and concentrates	1,183	1,338
Zinc ores and concentrates	2,464	2,606
Metallic ores and concentrates, nes	499	146
Total metallic minerals	51,355	70,951
Nonmetallic Minerals		
Abrasives, natural	90	106
Asbestos	1,199	1,194
Barite	115	86
Clay	663	742
Gravel	1,644	3,269
Gypsum	5,041	5,101
Limestone, agricultural	134	205
Limestone, industrial	388	413
Limestone, nes	3,651	4,332
Nepheline syenite	424	351
Phosphate rock	2,097	2,170
Potash (KCl)	6,353	7,989
Refractory materials, nes	16	22
Salt, rock	1,261	1,133
Salt, nes	223	272
Sand, industrial	1,570	1,757
Sand, nes	1,366	1,354
Silica	6	9
Sodium carbonate	669	639
Sodium sulphate	526	614
Stone, building, rough	108	89
Stone, nes	1,661	1,192
Sulphur, liquid	1,313	1,425
Sulphur, nes	2,143	3,164
Nonmetallic minerals, nes	376	595
Total nonmetallic minerals	33,037	38,223
Mineral Fuels		
Coal, anthracite	384	391
Coal, bituminous	12,816	14,035
Coal, lignite	794	737
Coal, nes '	17	27
Natural gas and other crude bituminous substances	4	7
Petroleum, crude	185	318
Total mineral fuels	14,200	15,515
Total crude minerals	98,592	124,689
Total all revenue freight moved by Canadian railways	237,910	265,946
Crude minerals as a per cent of total revenue freight	41.4	46.9

nes Not elsewhere specified.

Table 57. Canada, crude minerals transported by Canadian railways, 1964-73

Year	Total Revenue Freight	Total Crude Minerals	Crude Minerals as a % of Total Revenue Freight
	(millions of short tons)		
1964	198.4	82.3	41.5
1965	205.2	89.2	43.5
1966	214.4	88.9	41.5
1967	209.5	89.5	42.7
1968	215.4	95.6	44.4
1969	208.3	90.3	43.4
1970	233.3	107.5	46.1
1971	236.4	105.4	44.6
1972	237.9	98.6	41.4
1973	265.9	124.7	46.9

Table 58. Canada, fabricated mineral products transported by Canadian railways, 1972-73

	1972	1973
	(thousand short tons)	
Metallic mineral products		
Ferrous mineral products		
Ferroalloys	146	191
Pig iron	192	209
Ingots, blooms, billets, slabs of iron and steel	904	692
Other primary iron and steel	45	52
Castings and forgings, iron and steel	296	315
Bars and rods, steel	729	969
Plates, steel	429	498
Sheet and strip, steel	1,697	1,738
Structural shapes and sheet piling, iron and steel	521	575
Rails and railway track material	187	243
Pipes and tubes, iron and steel	769	725
Wire, iron or steel	38	50
Iron and steel scrap	1,785	2,007
Slags, drosses, etc.	154	260
Total ferrous mineral products	7,892	8,524
Nonferrous mineral products		
Aluminum paste, powder, pigs, ingots, shot	210	183
Aluminum and aluminum alloy fabricated material, nes	326	321
Copper matte and precipitates	2	5
Copper and alloys, in primary forms	506	464
Copper and alloys, nes	71	78
Lead and alloys	206	196
Nickel and nickel-copper matte	487	177
Nickel and alloys	116	86
Zinc and alloys	570	558
Other nonferrous base metals and alloys	17	17
Nonferrous metal scrap	225	185
Total nonferrous mineral products	2,736	2,270
Total metallic mineral products	10,628	10,794
Nonmetallic mineral products		
Natural stone basic products, chiefly structural	201	206
Bricks and tiles, clay	95	99
Fire brick and similar shapes	205	208
Dolomite and magnesite, calcined	86	83
Refractories, nes	43	75
Glass basic products	149	162
Asbestos and asbestos-cement basic products	26	20
Portland cement, standard	1,584	1,814
Concrete pipe	70	91
Cement and concrete basic products, nes	310	236
Plaster	57	66
Gypsum wallboard and sheathing	92	98
Gypsum basic products, nes	1	2
Lime, hydrated and quick	641	726
Nonmetallic mineral basic products, nes	531	591
Fertilizers and fertilizer materials, nes	2,626	2,470
Total nonmetallic mineral products	6,717	6,947
Mineral fuel products		
Gasoline	2,313	2,255
Aviation turbine fuel	138	91
Diesel fuel	3,293	3,937
Kerosene	15	13
Fuel oil, nes	935	968
Lubricating oils and greases	452	454
Petroleum coke	193	306
Coke, nes	1,350	1,413
Refined and manufactured gases, fuel type	3,689	3,946
Asphalts and road oils	267	369
Bituminous pressed or molded fabricated materials	5	2
Other petroleum and coal products	392	549
Total mineral fuel products	13,042	14,303
Total fabricated mineral products	30,387	32,044
Total revenue freight moved by Canadian railways	237,910	265,946
Fabricated mineral products as a percentage of total revenue freight	12.8	12.0

nes Not elsewhere specified.

Table 59. Canada, crude and fabricated minerals transported through the St. Lawrence Seaway, 1973-74

	Montreal-Lake Ontario Section		Welland Canal Section	
	1973	1974	1973	1974
	(short tons)			
Crude minerals				
Bituminous coal	277,667	193,116	8,139,388	6,483,941
Iron ore	15,691,569	14,291,462	17,183,362	14,913,659
Aluminum ores and concentrates	107,648	16,570	94,298	16,570
Clay and bentonite	193,055	272,950	216,130	290,850
Gravel and sand	—	430	38,411	127,321
Stone, ground or crushed	28,734	44,734	1,412,228	1,435,326
Stone, rough	2,019	5,674	14,130	5,594
Petroleum, crude	799,782	1,237,867	134,872	178,031
Salt	903,707	894,927	1,529,827	1,549,689
Phosphate rock	40,812	—	—	—
Sulphur	—	84,571	—	84,571
Other crude minerals	816,620	745,864	897,543	1,317,492
Total crude minerals	18,861,613	17,788,165	29,660,189	26,403,044
Fabricated mineral products				
Coke	815,067	1,312,341	651,981	490,555
Gasoline	234,608	125,864	125,718	168,605
Fuel oil	3,783,946	1,999,308	2,156,600	1,178,544
Lubricating oils and greases	163,692	196,421	143,479	189,857
Other petroleum products	78,600	144,629	69,924	103,302
Tar, pitch and creosote	45,089	43,918	58,108	77,598
Pig iron	151,623	135,223	143,005	130,863
Iron and steel: bars, rods, slabs	509,908	545,736	478,938	517,583
Iron and steel: nails, wire	130,201	67,682	124,594	59,875
Iron and steel: other manufactured products	3,723,202	2,991,938	3,425,347	2,707,994
Scrap iron and steel	935,078	136,749	887,310	124,487
Cement	53,746	36,278	242,458	244,354
Total fabricated minerals	10,624,760	7,736,087	8,507,462	5,993,617
Total crude and fabricated minerals	29,486,373	25,524,252	38,167,651	32,396,661
Grand total all products	57,634,137	44,146,444	67,194,684	52,359,962
Per cent crude and fabricated minerals of grand total	51.1	57.8	56.8	61.9

— Nil.

Table 60. Canada, crude minerals loaded and unloaded in coastwise shipping, 1973

	Loaded				Unloaded			
	Atlantic	Great Lakes	Pacific	Total	Atlantic	Great Lakes	Pacific	Total
	(short tons)							
Metallic minerals								
Copper ore and concentrates	32,138	—	—	32,138	32,138	—	—	32,138
Iron ore and concentrates	3,823,009	3,433,286	—	7,256,295	1,032,488	6,223,807	—	7,256,295
Manganese ore	113,867	—	—	113,867	67,000	46,867	—	113,867
Titanium ore	2,196,772	—	15	2,196,787	2,196,772	—	15	2,196,787
Zinc ore and concentrates	—	16,446	6,116	22,562	16,446	—	6,116	22,562
Ores and concentrates, nes	540	—	308	848	—	540	308	848
Iron and steel scrap	5,548	—	1,695	7,243	5,548	—	1,695	7,243
Nonferrous metal scrap	1,071	—	—	1,071	1,071	—	—	1,071
Slag, drosses, residues	4,084	12,003	5,035	21,122	4,084	12,003	5,035	21,122
Total metals	6,177,029	3,461,735	13,169	9,651,933	3,355,547	6,283,217	13,169	9,651,933
Nonmetallic minerals								
Asbestos	40	224	—	264	40	224	—	264
Barite	10,940	—	—	10,940	10,940	—	—	10,940
Clays, nes	6,754	—	206	6,960	1,254	5,500	206	6,960
Dolomite	50	11,835	—	11,885	11,885	—	—	11,885
Fluorspar	164,318	—	—	164,318	150,786	13,532	—	164,318
Gypsum	646,440	—	—	646,440	476,794	169,646	—	646,440
Limestone	10,188	2,338,846	340,617	2,689,651	10,188	2,338,846	340,617	2,689,651
Potash (KCl)	—	—	—	—	—	—	—	—
Salt	334,942	1,334,265	16,288	1,685,495	953,866	715,341	16,288	1,685,495
Sand and Gravel	1,515	28,440	3,050,597	3,080,552	1,495	28,460	3,050,597	3,080,552
Stone, crushed	126	—	—	126	126	—	—	126
Stone, crude, nes	74	285,496	6,750	292,320	53	285,517	6,750	292,320
Sulphur	25	—	16,724	16,749	25	—	16,724	16,749
Crude nonmetallic minerals, nes	52	—	58	110	52	—	58	110
Total nonmetals	1,175,464	3,999,106	3,431,240	8,605,810	1,617,504	3,557,066	3,431,240	8,605,810
Mineral fuels								
Coal, bituminous	4,122	6,682	4	10,808	4,122	6,682	4	10,808
Total crude minerals	7,356,615	7,467,523	3,444,413	18,268,551	4,977,173	9,846,965	3,444,413	18,268,551
Grand total all commodities	21,612,724	24,444,036	14,916,534	60,973,294	27,985,223	18,105,929	14,882,142	60,973,294
% crude minerals of grand total	34.0	30.6	23.1	30.0	17.8	54.4	23.1	30.0

nes Not elsewhere specified; — Nil.

Table 61. Canada, crude minerals loaded and unloaded at Canadian ports in international shipping trade with foreign countries, 1972-73.

	1972		1973	
	Loaded	Unloaded	Loaded	Unloaded
	(short tons)			
Metallic minerals				
Alumina, bauxite ore	6,008	3,591,521	31,300	3,466,017
Copper ores and concentrates	844,629	—	1,168,100	88,783
Iron ore and concentrates	31,520,962	2,003,874	39,696,664	3,039,921
Lead ore and concentrates	108,943	—	94,546	—
Manganese ore	10,500	153,623	47,713	326,924
Nickel-copper ore and concentrates	113,914	39,922	124,433	15,454
Titanium ore	335,028	10,306	694,638	16,437
Zinc ore and concentrates	971,751	148	1,334,028	—
Ores and concentrates, nes	65,813	80,780	78,829	99,815
Iron and steel scrap	243,023	14,821	358,135	3,013
Nonferrous metal scrap	8,660	392	21,217	335
Slags, drosses, residues	849,162	26,346	770,796	37,264
Total metals	35,078,393	5,921,733	44,420,399	7,093,963
Nonmetallic minerals				
Asbestos	487,467	12,556	518,162	1,963
Barite	20,100	292	49,862	3,320
Bentonite	20,725	121,599	16	192,081
China clay	—	46,243	—	33,413
Clays, nes	756	40,355	31,949	78,457
Dolomite	978,076	13,500	1,358,104	—
Fluorspar	60,339	113,040	58,650	240,523
Gypsum	6,234,574	60,000	6,303,738	79,223
Limestone	1,412,817	1,742,663	1,367,710	2,313,699
Phosphate rock	24,180	1,373,169	35,750	1,423,381
Potash (KCl)	1,670,807	75,929	1,486,484	10,432
Salt	888,556	916,373	1,109,699	878,150
Sand and gravel	116,524	973,722	81,665	1,258,855
Stone, crushed	230	135	16	72,454
Stone, crude, nes	32,534	15,120	90,402	12,412
Sulphur	1,682,375	18,870	2,297,967	34,792
Crude, nonmetallic minerals, nes	40,432	33,486	25,499	29,265
Total nonmetals	13,670,492	5,557,052	14,815,673	6,662,420
Mineral fuels				
Coal, bituminous	8,318,546	12,550,259	10,467,592	15,749,593
Coal, nes	33	323,923	3	408,426
Natural gas	—	—	65	—
Petroleum, crude	156,067	19,077,985	1,059,236	22,386,173
Total fuels	8,474,646	31,952,167	11,526,896	38,544,192
Total crude minerals	57,223,531	43,430,952	70,762,968	52,300,575
Grand total, all commodities	109,115,679	68,360,673	123,937,304	72,708,223
Per cent crude minerals of grand total	52.4	63.5	57.1	71.9

nes Not elsewhere specified.
— Nil.

Table 62. Canada, fabricated mineral products loaded and unloaded at Canadian ports in international shipping trade with foreign countries, 1972-73

	1972		1973	
	Loaded	Unloaded	Loaded	Unloaded
	(short tons)			
Metallic products				
Aluminum	379,093	14,078	369,367	17,993
Copper and alloys	60,844	1,838	47,344	2,000
Ferroalloys	20,424	35,904	13,354	61,404
Iron and steel, primary	12,880	51,266	26,216	36,090
Iron, pig	566,698	1,154	553,307	77
Iron and steel, other				
bars and rods	25,021	264,858	40,095	175,444
castings and forgings	23,081	29,325	9,153	29,401
pipe and tubes	11,419	144,102	24,043	57,671
plate and sheet	265,818	628,315	186,309	439,352
rails and track material	8,425	5,744	19,937	8,545
structural shapes	38,747	291,080	58,516	362,144
wire	10,723	26,972	5,642	12,469
Lead and alloys	27,467	7,185	19,442	56
Nickel and alloys	28,097	16,835	23,036	22,873
Zinc and alloys	72,940	10,450	58,764	5,451
Nonferrous metals, nes	5,938	10,851	32,448	19,051
Metal fabricated basic products	13,482	59,974	29,905	70,868
Total metals	1,571,097	1,599,931	1,516,878	1,320,889
Nonmetallic products				
Asbestos basic products	3,635	596	4,758	2,706
Building brick, clay	89	1,484	296	2,563
Bricks and tiles, nes	10,525	14,377	11,596	6,415
Cement	1,332,123	14,418	1,717,128	60,815
Cement basic products	3,729	2,388	1,379	2,882
Drain tiles and pipes	82	56	—	239
Glass basic products	3,259	42,382	11,431	28,174
Lime	701	172	5,558	1,830
Nonmetallic mineral basic products	8,805	21,081	5,929	10,686
Fertilizers, nes	261,171	99,870	147,790	69,073
Total nonmetals	1,624,119	196,824	1,905,865	185,383
Mineral fuel products				
Asphalts, road oils	178	40,989	2,255	7,948
Coal tar, pitch	42,027	68,819	9,971	66,661
Coke	405,976	857,363	375,111	841,480
Fuel oil	5,604,911	6,883,914	6,295,604	5,374,500
Gasoline	117,716	346,068	410,456	13,450
Lubricating oils and greases	780	23,586	1,554	32,210
Petroleum and coal products, nes	654,591	187,237	618,526	149,644
Total fuels	6,826,179	8,407,976	7,713,477	6,485,893
Total fabricated mineral products	10,021,395	10,204,731	11,136,220	7,992,165
Grand total, all commodities	109,115,679	68,360,673	123,937,304	72,708,223
Per cent fabricated mineral products of grand total	9.2	14.9	9.0	11.0

nes Not elsewhere specified; — Nil.

Table 63. Canada, financial statistics of corporations in the mining industry*,

	Corporations		Assets	
	Number	%	$ million	%
Metal mines				
Reporting corporations				
50 per cent and over non-resident	51	25.0	4,542	55.1
Under 50 per cent non-resident	109	53.4	3,601	43.7
Government business enterprise	1	0.5	. .	. .
Other corporations	43	21.1	. .	. .
Total, all corporations	204	100.0	8,242	
Mineral fuels				
Reporting corporations				
50 per cent and over non-resident	258	31.2	5,427	79.5
Under 50 per cent non-resident	206	24.9	1,299	19.0
Government business enterprise	3	0.4	78	1.1
Other corporations	359	43.5	24	0.4
Total, all corporations	826	100.0	6,828	100.0
Other mining (including mining services)				
Reporting corporations				
50 per cent and over non-resident	189	7.1	1,853	58.1
Under 50 per cent non-resident	883	33.1	1,187	37.2
Government business enterprise	3	0.1	. .	. .
Other corporations	1,592	59.7	. .	. .
Total, all corporations	2,667	100.0	3,188	
Total mining				
Reporting corporations				
50 per cent and over non-resident	498	13.5	11,822	64.7
Under 50 per cent non-resident	1,198	32.4	6,087	33.3
Government business enterprise	7	0.2	190	1.1
Other corporations	1,994	53.9	160	0.9
Total, all corporations	3,697	100.0	18,258	100.0

* Classification of the industry is the same as in Table 27.
Note: Footnotes for Table 64 apply to this Table.
— Nil; . . Not available; — — Amount too small to be expressed.

by degree of non-resident ownership, 1972

Equity		Sales		Profits		Taxable Income	
$ million	%	$ million	%	$ million	%	$ million	%
2,206	50.7	1,564	55.1	185	55.1	15.8	17.9
2,103	48.3	1,261	44.4	158	47.0	72.3	82.1
. .	. .	. .	. .	. .	. .	—	—
. .	. .	. .	. .	. .	. .	—	—
4,352		2,837		336		88.1	100.0
3,637	80.4	2,042	89.6	289	83.5	117.3	91.0
830	18.3	203	8.9	61	17.6	10.9	8.5
57	1.3	25	1.1	– 3	– 0.9	—	—
1	– –	9	0.4	– 1	– 0.3	0.7	0.5
4,525	100.0	2,279	100.0	346	100.0	128.9	100.0
992	54.3	784	64.7	115	94.3	41.9	66.8
758	41.5	348	28.7	10	8.2	16.1	25.7
. .	. .	. .	. .	. .	. .	—	—
. .	. .	. .	. .	. .	. .	4.7	7.5
1,826		1,211		122		62.7	100.0
6,835	63.9	4,390	69.4	589	73.3	175.0	62.6
3,691	34.5	1,812	28.6	230	28.6	99.3	35.5
113	1.1	40	0.6	– 7	– 0.9	—	—
64	0.5	86	1.4	– 8	– 1.0	5.4	1.9
10,703	100.0	6,328	100.0	804	100.0	279.7	100.0

Table 64. Canada, financial statistics of corporations in the mineral manufacturing

	Corporations[1]		Assets[4]	
	Number	%	$ millions	%
Primary metal products				
Reporting corporations[1]				
50% and over non resident	58	13.6	. .	. .
under 50% non-resident	148	34.6	. .	. .
Government business enterprises[2]	3	0.7	233	4.9
Other[3]	219	51.1	20	0.4
Total all corporations	428	100.0	4,804	
Non-metallic mineral products				
Reporting corporations[1]				
50% and over non-resident	92	9.4	1,287	61.1
under 50% non-resident	404	41.1	760	36.1
Government business enterprises[2]	2	0.2	. .	. .
Other[3]	485	49.3	. .	. .
Total all corporations	983	100.0	2,105	
Petroleum and coal products				
Reporting corporations[1]				
50% and over non-resident	21	42.0	6,632	99.5
under 50% non-resident	14	28.0	30	0.5
Government business enterprises[2]	—	—	—	—
Other[3]	15	30.0	2	— —
Total all corporations	50	100.0	6,664	100.0
Total mineral manufacturing industries				
Reporting companies[1]				
50% and over non-resident	171	11.8	. .	. .
under 50% non-resident	566	38.7	. .	. .
Government business enterprises[2]	5	0.3	. .	. .
Other[3]	719	49.2	. .	. .
Total all corporations	1,461	100.0	13,573	

* Classification of industries is the same as in Table 28.
[1]Corporations reporting under the Corporations and Labour Unions Returns Act. A corporation is considered to be foreign controlled if 50% or more of its voting rights are known to be held outside Canada, and/or by one or more Canadian corporations which are, in turn, foreign controlled. Each corporation is classified according to the percentage of its voting rights which are owned by non-residents, either directly or through other Canadian corporations, and the whole of the corporation is assigned to this particular degree of foreign ownership.
[2]Non-taxable federal and provincial Crown Corporations and municipally owned corporations.
[3]Corporations exempt from reporting under the Corporations and Labour Unions Returns Act. These include corporations reporting under other acts, small companies and corporations and non-profit organizations.
[4]Assets — Included are cash, marketable securities, accounts receivable, inventories, fixed assets, investments in affiliated corporations and other assets. The amounts tabulated are those shown on the balance sheets of corporations after deducting allowances for doubtful accounts, amortization, depletion and depreciation.
[5]Equity — This represents the shareholders interest in the net assets of the corporation and includes the total amount of all issued and paid up share capital, earnings retained in the business and other surplus accounts such as contributed and capital surplus.
[6]Sales — For non-financial corporations, sales are gross revenues from non-financial operations. For financial corporations sales include income from financial as well as non-financial sources.
[7]Profits — The net earnings from operations, investment income and net capital gains. Profits are tabulated after deducting allowances for amortization, depletion and depreciation, but before income tax provisions or declaration of dividends.
[8]Taxable Income — The figures are as reported by corporations prior to assessment by the Department of National Revenue. They include earnings in the reference year after the deduction of applicable losses of other years.
— Nil; — — Amount too small to be expressed; . . Not available.

industries*, by degree of non-resident ownership, 1972.

Equity[5]		Sales[6]		Profits[7]		Taxable Income[8]	
$ millions	%	$ millions	%	$ millions	%	$ millions	%
. .	. .	. .	. .	. .	. .	24.5	24.8
. .	. .	. .	. .	. .	. .	72.4	73.3
78	3.2	190	5.3	−12	−4.8	—	—
7	0.3	39	1.1	—	—	1.9	1.9
2,409		3,596		251		98.8	100.0
718	71.2	879	48.7	100	70.9	71.8	70.7
268	26.6	851	47.2	40	28.4	26.9	26.5
. .	. .	. .	. .	. .	. .	—	—
. .	. .	. .	. .	. .	. .	2.9	2.8
1,009		1,804		141		101.6	100.0
4,037	99.5	5,938	99.0	594	98.7	216.3	99.4
19	0.5	56	1.0	8	1.3	1.0	0.5
—	—	—	—	—	—	—	—
—	—	2	— —	—	—	0.2	0.1
4,056	100.0	5,996		602	100.0	217.5	100.0
. .	. .	. .	. .	. .	. .	312.6	74.8
. .	. .	. .	. .	. .	. .	100.3	24.0
. .	. .	. .	. .	. .	. .	—	—
. .	. .	. .	. .	. .	. .	5.0	1.2
7,474		11,396		994		417.9	100.0

Table 65. Canada, financial statistics of corporations in non-financial industries

		Agriculture, Forestry, Fishing and Trapping		Mining		Manufacturing	
		1971	1972[p]	1971	1972[p]	1971	1972[p]
Number of corporations							
Foreign control	Number	95	97	507	498	2,300	2,303
Canadian control	Number	1,575	1,856	1,214	1,198	7,506	7,925
Other corporations	Number	5,354	5,398	2,018	2,001	12,152	12,416
Total corporations	Number	7,024	7,351	3,739	3,697	21,958	22,644
Assets							
Foreign control	$ millions	222	192	11,026	11,821	28,935	29,538
Canadian control	$ millions	982	1,151	6,063	6,087	19,168	21,784
Other corporations	$ millions	529	524	278	350	1,574	1,598
Total corporations	$ millions	1,734	1,867	17,367	18,258	49,677	52,920
Equity							
Foreign control	$ millions	146	99	6,603	6,835	15,139	15,628
Canadian control	$ millions	349	402	3,846	3,691	8,530	9,538
Other corporations	$ millions	119	120	138	177	538	544
Total corporations	$ millions	614	621	10,587	10,703	24,207	25,710
Sales							
Foreign control	$ millions	99	128	3,983	4,390	33,143	36,528
Canadian control	$ millions	741	874	1,653	1,812	23,461	26,402
Other corporations	$ millions	435	432	86	126	2,115	2,130
Total corporations	$ millions	1,275	1,434	5,722	6,328	58,719	65,060
Profits							
Foreign control	$ millions	9	7	712	589	2,339	2,824
Canadian control	$ millions	42	54	261	230	1,306	1,493
Other corporations	$ millions	7	14	−19	−15	30	31
Total corporations	$ millions	58	75	954	804	3,675	4,348
Taxable income							
Foreign control	$ millions	2.5	4.9	−26.6	114.4	1,717.7	2,167.5
Canadian control	$ millions	15.8	26.2	49.2	69.9	782.5	995.2
Other corporations	$ millions	5.1	11.7	−11.9	−1.4	37.3	49.6
Total corporations	$ millions	23.4	42.8	10.7	182.9	2,537.6	3,212.3

Figures may not add to total due to rounding.
[p] Preliminary.

by major industry group and by control, 1971 and 1972.

Construction 1971	Construction 1972ᵖ	Transportation, Communication and Other Utilities 1971	Transportation, Communication and Other Utilities 1972ᵖ	Trade 1971	Trade 1972ᵖ	Services 1971	Services 1972ᵖ	Total 1971	Total 1972ᵖ
180	172	249	254	1,865	1,812	521	534	5,717	5,670
4,744	5,513	1,770	2,052	13,854	15,753	4,213	4,956	34,876	39,253
16,366	16,867	7,033	7,267	43,192	44,212	26,051	27,463	112,166	115,624
21,290	22,552	9,052	9,573	58,911	61,777	30,785	32,953	152,759	160,547
1,220	1,031	2,338	3,410	6,426	7,245	1,566	1,845	51,733	55,082
4,973	5,837	15,729	16,415	12,595	14,586	3,729	4,413	63,239	70,273
1,141	1,147	25,064	26,528	4,218	4,132	1,642	1,725	34,446	36,004
7,334	8,015	43,131	46,353	23,239	25,963	6,936	7,983	149,418	161,359
241	262	855	1,284	2,516	2,937	573	632	26,073	27,677
1,103	1,257	6,470	6,672	4,789	5,370	1,216	1,387	26,303	28,317
370	362	6,283	6,809	1,298	1,306	510	542	9,256	9,860
1,714	1,881	13,608	14,765	8,603	9,613	2,299	2,561	61,633	65,854
1,452	1,365	1,002	1,313	12,332	13,738	1,159	1,373	53,170	58,835
6,442	7,544	6,178	6,897	30,929	36,644	3,109	3,876	72,513	84,049
2,085	2,218	5,473	6,074	8,250	8,732	2,198	2,337	20,642	22,049
9,979	11,127	12,653	14,284	51,511	59,116	6,466	7,586	146,324	164,933
47	83	154	195	435	634	122	133	3,818	4,465
253	263	939	981	817	1,092	187	205	3,805	4,318
73	45	149	289	791	734	107	110	1,138	1,208
373	391	1,242	1,465	2,043	2,460	416	448	8,761	9,989
39.7	55.3	157.8	133.2	375.4	477.9	78.9	106.4	2,345.4	3,059.6
160.9	199.1	397.6	440.4	672.2	929.6	119.3	137.2	2,197.5	2,797.6
68.2	80.9	22.8	27.1	167.3	203.0	114.3	95.2	403.1	466.1
268.8	335.3	578.2	600.7	1214.9	1610.5	312.6	238.8	4,946.0	6,323.3

Table 66. Canada, capital and repair expenditures in the mining[1] and mineral manufacturing industries, 1973-75.

	1973			1974[p]			1975[f]		
	Capital	Repair	Total	Capital	Repair	Total	Capital	Repair	Total
	($ millions)								
Mining industry									
Metal mines									
Gold	16.9	5.1	22.0	23.2	5.7	28.9	29.2	6.6	35.8
Silver-lead-zinc	39.8	20.6	60.4	56.2	23.0	79.2	78.6	28.2	106.8
Iron	306.9	132.3	439.2	190.1	172.8	362.9	195.8	181.3	377.1
Other metal mines	234.8	189.7	424.5	267.6	205.7	473.3	304.1	238.5	542.6
Total metal mines	598.4	347.7	946.1	537.1	407.2	944.3	607.7	454.6	1,062.3
Nonmetal mines									
Quarries and sandpits	29.7	24.7	54.4	32.3	20.7	53.0	32.7	21.1	53.8
Other nonmetal mines[2]	117.5	117.0	234.5	219.8	136.0	355.8	258.6	151.7	410.3
Total nonmetal mines	147.2	141.7	288.9	252.1	156.7	408.8	291.3	172.8	464.1
Mineral fuels									
Petroleum and gas[3]	935.1	192.2	1,127.3	1,233.7	193.9	1,427.6	1,406.2	212.8	1,619.0
Total mining industries	1,680.7	681.6	2,362.3	2,022.9	757.8	2,780.7	2,305.2	840.2	3,145.4
Mineral manufacturing									
Primary metal industries									
Iron and steel mills	238.1	248.6	486.7	366.9	292.3	659.2	683.1	345.7	1,028.8
Steel pipe and tube mills	30.1	15.1	45.2	18.4	21.0	39.4	21.1	24.0	45.1
Iron foundries	14.4	13.3	27.7	21.6	14.7	36.3	16.6	14.8	31.4
Smelting and refining	96.0	162.4	258.4	176.1	187.5	363.6	261.0	202.2	463.2
Aluminum rolling, casting and extruding	12.5	9.1	21.6	26.2	10.1	36.3	30.9	11.2	42.1
Other primary metal industries	13.2	10.4	23.6	31.3	9.1	40.4	24.8	9.1	33.9
Total primary metal industries	404.3	458.9	863.2	640.5	534.7	1,175.2	1,037.5	607.0	1,644.5

Table 66. (concl'd)

	1973			1974[p]			1975[f]		
	Capital	Repair	Total	Capital	Repair	Total	Capital	Repair	Total
				($ millions)					
Nonmetallic mineral products									
Cement	63.9	20.9	84.8	50.5	26.8	77.3	86.7	29.4	116.1
Lime	1.0	2.2	3.2	4.8	2.9	7.7	2.9	3.2	6.1
Gypsum products[4]	. .	. .	. .	. .	. .	. .	. .	. .	. .
Concrete products and ready-mix	67.3	57.0	124.3	70.4	58.0	128.4	46.1	61.9	108.0
Clay products	3.5	5.1	8.6	10.7	5.0	15.7	12.8	4.8	17.6
Refractories[4]	. .	. .	. .	. .	. .	. .	. .	. .	. .
Asbestos[4]	. .	. .	. .	. .	. .	. .	. .	. .	. .
Glass and glass products	18.5	12.4	30.9	12.8	10.6	23.4	17.9	15.9	23.8
Abrasives	3.3	7.5	10.8	5.9	9.1	15.0	11.3	9.5	20.8
Other nonmetallic mineral products	31.2	14.4	45.6	26.0	15.0	41.0	35.0	16.4	51.4
Total nonmetallic mineral products	188.7	119.5	308.2	181.1	127.4	308.5	212.7	141.1	353.8
Petroleum and coal products	318.8	88.4	407.2	407.6	112.5	520.1	443.5	128.8	572.3
Total mineral manufacturing industries	911.8	666.8	1,578.6	1,229.2	774.6	2,003.8	1,693.7	876.9	2,570.6
Total mining and mineral manufacturing industries	2,592.5	1,348.4	3,940.9	3,252.1	1,532.4	4,784.5	3,998.9	1,717.1	5,716.0

[1]Does not include cement, lime and clay products (domestic clay) manufacturing, smelting and refining.
[2]Includes coal mines, asbestos, gypsum, salt and miscellaneous nonmetals.
[3]The total of capital expenditures shown under "petroleum and gas" is equal to the total capital expenditures under the column entitled "petroleum and natural gas extraction" and under the column "natural gas processing plants" of Table 69.
[4]Shown separately during past years, but included in other nonmetallic mineral products for 1973-1975.
[p]Preliminary; [f]Forecast intentions; . . Not available.

Table 67. Canada, capital and repair expenditure in the mining industry[1], 1965-75

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974[p]	1975[f]
						($ million)					
Metal mines											
Capital											
Construction	121.4	209.9	238.1	264.8	295.1	335.6	590.8	345.7	357.1	378.7	382.6
Machinery	79.2	138.5	131.3	105.2	98.2	150.3	239.8	313.0	241.3	158.4	225.1
Total	200.6	348.4	369.4	370.0	393.3	485.9	830.6	658.7	598.4	537.1	607.7
Repair											
Construction	21.9	25.1	33.4	47.9	35.7	36.6	38.9	26.4	48.0	44.2	51.0
Machinery	100.5	115.9	116.6	152.2	160.9	220.2	240.9	242.4	299.7	363.0	403.6
Total	122.4	141.0	150.0	200.1	196.6	256.8	279.8	268.8	347.7	407.2	454.6
Total capital and repair	323.0	489.4	519.4	570.1	589.9	742.7	1,110.4	927.5	946.1	944.3	1,062.3
Nonmetal mines[2]											
Capital											
Construction	58.1	106.7	121.1	110.2	128.1	107.9	84.6	59.8	67.5	109.9	116.8
Machinery	34.8	68.9	85.4	128.4	113.9	115.9	105.6	81.3	79.7	142.2	174.5
Total	92.9	175.6	206.5	238.6	242.0	223.8	190.2	141.1	147.2	252.1	291.3
Repair											
Construction	3.7	3.4	4.5	4.3	10.4	7.1	7.9	6.2	6.5	10.1	15.0
Machinery	47.2	49.4	57.0	57.5	64.7	99.9	107.1	116.4	135.2	146.6	157.8
Total	50.9	52.8	61.5	61.8	75.1	107.0	115.0	122.6	141.7	156.7	172.8
Total capital and repair	143.8	228.4	268.0	300.4	317.1	330.8	305.2	263.7	288.9	408.8	464.1
Mineral fuels											
Capital											
Construction	419.2	450.0	403.0	407.4	465.3	552.6	639.4	729.3	851.7	1,040.0	1,263.1
Machinery	22.1	55.8	71.8	58.0	76.6	86.2	101.3	91.2	83.4	193.7	143.1
Total	441.3	505.8	474.8	465.4	541.9	638.8	740.7	820.5	935.1	1,233.7	1,406.2

Table 67. (concl'd)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974[p]	1975[f]
						($ million)					
Repair											
Construction	25.4	28.6	34.2	56.3	73.7	93.5	102.7	106.8	138.0	128.7	144.9
Machinery	24.0	21.3	14.7	19.2	19.0	22.5	28.7	35.6	54.2	65.2	67.9
Total	49.4	49.9	48.9	75.5	92.7	116.0	131.4	142.4	192.2	193.9	212.8
Total capital and repair	490.7	555.7	523.7	540.9	634.6	754.8	872.1	962.9	1,127.3	1,427.6	1,619.0
Total mining											
Capital											
Construction	598.7	766.6	762.2	782.4	888.5	996.1	1,314.8	1,134.8	1,276.3	1,528.6	1,762.5
Machinery	136.1	263.2	288.5	291.6	288.7	352.4	446.7	485.5	404.4	494.3	542.7
Total	734.8	1,029.8	1,050.7	1,074.0	1,177.2	1,348.5	1,761.5	1,620.3	1,680.7	2,022.9	2,305.2
Repair											
Construction	51.0	57.1	72.1	108.5	119.8	137.2	149.5	139.4	192.5	183.0	210.9
Machinery	171.7	186.6	188.3	228.9	244.6	342.6	376.7	394.4	489.1	574.8	629.3
Total	222.7	243.7	260.4	337.4	364.4	479.8	526.2	533.8	681.6	757.8	840.2
Total capital and repair	957.5	1,273.5	1,311.1	1,411.4	1,541.6	1,828.3	2,287.7	2,154.1	2,362.3	2,780.7	3,145.4

[1] Does not include cement, lime and clay products (domestic clays) manufacturing, smelting and refining.
[2] Includes coal mines, asbestos, gypsum, salt, miscellaneous nonmetals, quarrying and sand pits.
[p] Preliminary estimates of intentions; [f] Forecast intentions.

Table 68. Canada, capital and repair expenditures in the mineral manufacturing industries[1], 1965-75.

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974p	1975f
						($ millions)					
Primary metal industries[2]											
Capital											
Construction	61.6	85.2	82.0	77.5	71.5	114.0	89.0	95.3	75.8	131.5	277.8
Machinery	202.9	300.7	202.8	157.9	221.4	311.2	312.4	276.6	328.5	509.0	759.7
Total	264.5	385.9	284.8	235.4	292.9	425.2	401.4	371.9	404.3	640.5	1,037.5
Repair											
Construction	18.5	21.8	24.9	27.7	22.6	28.6	28.4	35.3	38.8	47.1	53.7
Machinery	215.0	253.4	258.1	281.4	267.9	324.6	343.5	383.2	420.1	487.6	553.3
Total	233.5	275.2	283.0	309.1	290.5	353.2	371.9	418.5	458.9	534.7	607.0
Total capital and repair	498.0	661.1	567.8	544.5	583.4	778.4	773.3	790.4	863.2	1,175.2	1,644.5
Nonmetallic mineral products[3]											
Capital											
Construction	30.0	50.9	39.5	19.6	37.1	30.7	21.8	30.7	37.6	34.5	40.2
Machinery	78.3	108.6	80.3	66.5	84.0	104.3	58.5	99.2	151.1	146.6	172.5
Total	108.3	159.5	119.8	86.1	121.1	135.0	80.3	129.9	188.7	181.1	212.7
Repair											
Construction	6.4	7.2	9.3	7.2	7.2	5.4	7.0	8.5	7.5	11.7	11.4
Machinery	66.1	72.1	63.9	73.8	72.1	77.1	80.4	85.7	112.0	115.7	129.7
Total	72.5	79.3	73.2	81.0	79.3	82.5	87.4	94.2	119.5	127.4	141.1
Total capital and repair	180.8	238.8	193.0	167.1	200.4	217.5	167.7	224.1	308.2	308.5	353.8
Petroleum and coal products											
Capital											
Construction	30.3	55.5	78.8	99.0	116.9	213.7	211.3	214.0	229.7	315.4	362.8
Machinery	10.3	9.6	21.4	28.8	12.9	17.4	20.1	29.8	89.1	92.2	80.7
Total	40.6	65.1	100.2	127.8	129.8	231.1	231.4	243.8	318.8	407.6	443.5

Table 68. (concl'd)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974p	1975f
						($ millions)					
Repair											
Construction	29.5	32.6	36.0	46.6	52.1	51.0	51.3	61.3	71.1	93.4	106.1
Machinery	7.0	9.1	10.2	8.6	6.8	9.2	9.8	14.6	17.3	19.1	22.7
Total	36.5	41.7	46.2	55.2	58.9	60.2	61.1	75.9	88.4	112.5	128.8
Total capital and repair	77.1	106.8	146.4	183.0	188.7	291.3	292.5	319.7	407.2	520.1	572.3
Total mineral manufacturing industries											
Capital											
Construction	121.9	191.6	200.3	196.1	225.5	358.4	322.1	340.0	343.1	481.4	680.8
Machinery	291.5	418.9	304.5	253.2	318.3	432.9	391.0	405.6	568.7	747.8	1,012.9
Total	413.4	610.5	504.8	449.3	543.8	791.3	713.1	745.6	911.8	1,229.2	1,693.7
Repair											
Construction	54.4	61.6	70.2	81.5	81.9	85.0	86.7	105.1	117.4	152.2	171.2
Machinery	288.1	334.6	332.2	363.8	346.8	410.9	433.7	483.5	549.4	622.4	705.7
Total	342.5	396.2	402.4	445.3	428.7	495.9	520.4	588.6	666.8	774.6	876.9
Total capital and repair	755.9	1,006.7	907.2	894.6	972.5	1,287.2	1,233.5	1,334.2	1,578.6	2,003.8	2,570.6

[1]Industry groups are the same as in Table 28. [2]Includes smelting and refining. [3] Includes cement, lime, and clay products manufacturing.
[p]Preliminary estimates of intentions; [f]Forecast intentions.

Table 69. Canada, capital expenditures in the petroleum, natural gas and allied industries[1], 1965-75

	Petroleum and natural gas extraction[2]	Transportation including rail, water and pipelines	Marketing (chiefly outlets of oil companies)	Natural gas distribution	Petroleum refining including lubricants	Natural gas processing plants	Total capital expenditures
			($ million)				
1965	381.0	112.1	55.2	72.5	39.8	41.5	702.1
1966	453.5	154.0	64.0	92.3	64.8	50.1	878.7
1967	385.1	204.9	86.8	76.4	99.6	89.7	942.5
1968	374.3	247.9	87.6	117.4	127.6	91.1	1,045.9
1969	438.1	220.6	103.6	117.0	128.9	103.8	1,112.0
1970	449.3	246.5	100.0	100.4	229.8	189.5	1,315.5
1971	489.6	352.0	99.2	115.2	227.0	251.1	1,534.1
1972	690.2	440.9	111.8	141.7	239.1	130.3	1,754.0
1973	864.8	390.9	128.0	146.3	313.8	70.3	1,914.1
1974[p]	1,088.6	264.0	142.0	176.6	403.1	145.1	2,219.4
1975[f]	1,257.9	271.4	156.3	205.5	439.9	148.3	2,479.3

[1]The petroleum and natural gas industries in this table include all companies engaged, in whole or in part, in oil and gas activities.
[2]Includes capital expenditures by oil and gas drilling contractors back to 1965. Does not include expenditures for geological and geophysical operations. See also footnote 3 of Table 66.
[p]Preliminary; [f]Forecast intentions.

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