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MINERAL REPORT 34

CANADIAN MINERALS YEARBOOK 1985

REVIEW AND OUTLOOK

Energy, Mines and Resources Canada — Énergie, Mines et Ressources Canada

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Foreword

This issue of the Canadian Minerals Yearbook reviews the activity in the Canadian mineral industry during 1985 and looks at the direction the industry is likely to take in the foreseeable future. The present edition is the latest in a series of official documents published under various titles since 1886 when the Government of Canada produced its first comprehensive report on the country's mineral industry.

The chapter entitled General Review deals with the main economic events of the past year and describes trends in the Canadian economy. This section also deals with general developments and overall patterns in the mineral industry. The commodity reviews provide the same type of information as in past issues, however, the Outlook section under each review has been expanded to place greater emphasis on projections for the future of the industry. With this change, the Yearbook should prove to be a more useful tool and appeal to a broader audience.

Unless otherwise stated, the basic statistics on Canadian production, trade and consumption were collected by the Information Systems Division, Mineral Policy Sector of Energy, Mines and Resources Canada, and by Statistics Canada. Corporate data were obtained directly from company officials through surveys or correspondence, or were extracted from annual reports. Market quotations were taken mainly from standard marketing reports.

Additional copies of the Yearbook can be purchased from the Canadian Government Publishing Centre. Reprints of individual chapters and Map 900A, Principal Mineral Areas of Canada, may be obtained free of charge from:

Publication Distribution Office
Mineral Policy Sector
Energy, Mines and Resources Canada
580 Booth Street
Ottawa, Ontario
K1A OE4

Previous editions of the Canadian Minerals Yearbook have been deposited in various libraries across Canada.

Energy, Mines and Resources Canada is grateful to all those who contributed information used in the preparation of this report.

May 26, 1986

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Front Cover:
Geologist studies mineral sample in open-pit mine, Pine Point, N.W.T.
(George Hunter photo)

Contents

* The review for this commodity was not produced in 1985.

Conversion Factors

Imperial Units to Metric (SI) Units

Ounces to grams	x	28.349 523
Troy ounces to grams	x	31.103 476 8
to kilograms	x	.031 103 476
Pounds to kilograms	x	.453 592 37
Short tons to tonnes	x	.907 184 74
Gallons to litres	x	4.546 09
Barrels to cubic metres	x	.158 987 220
Cubic feet to cubic metres	x	.028 346 85

Source: Canadian Metric Practice Guide

General Review

D. PILSWORTH

THE ECONOMY IN 1985

The Canadian economy in 1985 got off to a restrained and rather hesitant start, as the long awaited business recovery failed to materialize. Real business spending in the first quarter of 1985 was 0.13 per cent below the level recorded over the same period one year ago. Imports increased, exports decreased, the merchandise trade balance declined, and unemployment remained high.

Forecasters, noting these negative indicators, predicted that the Canadian economy was heading into another slowdown.

The economic recovery in 1984, was essentially trade driven. By year end, the merchandise trade balance had reached a record surplus of $5.8 billion. This surplus in 1984 was principally a result of strong U.S. demand where real GNP that year had grown at a rate of 6.8 per cent. The rate of growth slowed in the U.S. economy in 1985, and Canadian exports declined. Canadian merchandise imports registered stronger growth, and by the second quarter of 1985, the merchandise trade surplus had dropped to $5.0 billion. But as trade as a source of economic growth began to weaken in 1985, evidence of new momentum in the consumer and business sectors of the Canadian economy began to emerge.

Increased demand, particularly for automobiles and other durables helped increase consumer spending in 1985 over 1984, by nearly 5 per cent. The personal savings rate of 13.3 per cent was down to 11.3 per cent in the third quarter.

Increased business investment, (defined as plant and equipment plus residential construction activity), also helped sustain economic growth in 1985. During 1983 and 1984 business investment had declined by $1.6 billion in real terms, and as late as the first quarter in 1985, levels were still 21 per cent below the pre-recession peak. In the second quarter of 1985, however, real business outlays were up by 5.0 per cent, relative to the first quarter, and by 6.9 per cent relative to the same quarter in 1984. This turnaround in business investment will be needed to help offset the slower growth in consumer spending, anticipated as a result of the May 1985 federal budget.

Real gross national product posted a 1 per cent seasonally adjusted increase in both the first and second quarters of 1985, followed by an increase of 1.6 per cent in the third quarter. Forecasters revised their annual growth rate estimates to a possible 4.5 per cent for the year overall - a much more optimistic figure than the 3 per cent predicted earlier in the year.

A relatively low and stable rate of inflation during 1985 encouraged business investment and consumer spending. The consumer price index, a measure of inflation, fell to approximately 4.2 per cent during the year, from 12.5 per cent in 1981. Interest rates in Canada also declined in 1985, as the Bank of Canada rate fell to a seven-year low of 8.77 per cent in the first quarter, but had risen slightly to the 9.3 per cent range by year-end.

In spite of enthusiasm over the unexpected growth in GNP, and the low interest and inflation rates, continued high levels of unemployment, remained a serious concern in 1985. The unemployment rate, although declining from previous levels, remained at 10.2 per cent, as of November, 1985. High unemployment levels precluded pressures directed toward higher wages, although by year-end, wage increases were slightly higher than the inflation rate.

The high federal deficit in Canada of approximately $34 billion continued to be a concern, even though it began to ease toward the end of the year.

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THE MINERAL INDUSTRY IN 1985

The Canadian mineral industry in 1985, continued to cope with the aftermath of the recent recession, technological change, and major shifts in world production and trading patterns.

In particular, Canada's mineral export trade faced intensified world competition, and some erosion of traditional market shares.

Base metals remained under pressure, and prices in real terms for some products were near the lows set during the 1930s.

Industry debt to equity ratios, which had begun to decline in 1983 and 1984, began to rise again in 1985, and mining companies' profits dropped by $31.4 million or 82.2 per cent from a year earlier.

According to an editorial in the Northern Miner Press, the mining industry was "hurting - and deeply".

There was, however, some optimism expressed that if efforts to devalue the U.S. dollar were successful, some improvement in the price of Canadian minerals, particularly gold, could result. Contrary to expectations, however, metal prices late in 1985, continued to fall, even after the U.S. dollar started to decline.

Low metal prices in 1985 did not prevent the industry from achieving some growth. The Canadian mineral industry increased the value of its output, in 1985 to $45 billion, up from $43.8 billion in 1984.

The mineral industry is made up of four sectors; namely metallics, nonmetallics, structural materials, and mineral fuels.

The mineral fuel sector made the greatest contribution to the value of output in 1985, accounting for $31.5 billion, or 70.1 per cent of the total, an increase of 3.5 per cent over 1984.

The metals group accounted for $8.5 billion, or 19.0 per cent of the total value of output in 1985, a decrease of 1.4 per cent relative to 1984.

The nonmetallic sector contributed $2.4 billion, or 5.4 per cent of the total value of output, an increase of 2.9 per cent over 1984.

Value of output for structural materials, which includes stone, sand and gravel, reached $2.0 billion, showing little change from 1984.

Indexes of real growth within the industry presented a mixed picture in 1985. Based on indexes of gross domestic product, where 1971 = 100, the mineral industry as a whole, showed a marginal increase and rose from 110.4 in 1984 to 111.0 in the first nine months of 1985.

The indexes for metal mines, and nonmetal mines were down in the first nine months of 1985 relative to 1984, showing a drop from 80.7 to 76.9 for metal mines, and from 115.9 to 104.5 for nonmetal mines. Offsetting these losses were gains in the first nine months of 1985 for mineral fuels, up from 128.2 to 133.1, and coal mines in particular, up substantially from 328.3 in 1984 to 356.4 in 1985.

Canadian Mineral Production 1984 and 1985

	1984	1985	% Change 1984/1985
	(billions of current dollars)		
Metals	8.7	8.5	-1.4
Nonmetals	2.4	2.4	+2.9
Structurals	2.0	2.0	+2.0
Fuels	30.4	31.5	+3.5
Total	43.8	45.0	+2.5

On a commodity basis, the percentage contributions of the 10 leading minerals to the total value of mineral output were as follows: crude petroleum, 42.2 per cent; natural gas, 17.6 per cent; natural gas byproducts, 6.1 per cent; coal, 4.2 per cent; iron ore, 3.4 per cent; copper, 3.2 per cent; zinc 2.9 per cent; nickel, 2.8 per cent; gold, 2.7 per cent; and finally uranium, 2.1 per cent.

Regionally, Alberta continued to represent the largest share of output, which reached $27.3 billion, or 60.9 per cent, in 1985. Value of output in Ontario was $4.6 billion, or 10.2 per cent of the total. Output in Saskatchewan was valued at $3.8 billion or 8.4 per cent, British Columbia $3.4 billion or 7.6 per cent, and Quebec $2.2 billion or 5.0 per cent.

THE MINERAL INDUSTRY: COMMODITY PRICES AND TRENDS

Few signs of encouragement were evident for the base-metals industry in 1985. In the face of poor demand, prices maintained their downward trend. By October 1985, base-metal prices had dropped below the recession-level prices of 1982.

Copper producers in 1985, continued to face low prices resulting from overcapacity and price insensitivity to production cutbacks. Copper prices on the LME averaged 64.2 cents (U.S.) per pound in 1985 compared with 62.5 cents in 1984, and 72.2 cents in 1983. Prices are forecast to average 69 cents (U.S.) in 1986. The consumption of copper is decreasing, partly as a result of substitution, but also because of more efficient fabrication processes.

Canadian nickel companies, despite being the lowest cost producers in the world, continued their efforts in 1985, to lower the costs of production even further. Due to global overcapacity, nickel prices had been under downward pressure for the past few years. As a result, major cost reductions were undertaken. Low prices in the fourth quarter had an adverse effect on the overall return to profitability experienced by the industry in 1985.

At the beginning of 1985, the prospects for molybdenum were looking considerably brighter. Having started the year below $US 3 per pound, free market prices for molybdenum advanced rapidly to $US 4.50 per pound at the end of March. Toward the end of 1985 however, weaker demand, and a gradual accummulation of stocks caused the price to fall to about $US 2.60 per pound.

Forecasts for iron ore indicate a supply surplus on world markets until the early 1990s, primarily because of decreasing demand for steel and increasing supply from new mines. This chronic overcapacity, suggests that high-cost producers, including those in Canada, may continue to face financial difficulties well into the foreseeable future. During the past several years, the Canadian industry has undertaken a number of restructuring actions and technological changes. These have strengthened the industry's competitive position in both domestic and foreign markets. As a result, production levels appear to be stabilizing at about 80 per cent of capacity.

Gold continued to be a major focus of exploration and development in the Canadian mining industy in 1985, particularly in the Casa Berardi area in northern Quebec, and the La Ronge area in Saskatchewan. Production from the Hemlo camp near Marathon, Ontario, also contributed to the positive picture for this industry. The price of gold, which averaged about $US 317 per ounce in 1985, was predicted to reach $US 350 in 1986.

Because of its byproduct nature, silver continued to suffer from the oversupply conditions experienced by the major base metals; namely lead, zinc and copper. In addition, large stockpiles of silver held by governments and private companies continued to suppress the price of silver to the $US 6 per ounce range.

The outlook for the uranium industry brightened considerably in 1985. Uranium production no longer greatly exceeds reactor requirements, as has been the case since the mid 60s. The high inventory levels which have plagued the industry worldwide, are expected to be reduced, and overall supply and demand are expected to come into balance before 1990.

Zinc traded at 47 cents (U.S.) per pound in the spring of 1985, and forecasters believed that this metal would survive the 1985 base metals slump. By October, however, zinc was also suffering from weak markets, and low prices of 35 cents (U.S.) per pound, and as a result, Noranda Inc., and Cominco Ltd., announced cutbacks in production of 10 per cent.

The outlook for the production of aluminum in Canada was less than optimistic in 1985. Low ingot prices and high world inventories, caused postponement of several Canadian smelter projects. Competition intensified as a larger share of the world's primary aluminum capacity is now located in areas with abundant energy resources such as Brazil, Venezuela, and Australia. Canada, however, also has inexpensive electricity. As a result Canada remained a low-cost producer in 1985, and the world's largest exporter of primary aluminum. The United States continued to be Canada's major export market for this commodity.

A crisis in the tin market, during the last quarter of 1985, was precipitated by the financial collapse of the International Tin

Council, a group of 24 tin-producing and consuming nations. (Problems had begun when higher tin prices enticed non-ITC countries such as Brazil and China to increase production). As the impact of the tin crisis spread to the commodities market generally, trade in other metals also slumped. Canada's only tin mine, located in Nova Scotia, was expected to face substantially lower price realization as a result of the tin market collapse. The price for tin when trading was suspended late in 1985, was $Cdn 16,000 per t. Analysts expected the price to drop by as much as 50 per cent when trading resumed.

Canada is the non-communist world's largest producer of asbestos. Relative to 1979, however, Canada's production has declined by about 50 per cent. This production decline has been largely a result of reduced demand for products containing asbestos. In addition, Canada currently faces stiff competition in asbestos from producers in Brazil, Zimbabwe and Greece.

Saskatchewan has the largest and lowest cost reserves of potash in Canada, and will undoubtedly continue to occupy an important place in world markets. World demand for potash is expected to grow in the long term, and Canada's most likely markets are the United States, China, India and Brazil. The average price received for potash (KCl) over the first nine months of 1985 was $Cdn 98.25 per t compared with $104.05 in 1984. Surplus supply continued, and prices in 1985 were about 30 per cent below normal levels.

Canada, as the fifth largest producer of salt in the world, had an output of nearly 10 million t in 1985, although production levels were reduced slightly as a result of two lengthy strikes.

MINERAL TRADE AND INVESTMENT

Investment in the mineral industry showed moderate improvement in 1985. New capital expenditure intentions for mines, quarries and oil wells reached $11.0 billion, a level which for the first time, surpassed the pre-recession high of $10.0 billion recorded in 1981.

Metal mines contributed significantly to this increase, with spending intentions reaching $1.6 billion, up from $1.3 billion in 1984. Gold was clearly in the limelight in 1985, and remained a major focus of exploration and development in the Canadian mining industry. Nonmetal mines, however, fared less well, and showed a 25 per cent decrease in spending intentions in 1985, over those of 1984. The $887 million spending forecast for this sector was well below the levels recorded in both 1983 and 1984, which were $1.6 billion and $1.1 billion respectively.

Mineral exports continued to make a significant contribution to the Canadian surplus in merchandise trade. In the first 9 months of 1985, exports of crude and fabricated materials including fuels totalled $23.3 billion, up 7.7 per cent from the same period a year before. Crude mineral products accounted for $13.7 billion or 59 per cent of the total, while fabricated mineral products represented $9.6 billion or 41 per cent of the total. These two components together accounted for 27.2 per cent of all domestic exports in the first 9 months of 1985. The United States was the principal buyer of Canada's mineral exports, followed by Japan, the United Kingdom, and the rest of the European Economic Community.

Mineral industry imports totalled $11.1 billion in the first 9 months of 1985, up from $10.1 billion in 1984. 54 per cent of all Canada's mineral imports originated in the United States.

OUTLOOK

After two years of growth, the Canadian economy is expected to lose a little momentum in 1986. Growth of 2.5 to 3.0 per cent in GNP is being forecast, as opposed to the 4.5 per cent growth experienced in 1985. There are however, reasons for optimism. Even with slightly slower growth, the economy is expected to outpace that of the United States again in 1986, just as it did in 1985. In addition, consumer spending, although forecast to slow down slightly in 1986, will retain strength as an impetus to economic growth, particularly if increases in housing starts and automobile sales experienced toward the end of 1985 are sustained in 1986.

Finally, there is increasing evidence that the long-awaited boom in domestic capital spending, which emerged in the latter part of 1985 to replace consumer spending and trade as the sources of growth, will continue to be felt throughout 1986 and perhaps even beyond.

Also on the positive side, inflation and interest rates in 1986, are expected to stay relatively stable and close to those of 1985.

A marginal improvement in the unemployment rate to slightly less than 10 per cent, is anticipated, and wage settlements are expected to slightly outpace inflation in 1986.

While many other sectors of the Canadian economy had managed to pull out of the recession by the end of 1985, the mineral industry continued to experience some difficulty. The mining industry in particular, faces an international situation of declining or stagnant demand for its products coupled with growing sources of supply. A lower economic growth rate globally, created by oil shocks, historically high interest rates, and world debt of significant proportions has resulted in decreased demand and thus surplus capacity for many metals.

Reductions in world demand have been accompanied by large increases in the supply of some minerals. Production-driven output, continues to pose a serious competitive threat to the health of the export-oriented Canadian minerals industry.

The predicted rates of real price change for many minerals are less than optimistic. Although the general economic expansion in Canada is now more than three years old, prices for the base metals and precious metals remain at or below levels reached at the bottom of the business cycle in 1982. With inflation remaining at low levels and supplies in many cases exceeding demand, there does not appear to be any reason for a sudden reversal of the price downtrend.

The scene is not, however, without its bright spots.

For example, a review of the capital expenditures in the mining industry in Canada predict that estimated spending for the years 1985 to beyond 1989 will total $8.6 billion.

Efforts by five major trading nations to devalue the $US in late 1985, may also give metals a needed shot in the arm, although normally, six months or more will elapse before currency changes show up in commodity price quotes. Even a small improvement in selling prices for metals, however, could put some companies back in the black.

The Canadian minerals industry will also benefit if interest rates remain stable. This situation would allow companies to improve their debt to equity ratio, and thus achieve greater profitability.

The industry must continue its efforts to reduce labour, energy, and capital costs. In addition, the adoption of an aggressive marketing stance, and increased use of the latest technology are essential if the industry is to remain competitive. With commitment to face the challenges, however, and with the return of a much improved capital investment climate in 1986, the mineral industry will remain a significant contributor to the Canadian economy, well into the foreseeable future.

CANADA, EXPORTS OF MINERALS, CRUDE AND FABRICATED

	Year 1974	Year 1979	Year 1984	1st 9 months 1984	1st 9 months 1985	% changes 1st 9 months 1985 / 1st 9 months 1984
			($ millions)			
Crude						
Ferrous	574.0	1,469.6	1,206.9	890.9	1,017.8	+14.2
Nonferrous	1,801.8	2,425.1	2,463.2	1,664.4	1,603.0	-3.7
Nonmetallic	799.0	1,715.3	2,767.2	1,987.6	2,312.3	+16.3
Fuels	4,232.6	6,128.9	10,123.5	7,358.2	8,702.9	+18.3
Total	7,407.4	11,738.9	16,560.8	11,901.1	13,636.0	+14.6
Fabricated						
Ferrous	917.7	1,947.6	2,666.1	1,964.2	2,173.1	+10.6
Nonferrous	2,102.7	3,807.0	6,664.5	5,048.3	4,743.9	-6.1
Nonmetallic	178.4	455.9	546.8	400.2	422.1	+5.5
Fuels	611.3	1,885.3	3,192.7	2,303.8	2,310.6	+0.3
Total	3,810.1	8,095.8	13,070.1	9,716.5	9,649.7	-0.7
Total crude and fabricated minerals						
Ferrous	1,491.7	3,417.2	3,873.0	2,855.1	3,190.9	+11.8
Nonferrous	3,904.5	6,232.1	9,127.7	6,712.7	6,346.9	-5.4
Nonmetallic	977.4	2,171.2	3,314.0	2,387.8	2,734.4	+14.5
Fuels	4,843.9	8,014.2	13,316.2	9,662.0	11,013.5	+14.0
Total	11,217.5	19,834.7	29,630.9	21,617.6	23,285.7	+7.7
Total domestic exports all products	31,739.5	64,317.3	109,543.5	81,439.9	85,542.7	+5.0
Crude minerals as % of exports, all products	23.3	18.3	15.1	14.6	15.9	
Crude and fabricated minerals as % of exports, all products	35.3	30.8	27.0	26.5	27.2	
Crude mineral exports as % of mineral exports	66.0	59.2	55.9	55.1	58.6	

Source: Statistics Canada.

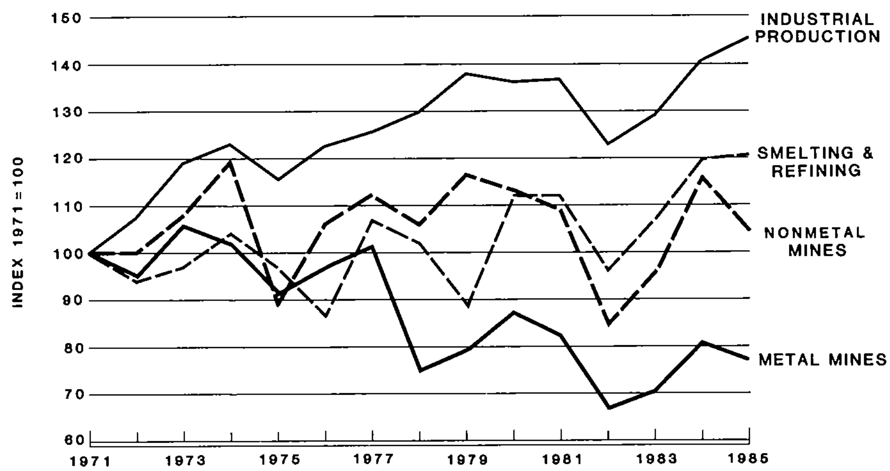
CANADA, PRODUCTION OF LEADING MINERALS, 1984 AND 1985

	1984	1985	% change 1985/1984	1984	1985	% change 1985/1984
	(000 tonnes except where noted)			($ millions)		
Metals						
Copper	721.8	730.3	+1.2	1,365.7	1,445.4	+5.8
Gold (kg)	83 466.0	86 044.0	+3.1	1,252.3	1,197.1	-4.4
Iron ore	39 930.0	40 348.0	+1.0	1,482.4	1,545.8	+4.3
Lead	264.3	263.9	-0.2	195.3	152.3	-22.0
Molybdenum (t)	11 557.0	7 569.0	-35.0	106.2	75.4	-30.0
Nickel	173.7	175.6	+1.1	1,166.1	1,235.0	+5.9
Silver (t)	1 327.0	1 209.0	-8.9	461.9	337.4	-27.0
Uranium (U)(t)	10 272.0	10 029.0	-2.4	901.6	957.7	+6.2
Zinc	1 062.7	1 038.5	-2.3	1,495.2	1,316.8	-11.9
Nonmetals						
Asbestos	837.0	744.0	-11.1	379.3	352.3	-7.1
Gypsum	7 775.0	8 384.0	+7.8	61.6	80.3	+30.4
Potash (K_2O)	7 527.0	6 923.0	-8.0	867.5	642.1	-26.0
Salt	10 235.0	10 043.0	-1.9	210.2	226.0	+7.0
Cement	9 240.0	9 772.0	+5.8	717.3	780.1	+8.8
Clay Products	..	..	..	136.8	144.5	+5.6
Lime	2 249.0	2 010.0	-10.6	157.6	137.0	-13.1
Fuels						
Coal	57 402.0	60 480.0	+5.4	1,794.6	1,884.1	+5.0
Natural gas (million m^3)	78 266.0	80 181.0	+2.5	7,940.9	7,906.0	-0.4
Petroleum (million m^3)	83 680.0	84 311.0	+0.8	17,813.9	18,938.7	+6.3

.. Not applicable.
Note: Figures have been rounded.

FIGURE 1

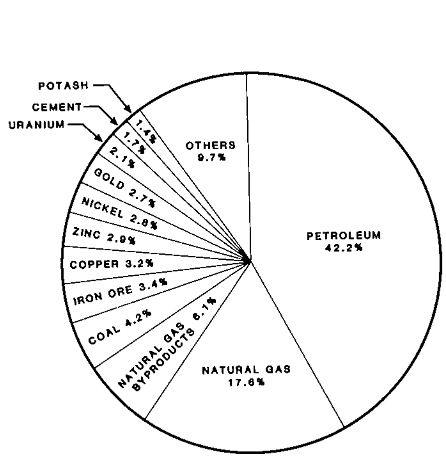
INDEXES OF GROSS DOMESTIC PRODUCT IN 1971 PRICES



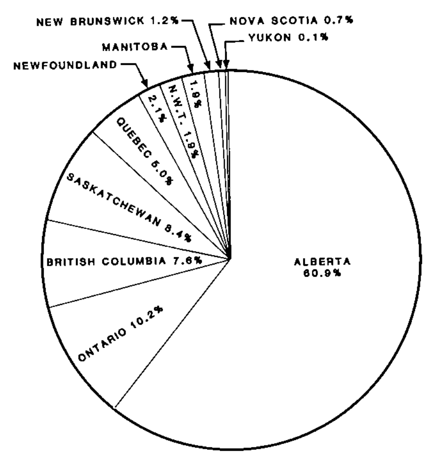
SOURCE: STATISTICS CANADA

FIGURE 2

CANADA, MINERAL PRODUCTION, 1985



% OF TOTAL BY COMMODITY

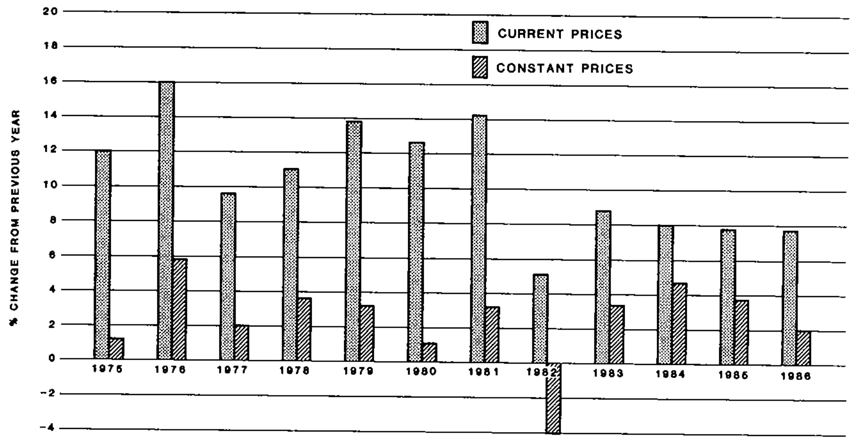


% OF TOTAL BY PROVINCE

FIGURE 3

TRENDS IN CANADIAN ECONOMIC ACTIVITY

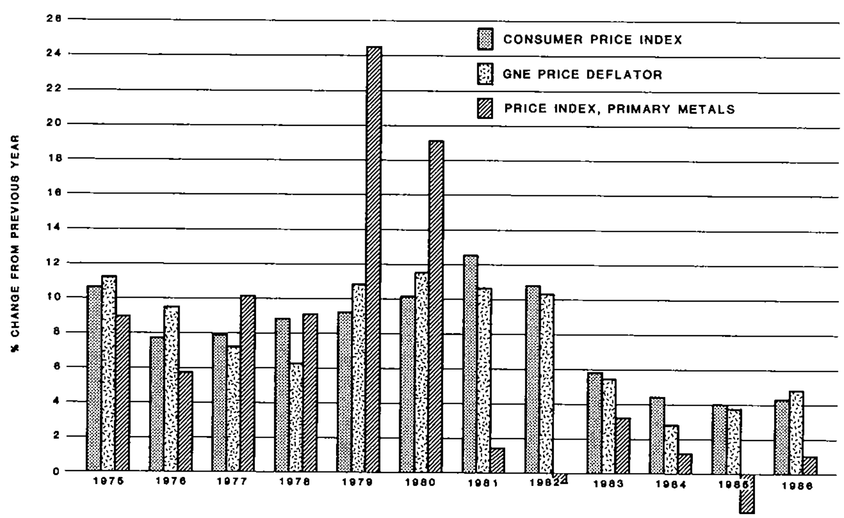
(% CHANGE IN GROSS NATIONAL PRODUCT)



NOTE: FIGURES FOR 1985 AND 1986 ARE ESTIMATED

FIGURE 4

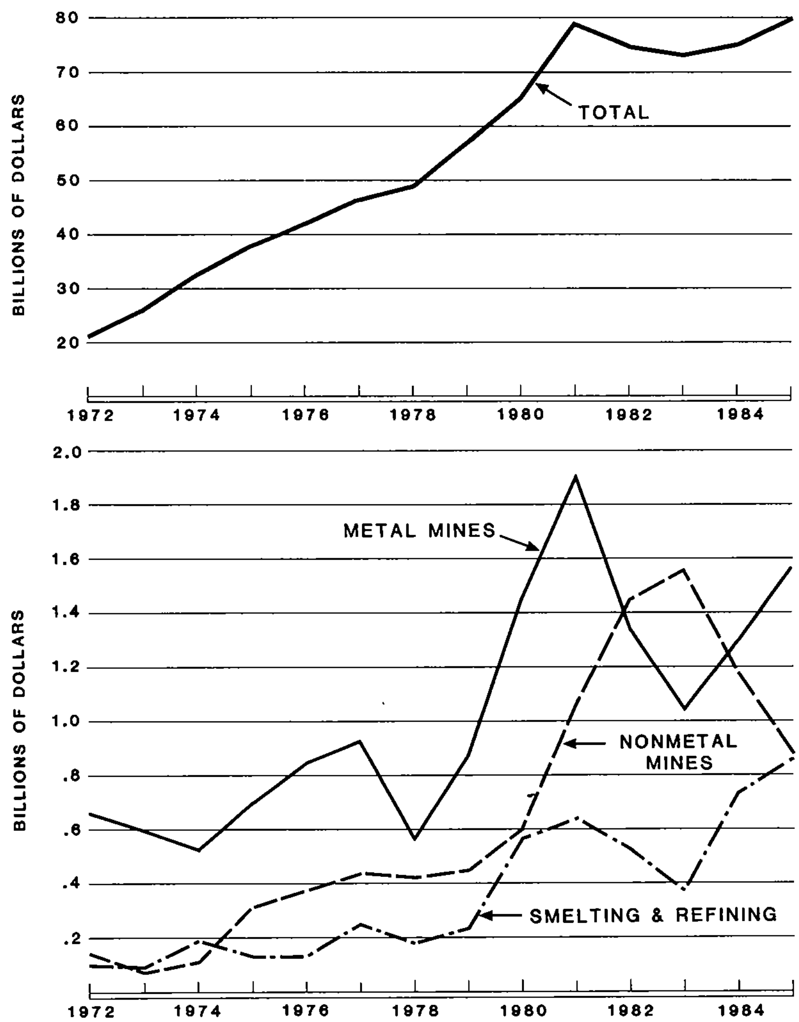
GENERAL CANADIAN PRICE TRENDS



NOTE: FIGURES FOR 1985 AND 1986 ARE ESTIMATED

FIGURE 5

INVESTMENT [1] IN THE CANADIAN ECONOMY

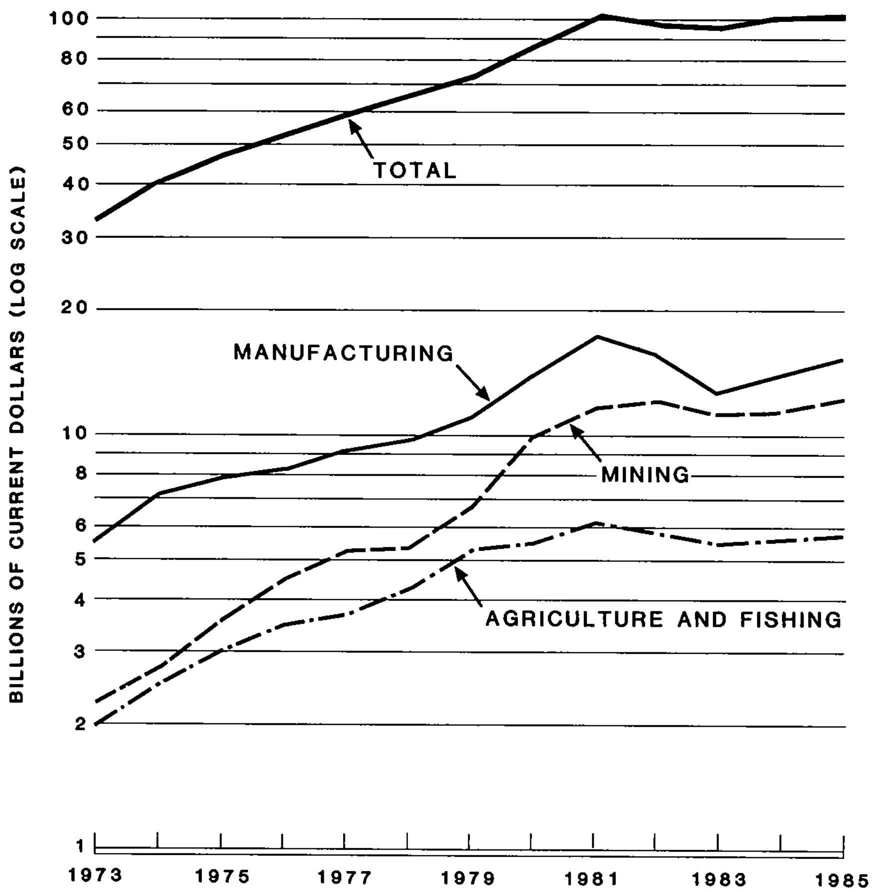


(1) CAPITAL EXPENDITURES ON MACHINERY & EQUIPMENT & CONSTRUCTION

SOURCE: STATISTICS CANADA

FIGURE 6

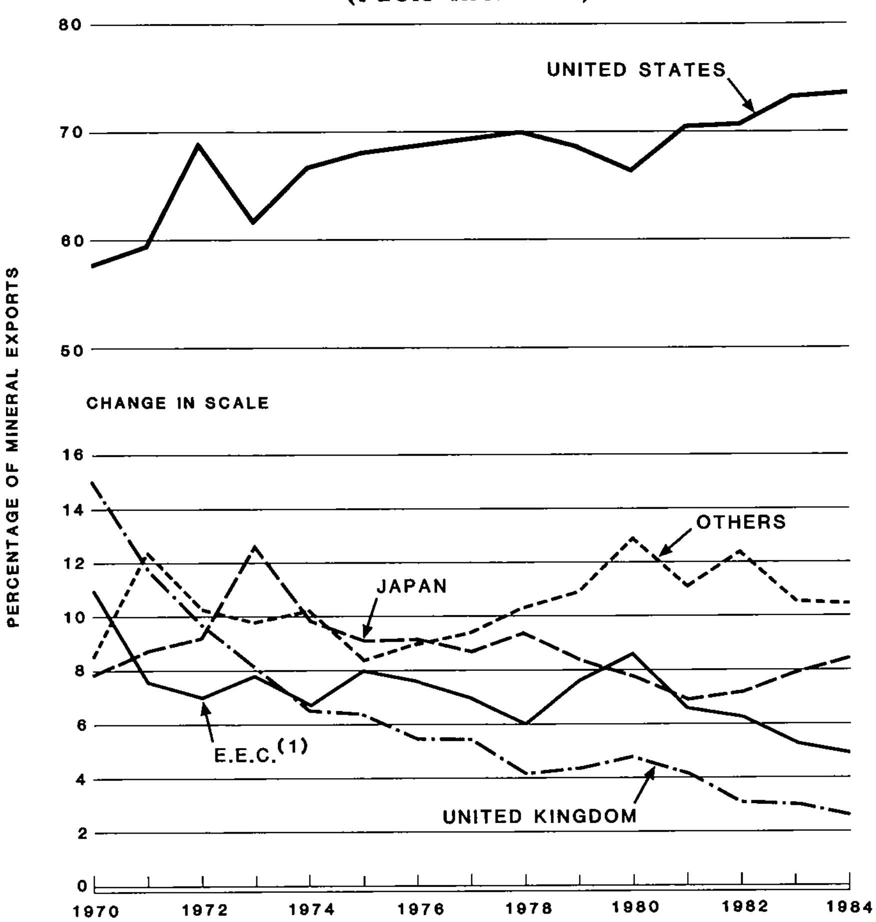
INVESTMENT(1) IN THE CANADIAN ECONOMY



(1)INCLUDES BOTH CAPITAL AND REPAIR EXPENDITURES

FIGURE 7

CANADA, CRUDE AND FABRICATED MINERAL EXPORTS BY DESTINATION (Fuels Included)



(1) EXCLUDED UNITED KINGDOM

FIGURE 8

CANADA
POPULATION AND LABOUR FORCE

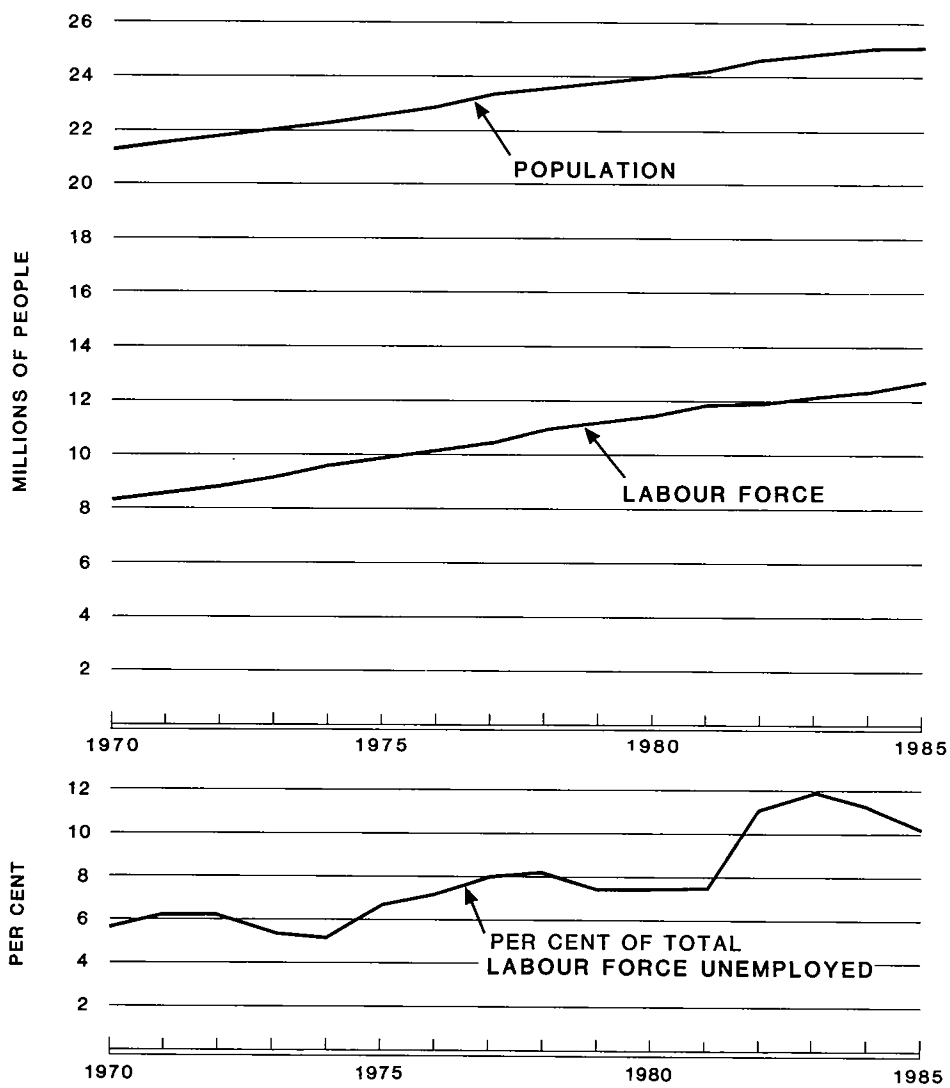
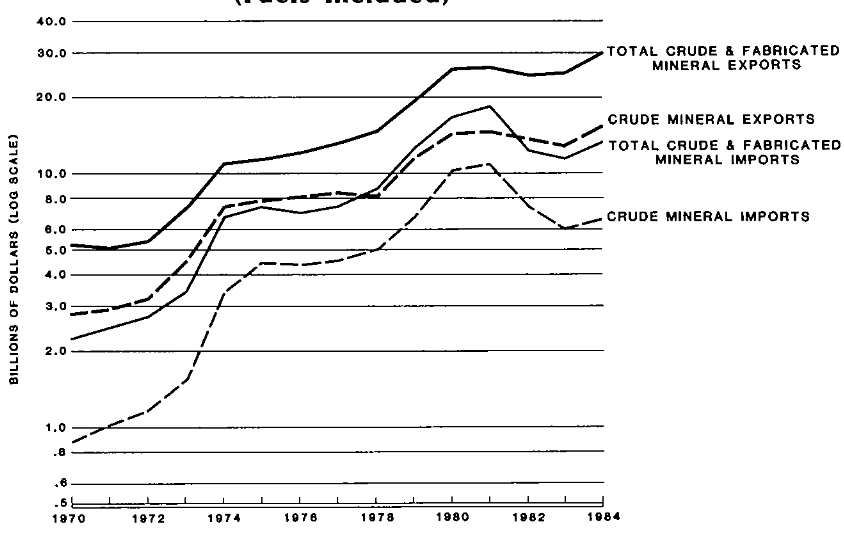


FIGURE 9

CANADA, MINERAL TRADE (Fuels Included)



International Review

W.H. JACKSON

CANADA'S NON-FUEL MINERAL TRADE

The mineral industry has shown resilience in adapting to extremely competitive world export markets. As the greater part of Canadian production is exported, producers continue to be exposed to the full impact of world economic conditions.

International prices for many commodities have declined to levels that seem low in the long-term. Canadian producers have responded by improving their competitiveness through cost-cutting, introduction of new technology, improvements in mining techniques and generally through finding ways of becoming more efficient. This necessary response to market conditions has taken its toll in production cutbacks, mine closures and layoffs. In addition, many corporations carry heavy debt loads. There is obviously considerable variation possible on the part of exporters in responding to world competition for particular commodity markets. Overall, the commercial and financial decisions already made by Canadian producers will sustain their ability to be secure and cost-competitive suppliers to export markets.

Despite the problems of individual producers, the mineral industry as a whole continues to be a vital component of the Canadian economy. Mineral exports (less fuel) amounted to $16 billion in 1984 versus imports of $7 billion. The exports represented 13.7 per cent of total Canadian exports. Preliminary data for 1985 are shown in the tables.

WORLD SITUATION

A few simple facts will help to explain why there is a glut of minerals on world export markets. Many additions to capacity were begun in the 1970s on the assumption that the high-growth typical of the post-war period would continue indefinitely. It takes several years to bring major new mines into production; less for expansions of existing capacity. In many countries, mining was looked upon as a vehicle for economic development but this philosophy led to over-investment and disregard for market signals.

Even the most experienced producers did not recognize in time that the economic growth in the 1960s and 1970s was to be followed by a recession in the early-1980s of unexpected intensity and duration. For a while world mineral suppliers tried to produce and sell into a market that was not growing in the expectation that at least basic costs could be met. The result was over-supply and progressively deteriorating prices.

The broader picture of overall trade is illustrative[1]. Between 1980 and 1983, the level of total world exports declined by 11.4 per cent in value. The low point was reached in 1983. There has been a recovery but the value of world trade in 1985, more than $US 1,700 billion, is still slightly below the 1980 value.

Also from 1980 to 1985, prices for all exports measured in U.S. dollars declined 15 per cent overall. However, prices for all internationally traded commodities declined on average by 30 per cent, and metals shared the same decline. The main mineral commodities of interest to Canada whose price is at or below the average are precisely the commodities in oversupply. They include: copper, nickel, lead, potash and aluminum, with zinc showing similar signs.

Exchange rate fluctuations have undoubtedly had a significant impact on the structure, composition and direction of trade in the last few years. World producers in the best position to compete in trade are those whose costs and debt are in depreciating local currencies and whose returns are in high value currencies such as the U.S. dollar. Few producers fit this

[1] International Financial Statistics published by the International Monetary Fund.

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ideal situation. Many producers in industrial countries have had to close or have been weakened as their costs, and returns and debt are all in high value currencies. In general, developing country producers have high foreign debts and many of the mines, often government-owned, tend to maximize cash flow to generate foreign earnings so that necessary imports can be purchased and service charges met.

In this volatile situation, North American producers have viewed international aid institutions and development banks as being partially responsible for the oversupply problem. In pursuing their respective mandates in a somewhat uncoordinated manner, insufficient attention was given to market requirements in funding projects. A clear signal of U.S. disapproval of development bank activity became evident in the fiscal 1985 Supplemental Appropriations Act (HR 2577) which instructs U.S. directors of international financial institutions to oppose any assistance related to copper export commodities and limits U.S. contributions to international financial institutions to those projects that do not generate surplus commodities or displace private initiative.

At year-end a realignment of currencies that began in September was under way which is reversing the trend of the last few years. Prices have been slow to react. Most industrialized countries expect moderate economic growth in 1986 which should result in improved demand for mineral commodities.

MARKET ACCESS

Cost competitiveness alone is not enough to assure that mineral producers have equal access to markets. There are three broad categories of access problems: (1) tariffs, (2) non-tariff barriers to trade and (3) tariff preferences or trading blocs. Each presents special problems but a general review of key developments may be useful in assessing the direction of change in the next few years.

General Agreement on Tariffs and Trade

Mineral producers should pay particular attention to the GATT as it determines the rules for fair trade. GATT Contracting Parties decided on November 28, 1985, to establish a Preparatory Committee for a new round of multilateral trade negotiations (MTN). The Committee is to determine the objectives, subject matter, modalities for and participation in the MTN and to prepare a program for adoption at a Ministerial meeting in September 1986. The agenda for the Committee is wide open, thereby providing opportunity for drawing up an MTN negotiating program including all goods and services.

The Committee is to take account of the GATT Work Program embarked upon at the 1982 Ministerial meeting in Geneva. At that time, Contracting Parties decided to examine problems relating to trade in the following natural resource products including their semi-processed and processed forms: nonferrous metals and minerals; forestry products; and fish and fishery products. A special GATT Working Party was established in February 1984 to carry out the examination and to assist the GATT Secretariat for preparing background studies. During 1984-85, the Working Party examined trade in copper, nickel, lead, zinc, and tin. Aluminum is scheduled for the early part of 1986. It is anticipated that the report of the Working Party will recommend, among other things, that nonferrous metals figure prominently in the new round of MTN.

The working group has voiced concerns about the level of nominal tariffs, tariff escalation and the consequent effective rate of tariff protection, tariff preferences and non-tariff measures. All are of particular concern owing to their effect on prices and demand in export markets.

Non-tariff measures take many forms, including: quotas, restrictions on sourcing, frequent investigations, subsidies, countervailing actions, unreasonable bureaucratic impediments, environmental and health requirements, customs classification, import licencing, port taxes, surcharges, and prior deposits on goods to be imported. The list is endless. Some problems can be dealt with on a bilateral basis but it would be far better if the rules of the game could be more clearly defined on a multilateral basis in future GATT negotiations.

Canada-United States Discussions on Trade

Canada and the United States in 1985 opened an avenue of cooperation that has not been explored for many years. Both countries have now agreed to pursue discussions on the possibility of free trade or at least freer trade. For minerals there is already a high degree of interdependence. Canada's mineral exports (less fuels) to the United States were $10 billion in 1984 and imports from the United States amounted to almost $5 billion. The negotiations are to take place without any significant preconditions that affect minerals.

Commodity Study Groups

In view of the current imbalance in supply and demand, it is not surprising that both producers and consumers think there is a need for better information on commodity production and consumption. The study groups in existence for tungsten, and for lead-zinc have proven to be useful. A nickel study group is in the advanced stages of discussion and organization, and both copper and iron ore are possible candidates in the future.

International Tin Agreement

Tin trading on the London Metal Exchange (LME) was suspended on October 24 owing to a failure on the part of the Buffer Stock Manager of the International Tin Council to meet financial obligations. In December, member countries began meetings with banks and metal traders in an effort to sort out responsibility and negotiate a settlement.

The collapse of the tin market temporarily affected the pricing of other metals. The LME price is the basis of many supply contracts and the stability of the entire trading system seemed to be at risk as traders liquidated positions to cover possible losses.

The tin situation raises questions about the viability of commodity agreements which have economic provisions as opposed to study groups which do not. The question is why the 22 member countries of the oldest agreement of all failed to recognize and act to prevent a collapse in the market. There are also broader problems for banks about the prudence of lending funds to international bodies, and the question as to whether member states of international bodies can face unexpected financial risks in implementing economic provisions of international commodity agreements. Preserving or negotiating future commodity agreements could prove difficult if there are possibilities of unanticipated political, legal, or economic repercussions.

POSITIVE TREND FOR 1986

Mineral demand is derived from economic activity. If the world economy improves even moderately in 1986 in line with expectations, mineral trade should benefit. Such a trend, coupled with a reduction in inventories and production cutbacks would help to improve supply-demand balances and create the conditions that could lead to improved prices for many mineral commodities. Realistically, this process could take up to two years.

Fortunately, a start has been made by governments in addressing the broad problems of the international trade. Finance ministers started the process of reducing the value of the U.S. dollar in September. There are also tentative plans to deal with the world debt crisis. Once exchange rates are realigned and financial volatility is lessened, international economic stability becomes a distinct possibility. In the European Community there are moves that could result in the removal of internal trade barriers by 1992. The Canada-United States trade discussions and the decision to pursue GATT negotiations have already been mentioned. These are all positive developments and represent efforts to come to grips with world trade problems.

Canada's mineral industry is clearly influenced by many factors outside its control. While price competitiveness is not enough in today's world, it remains the most important factor in determining the future of the Canadian mining industry in international trade.

TABLE 1. CANADA'S NONFUEL MINERALS EXPORTS 1984-85, BY MAJOR MARKET AND STAGE OF PROCESSING[1]

	1984				1985[2]			
	United States	EEC[3]	Japan	Total	United States	EEC[3]	Japan	Total
				($ million)				
Crude								
Ferrous	591.5	403.0	68.6	1,112.1	474.7	662.0	61.0	1,250.7
Nonferrous	120.9	387.2	449.4	1,036.3	92.3	242.7	461.6	861.7
Industrial	1,116.1	321.7	138.2	2,849.4	1,034.2	395.8	129.6	3,172.1
Total	1,828.5	1,111.9	656.2	4,997.8	1,601.2	1,300.5	652.2	5,284.5
Scrap								
Ferrous	57.1	16.9	2.5	94.8	56.2	23.1	5.4	106.4
Nonferrous	276.3	104.6	15.3	411.3	227.8	100.8	19.8	367.6
Total	333.4	121.5	17.8	506.1	284.0	123.9	25.2	474.0
Smelted and refined								
Ferrous	177.3	35.4	21.8	247.8	125.6	72.6	14.8	226.3
Nonferrous	4,655.4	675.0	420.2	6,636.7	4,219.6	725.2	336.9	6,335.6
Total	4,832.7	710.4	442.0	6,884.5	4,345.2	797.8	351.7	6,561.9
Semi-manufactured								
Ferrous	1,845.7	28.7	1.8	2,007.5	2,063.7	14.0	1.1	2,228.5
Nonferrous	476.1	21.5	2.6	573.8	397.5	20.6	11.5	504.5
Industrial	989.2	96.3	22.4	1,189.9	1,009.5	90.3	22.4	1,180.9
Total	3,311.0	146.5	26.8	3,771.2	3,470.7	124.9	35.0	3,913.9
Grand total (excluding scrap)	9,972.9	1,968.8	1,125.0	15,653.5	9,417.1	2,223.2	1,038.9	15,760.3
Percentage of grand total	63.8	12.6	7.2		59.8	14.1	6.6	

[1] The trade data compiled on the basis of a mineral industry definition developed by the Mineral Policy Sector of EMR in 1977. [2] 1985 estimates based on nine month data. [3] EEC: Belgium, Denmark, France, West Germany, Ireland, Italy, Luxembourg, Netherlands, United Kingdom and Greece.

TABLE 2. CANADA'S NONFUEL MINERALS IMPORTS 1984-85, BY MAJOR MARKET AND STAGE OF PROCESSING[1]

	1984				1985[2]			
	United States	EEC[3]	Japan	Total	United States	EEC[3]	Japan	Total
				($ million)				
Crude								
Ferrous	288.1	...	-	292.7	311.1	...	-	324.3
Nonferrous	546.6	2.0	2.4	773.5	335.5	1.8	-	542.7
Industrial	282.5	14.3	...	331.7	298.4	12.0	...	342.5
Total	1,135.2	16.3	2.4	1,397.9	945.0	13.8	...	1,209.5
Scrap								
Ferrous	106.1	...	-	106.1	74.2	...	-	74.2
Nonferrous	199.8	15.1	...	360.0	206.6	10.9	...	306.7
Industrial	0.5	-	-	0.6	0.6	-	-	0.6
Total	306.4	15.1	...	466.7	281.4	10.9	...	381.5
Smelted and refined								
Ferrous	72.1	46.5	...	174.0	73.9	37.9	...	143.2
Nonferrous	1,265.7	122.1	69.8	1,880.6	1,589.9	149.2	64.0	2,208.0
Total	1,337.8	168.6	69.8	2,054.6	1,663.8	187.1	64.0	2,351.2
Semi-manufactured								
Ferrous	704.7	380.9	163.0	1,503.5	916.9	473.3	215.6	1,859.5
Nonferrous	633.3	156.5	19.6	835.0	628.4	132.2	19.4	808.3
Industrial	821.4	222.9	45.4	1,190.9	917.1	251.6	48.4	1,323.8
Total	2,159.4	760.3	228.0	3,529.4	2,462.4	857.1	283.4	3,991.6
Grand total (excluding scrap)	4,632.4	945.2	300.2	6,981.9	5,071.2	1,058.0	347.4	7,552.3
Percentage of grand total	66.3	13.5	4.3		67.1	14.0	4.6	

[1] The trade data compiled on the basis of a mineral industry definition developed by the Mineral Policy Sector of EMR in 1977. [2] 1985 estimates based on nine month data. [3] EEC: Belgium, Denmark, France, West Germany, Ireland, Italy, Luxembourg, Netherlands, United Kingdom and Greece.
... Amount too small to be expressed; - Nil.

Regional Review

VALERIE FELL

The value of mineral production increased slightly in 1985 in most areas of Canada, with the exception of Newfoundland, New Brunswick and Yukon. New mine developments and exploration programs have been mainly limited to the precious metals sector.

The industry can be expected to continue its important role in the economy, but future growth will likely be at a modest rate. The federal and provincial governments have implemented programs: to stimulate mineral exploration, to improve mining and processing technology and to identify new development opportunities.

Mineral Development Agreements (MDA's) between Canada and Newfoundland, Nova Scotia, New Brunswick, Manitoba and Saskatchewan entered their second year in April 1985, and considerable progress was being made in the initiation and implementation of work programs. Industry, the principal client for the output of these programs, participates in the planning and is generally pleased with the results that have been released to date. Energy, Mines and Resources is the responsible federal department in these MDA's.

Negotiations proceeded with Ontario, Quebec and British Columbia during early-1985, and MDA's were signed by mid-year. A small MDA with Prince Edward Island was also agreed on and had received final approval just prior to year-end. All these MDA's are subsidiary to federal-provincial Economic and Regional Development Agreements (ERDA's), which spell out the type of cooperation that the two levels of government have agreed upon and the initiatives that can be pursued under subsidiary agreements.

In the first half of 1985, a Canada-Yukon Mineral Resources Agreement was signed. It is similar to the MDA's and under the umbrella of the Canada-Yukon Economic Development Agreement. Indian Affairs and Northern Development is the lead federal department, with Energy, Mines and Resources participation.

All these MDA's have major geoscience programs for generating the data that industry needs for mineral exploration. Some also have programs dedicated to improvements in mining and processing technology, to the identification of opportunities for mineral development and to the direct stimulation of mineral development. The total federal commitment, on the basis of five-year periods, is about $140 million; provincial commitments total $108 million.

A joint report submitted to the Ministers of Mines in September 1985, by the federal and Manitoba governments, explored various ideas for new financial mechanisms to help mining communities facing loss of their economic base.

NEWFOUNDLAND

The mineral industry in Newfoundland accounts for about 10 per cent of the Gross Provincial Product. In 1985, the value of mineral production decreased by 5.3 per cent to $927 million from 1984. Output of the three most important commodities fell in value in 1985; production of iron ore was $835 million, down from $851 million; zinc output was $37 million, down from $59 million; and asbestos shipments were $20 million compared with $25 million.

The exploration industry was very active in 1985; expenditures are estimated to be about $11 million, up from $8.3 million the previous year and $7.7 million in 1983. The number of claims staked exceeded 13,000, and more than 27,000 were in good standing at year-end.

Gold was the driving force behind this exploration activity. In the southwest, 80 km east of Port-aux-Basques, BP Resources Canada Limited carried out a $6 million program on their Chetwynd property, involving more than 10 000 m of diamond drilling and a heap-leach recovery test project. Elsewhere, several companies had programs in northern Newfoundland, in the White Bay area; others were active in the search for gold on the Burin peninsula.

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Provincial geologists reported gold values in samples taken during mapping in Labrador. However, little exploration work was reported from that part of the province.

Base-metal output has declined sharply over recent years. The only operating property is that of Newfoundland Zinc Mines Limited on the west coast. Ore reserves are not extensive, but the company is actively exploring for more.

Following a lengthy summer shutdown, Transpacific Resources Inc. is shipping asbestos fibre from the Advocate mine.

The former fluorspar mine at St. Lawrence, closed since 1977, reverted to the Crown in 1983. A new operator, Minworth Ltd. of Britain, is preparing to reopen the mine in 1986.

During 1985, work continued under the five-year, $22 million Canada-Newfoundland Mineral Development Agreement (MDA). Geological mapping was conducted in Labrador, and on the Island. Projects concerning mining and mineral technology and economic development are being planned and contracts let to private sector firms. These contracts include investigating the use of dolomite as a reducing agent in iron ore pellets in Labrador, research to improve recovery of iron ore, research into the production of better quality concrete and research on the metallurgy of potentially economic base-metal deposits. This MDA continues the federal-provincial cooperation that started in the late-1960s and has led to the discovery of several promising mineral deposits including the Chetwynd gold discovery.

NOVA SCOTIA

In 1985 the value of mineral production in Nova Scotia increased by 7.9 per cent from 1984 to $327 million, of which $169 million was for coal and $52 million for gypsum.

Contracts have been signed for a second tunnel at the Donkin-Morien mine of Cape Breton Development Corporation (CBDC). In other developments, Seabright Resources Inc. is contracting a 850 foot exploration shaft at its Forest Hill gold property. Seabright also purchased the Gays River mill from Esso Resources Canada Limited.

Rio Algom Limited started production at its $150 million tin mine near Yarmouth during October. This was almost coincident with the collapse of the tin market on the LME; however, the company has not announced any changes to its plans. Unless tin prices fall further, this mine should remain in production.

In October 1985, the federal and provincial governments announced a $1.8 million Mineral Investment Stimulation Program under the Canada-Nova Scotia Mineral Development Agreement. Financial incentives will be provided for

- advanced exploration or assessment of an established deposit
- mineral processing studies
- market studies and promotion
- specific studies related to production and management systems.

NEW BRUNSWICK

In 1985, New Brunswick's mineral production decreased by 10.2 per cent to $550 million, of which $292 million was for zinc, $42 million for lead, $52 million for silver and $29 million for coal. Although the mineral industry in New Brunswick was adversely affected by the general oversupply of mineral commodities and a soft demand condition in most world markets, a number of positive events occurred in 1985. These included: a new potash mine, the Denison-Potacan Potash Company underground mine, which started up in July at Salt Springs; the reopening of the Lake George antimony mine by Durham Resources Inc.; the construction of a pilot plant for a heap leach gold mining operation by Gordex Minerals Limited at Cape Spencer; and a great deal of activity in exploration, particularly in the northern area, for gold and silver. Also the effects of the Canada-New Brunswick Mineral Development Agreement (MDA) were being felt during the year.

In May, Enhanced Recovery Systems Ltd. opened a pilot plant near Chatham. The 10 tpd plant is to test the sulphation roast leach process developed by the New Brunswick Research and Productivity Council (RPC). The $18.75 million project, funded jointly by Canada and New Brunswick, is designed to improve the metal recoveries of fine grained complex sulphide ores like those found in northern New Brunswick. Continuous fully integrated trial runs of the plant using various feeds are expected to be completed during 1986.

In late-July, Billiton Canada Ltd. closed its Mount Pleasant tungsten mine, citing depressed tungsten prices and a poor long-term outlook as the main reasons. The operation never achieved the metal recoveries of tungsten and molybdenum originally expected when the project came on-stream in 1983. Lac Minerals Ltd. will explore the North Zone tin prospect near the Mount Pleasant mine site, under an agreement with Billiton.

In response to the general concern about the future of the Heath Steele Mines Limited operations, Premier Richard Hatfield appointed a Tripartite Task Force made up of representatives from the company, the United Steelworkers of America and the provincial government to make recommendations to the Minister of Natural Resources regarding the future of the mine. The Task Force submitted its Report to the Minister, the Honourable, M.N. MacLeod, who announced in October that as a result of deteriorating metal prices and current forecasts it would not be feasible to reopen the mine until at least 1987. However, under the Canada-New Brunswick MDA, a detailed study of the B and ACD ore zones has been initiated involving the company and the University of New Brunswick.

The first full year of the Canada-New Brunswick Mineral Development Agreement was under way during 1985. The $22.3 million accord is for a five-year period. Planned expenditures for activities presently in progress during 1985 amount to some $3.5 million. Major activities under way include geoscience projects, mining and minerals technology projects and economic development studies.

QUEBEC

In 1985, the value of mineral production in Quebec increased slightly from 1984 at $2.23 billion, of which $407 million was for gold, and $241 million for asbestos.

The mineral industry of Quebec, after many years of sustained growth, has entered, since 1981, a period characterized by mine closures, low levels of employment and investment, and low profitability of operations. This decline is attributable partly to the continuing effects of the world-wide recession and partly to structural changes that are affecting mineral markets, particularly for iron ore and asbestos. Although the industry reached the low point in 1983, a continued relatively weak performance can be expected as commodity markets around the world show few signs of recovery.

The mining industry in Quebec is diversified, with more than 15 minerals produced. On the other hand, about 60 per cent of production value derives from four minerals; gold, iron ore, asbestos and copper. Since 1980, the value of gold production has increased by 17 per cent, despite a major decline in price. However, the value of production of the other three minerals has fallen dramatically because of declining prices and volumes produced.

Mining is a major element in the economic base of northeastern and north-central Quebec, as well as the Gaspé and the Eastern Townships. Consequently, the general slowdown of the mining industry has had major regional impacts. Certain mining communities have lost part of their population and, in some cases, specifically Schefferville and Gagnon, towns have been virtually shut down.

Faced with the need to maintain some degree of economic activity in the more remote parts of the province, the Quebec government decided to invest heavily in the mining sector. Accordingly, through an assistance program designed to accelerate investment, Quebec has, during an eighteen month period in 1982-84, committed nearly $120 million to assist the mining sector. This is expected to generate mining investments of $600 million and create 4,500 temporary jobs and 2,000 permanent jobs. Some 18 projects, in the gold and base-metal sectors in particular, will benefit from this program.

A Mineral Development Agreement (MDA) was signed on July 5, 1985, by the federal and Quebec governments. Under the five-year MDA, $100 million will be spent, in cooperation with the private sector, to implement measures designed to stimulate mineral development and increase the mining industry's contribution to the province's economy. This major agreement indicates the willingness of both governments to make the mining industry a priority for economic development.

The mining industry will continue to make an important contribution to the economy of Quebec, but it will no longer be characterized by megaprojects such as development of the Labrador iron ore mines during the 1960s and 1970s. Rather, it will be characterized by the development of smaller, higher grade mines. These will likely be precious metal mines, base-metal mines containing significant precious metal byproducts or industrial mineral deposits. Because of the smaller size, the impact of each mine will be more localized at the community level.

ONTARIO

In 1985, the value of Ontario's mineral production was almost unchanged from 1984 at $4.56 billion. Of this amount, $968 million was for nickel, $554 million for copper, $519 million for uranium, $341 million for zinc and $440 million for gold. Nickel and gold showed small increases and uranium and zinc output fell slightly.

Despite the generally gloomy outlook for mining, the exploration industry was very active in Ontario during 1985. The main target was gold and activity was strong all across the province, with major exploration at Shoal Lake, Mishibishu Lake, Cameron Lake and in the Harker-Holloway area north of Kirkland Lake.

At Red Lake, Dickenson Mines Limited is to expand production from 700 tpd to 1 000 tpd by 1987, with further expansion under consideration. The Griffith iron ore mine, owned by Stelco Inc., is scheduled to close in April 1986, affecting about 280 persons. The impact on the Red Lake area in general, and the town of Ear Falls in particular, will be considerable.

In the Missanabie area, the Renabie gold mine continues to reduce operating costs, and exploration has led to discovery of a new zone on the property. In the same area, Canreos Minerals (1980) Limited and Anglo Dominion Gold Exploration Limited are shipping silica-gold ore to Kidd Creek Mines Ltd., for use as copper smelter fluxing material.

During the last year, interest has been shown in reprocessing tailings in the Timmins and Kirkland Lake areas.

Three mines came into production in 1985 at Hemlo. Noranda Inc.'s Golden Giant and Teck Corporation's Corona mines began gold production in April and May respectively, followed by Lac Minerals Ltd.'s Williams property in December. The impact of these developments is being felt in the neighbouring communities of Manitouwadge and Marathon. Within a few years, annual gold production from this region should reach 27 000 kg, and over a thousand jobs will have been created to add to the economic base of the region.

A continued weak price for zinc led to suspension of development at Corporation Falconbridge Copper's Winston Lake copper-zinc deposit near Terrace Bay, 225 km east of Thunder Bay.

The Detour Lake mine, about 140 km northeast of Cochrane, will cease open-pit operations in September, 1986. A 17-month shutdown is planned to further evaluate planned underground operations.

At Timmins, Kidd Creek Mines Ltd. is producing from the Owl Creek gold mine and is doing development work at the nearby Hoyle Pond gold deposit. Mill upgrading to process these ores will be completed in February, 1986. Crown-owned Kidd Creek Mines Ltd. was purchased by Falconbridge Limited under the federal government's privatisation program.

In December, Ontario Environmental Minister, the Honourable J. Bradley announced more stringent regulations to control acid rain. If these regulations are implemented, Ontario base-metal industries will be subjected to further pressures in addition to those of world overcapacity and low prices. Studies have estimated that modernization of the Sudbury smelters would cost up to $800 million.

In June 1985, a federal-provincial Mineral Development Agreement (MDA) was signed that calls for the expenditure of $30 million over the next five years. Projects planned under the MDA will be in geoscience, mining research and economic development. Community-centred geoscience programs, including mapping, deposit studies, geophysical and geochemical surveys, will be carried out around Ignace, Sudbury-Cobalt, Beardmore-Geraldton, Kenora-Fort Francis, Timmins-Chapleau and in eastern Ontario. Public access to geoscientific information will be improved. Research will be done in conjunction with companies in the Sudbury area into problems associated with deep mines, and studies will be made to assist small firm identify business opportunities in the industrial mineral industry. Road access from Kirkland Lake north to Highway 101 will be completed by construction of an access road through Harker and Holloway Townships.

The Ontario mineral industry is expected to experience continued weakness in 1986 especially if the demand for mineral commodities again falls off due to the predicted slowdown of the world economies. World-wide metal mining overcapacity and production will contribute to worsen the effects of the reduced demand.

MANITOBA

In 1985, the value of Manitoba's mineral production increased by 2 per cent from 1984 to $825 million, of which $266 million was for nickel, $180 million for crude petroleum, $133 million for copper and $80 million for zinc.

Base-metal mining provides the principal economic base for the northern communities of Flin Flon, Lynn Lake, Snow Lake, Leaf Rapids and Thompson. Low metal prices that have persisted since 1982 and declining ore reserves and grades have caused intermittent mine closures and the lay off of hundreds of employees. This has adversely impacted upon the northern mining communities, in particular, Lynn Lake, whose continued existence was in jeopardy because of the closure in November, 1985 of the Fox mine due to ore exhaustion, and Leaf Rapids, which was threatened because the Ruttan mine had become uneconomic.

In response, government and industry are taking measures to discover and develop new mineral deposits and reduce production costs at existing mines. At Lynn Lake, the MacLellan gold mine is being developed by SherrGold Inc. and will be staffed by approximately 160 former employees of the now closed Fox mine. The federal and provincial governments have provided assistance to this venture through the Canadian Jobs Strategy and the Manitoba Jobs Fund. Total investment will have reached approximately $40 million by the time the mine begins production in mid-1986 with a capacity of 70,000 oz./y of gold.

At Leaf Rapids, Sherritt Gordon Mines Limited is continuing to reduce production costs at its Ruttan mine. With the assistance of a provincial government loan, a deeper and higher grade ore zone has been developed. This new part of the mine is more highly mechanized, and capacity is being expanded from 1.6 million tpy to 2.0 million tpy.

During 1985, the second year of the five-year $24.7 million Canada-Manitoba Mineral Development Agreement (MDA) was completed. The MDA is intended to strengthen and diversify mineral development and production to aid the Manitoba economy, and northern mining communities in particular.

Geoscience activities included: Precambrian geological investigations; mineral investigations; geophysical surveys; geochemical surveys and glacial prospecting; and geological compilation. Mining and mineral processing research projects were initiated to improve productivity, mineral recovery and health and safety. Studies were initiated to determine the economic potential of industrial mineral deposits.

It is, however, mineral exploration and development by the private sector that is providing the most encouragement for an improving economic outlook for northern Manitoba. In the Flin Flon area, development is proceeding for a possible gold mine at Tartan Lake and a possible nickel-copper mine at Namew Lake. In the Snow Lake area, major zinc and precious metal finds are being explored at Morgan Lake; and in the Lynn Lake area, wide-spread gold mineralization has been discovered and is being explored.

The future is brighter at the Thompson nickel mining and smelting complex because of on-going efforts to lower operating costs. This is being achieved mainly by conversion to underground bulk mining methods and the development of an open-pit mine, which will reach full production in 1986. While employment levels will not be significantly affected, job security should be improved and the long-term viability of the Thompson operations enhanced.

Near Bissett, results are encouraging from an exploration program at the San Antonio gold mine, which has been shutdown since May 1983. Further work is still required. In the same area, Tantalum Mining Corporation of Canada Limited (TANCO) is building a plant to produce ceramic-grade spodumene concentrate from Bernic Lake ore. The plant will cost $6.4 million and employ 37 when fully operational.

The province and Canamax Resources Inc. are continuing with a feasibility study for the development of a potash mine near Russell. Manitoba is attempting to interest foreign governments to provide equity investment and a market for the potash that would be produced.

SASKATCHEWAN

In 1985, the value of Saskatchewan's mineral production increased by less than 1 per cent from 1984 to $3.78 billion. Of this amount, $2.35 billion was for crude petroleum, $438 million for uranium and $125 million for coal.

Potash sales have fallen since their partial recovery in 1984, resulting in intermittent layoffs. Uranium production has expanded as a result of the new Key Lake mine becoming fully operational. Mining of lignite coal, mainly used by nearby thermal electric generating stations to feed the provincial power grid, has been relatively stable.

Expansions are nearing completion at the Rabbit Lake uranium producing operation and the Lanigan potash mine. The Belle Plaine solution mining potash operation is being expanded by 25 per cent for completion in 1987.

In northern Saskatchewan, exploration for gold intensified during 1985, particularly in the La Ronge-Reindeer Lake-Flin Flon areas. Among the most promising deposits are those located at Waddy Lake, Laonil Lake, Sulphide Lake and Mallard Lake. At Star Lake, Saskatchewan Mining Development Corporation (SMDC) and partners are planning to develop a 220 tpd gold mine by 1987 at a cost of $13 million.

Farther north, exploration for uranium is continuing despite the current low price for this commodity. There are numerous active properties, the most significant is at Cigar Lake, where 110 000 tU in ore averaging 12 per cent U have been identified. Feasibility and environmental studies are under way.

In southern Saskatchewan, the Cory demonstration plant, which will utilize sodium sulphate and potassium chloride to produce potassium sulphate, has been completed. A feasibility study is under way for a 300 000 tpy potassium sulphate plant which would utilize sodium sulphate brine from Big Quill Lake. Also in the south, exploration for kaolin has identified deposits of 80 million t in the Wood Mountain area that could be brought into production by 1987.

The second year of the five-year $6.38 million Canada-Saskatchewan Mineral Development Agreement (MDA) was completed during 1985. Activities included: geological investigations, particularly for platinum and gold mineralization in the La Ronge and Rottenstone regions; studies of geological relationships in the Kisseynew terrain; airborne gradiometric surveys in the north-central region; a lake sediment sampling program; research on electrostatic separation of potash ore; and a study of the economic potential of building stone deposits.

In the latter half of the 1980s, the mineral industry in Saskatchewan will likely maintain its current contribution to the provincial economy, but, strong expansion is not expected. The potash industry will continue to experience relatively low to moderate prices and demand. Uranium exploration and development is expected to continue to receive world-wide attention because of favourable geology. Lignite coal production for consumption in nearby power stations will slowly increase.

ALBERTA

In 1985, the value of mineral production in Alberta was $27.34 billion. Of this amount, $15.76 billion was for crude petroleum, $7.27 billion for natural gas, $2.68 billion for natural gas byproducts, $851 million for sulphur and $458 million for coal.

Coal production, the principal mining activity in Alberta, is eclipsed in economic importance by the petroleum industry. However, it is important to the economy of a number of communities. The communities of Grande Cache, Edson and Hinton continued to be affected by intermittent layoffs at nearby mines because of reduced exports of thermal and coking coal, primarily to Japan.

The Smoky River coal mining operation of McIntyre Mines Limited at Grande Cache has been among the most affected as a result of diminished coal sales to Japanese steel mills, its traditional customers. The company has shut down its operation three times this year, affecting 350 employees, because of oversupply and weak demand for its metallurgical coal.

Mines supplying coal for domestic electric power generation continue to produce at increasing rates. New mines are under construction at Genesee, west of Edmonton, and at Sheerness, east of Drumheller. Weak offshore markets have resulted in deferral of several proposed coal projects.

In September, a new $22 million coal research centre was officially opened in Devon. The centre will house branches of the Alberta Research Council (ARC), the Canada Centre for Mineral and Energy Technology (CANMET) and the Coal Mining Research Centre. It was funded by the Alberta-Canada Energy Resources Research Fund. Research is focussed on: upgrading coal from lower grade deposits; increasing the efficiency of coal preparation; and increasing the efficiency and safety of coal mining operations. The complex includes a pilot plant, laboratories, mining equipment testing facilities, offices and a library.

Sulphur produced as a byproduct of sour natural gas is Alberta's other major non-petroleum mineral commodity. Demand has recovered since 1982 and prices are at record highs. Inventories are falling as a result of the continuing deficit in world production over world consumption.

BRITISH COLUMBIA

In 1985, the value of British Columbia's mineral production was $3.4 billion, up 1.8 per cent from 1984. Of this amount, $1.1 billion was for coal, $598 million for copper, $430 million for crude petroleum, $431 million for natural gas and $135 million for zinc. The increase in total value of production was mainly due to shipments from the northeast coalfields.

Employment in the mining industry dropped slightly from 16,600 in 1983 to 16,295 in 1984 according to the Mining Association of British Columbia. This continues a trend since 1981 when employment peaked at 20,240.

The March 14 provincial budget included a number of measures to strengthen the corporate sector. The most notable affects on the mining industry are:

- The phasing-out of the corporation capital tax over the next three years.
- The phasing-out of property taxes on machinery and equipment over the next three years.
- A gradual cut over three years in the school property tax rate applicable to industrial and commercial property from the present level of 3.4 times the residential rate to about twice the residential rate.
- A decrease in the tax rate on motor fuel for off-road use from rates of 10 to 20 per cent to 7 per cent.
- Water rental fees for the generation of hydro-electric power will be frozen for five years beginning in 1985.

As well in 1985, the provincial government established a Critical Industries Commission. The Commissioner acts as a mediator to obtain concessions on electrical power rates, municipal taxes and wages for operations that are closed or about to close. The Bell Copper mine and the Brenda mine were reopened with concession packages arranged by the Commissioner.

If Cominco Ltd. decides to construct a new lead smelter at Trail, the federal government has agreed to assist with the financing by purchasing $69 million in preferred shares. The planned smelter would produce 170 000 tpy of lead and 529 million g of byproduct silver and employ about 300 people. The existing lead smelter has a capacity of 132 000 tpy and 342 million g of silver.

On July 30 a Canada-British Columbia Mineral Development Agreement (MDA) was signed. The federal and provincial governments will each contribute $5 million over the next 5 years to three programs:

I Promotion of B.C. Mineral Potential,
II Financial Assistance for Mine Development, and
III Management, Public Information and Evaluation.

The first program will provide for geological surveys, geoscience data systems, and market intelligence, feasibility and technical studies. The second program will provide financial assistance for offsite infrastructure to new exploration and mine development projects.

NORTHERN CANADA

The Department of Indian Affairs and Northern Development (DIAND) released a consultation paper entitled "The Northern Mineral Sector: A Framework for Discussion". This should lead to a Northern Mineral Policy in 1986.

Northern Land Use Planning started in earnest in the Northwest Territories in 1985 with the approval of program funding in June. Two areas have been identified so far for initial planning. They are Lancaster Sound and the Mackenzie-Beaufort areas. The boundaries of these planning areas remain undefined, pending regional consultations in 1986.

Negotiations on native land claims were inactive for the first half of 1985 while the government conducted a policy review of the land claims process. In the fall, the Minister of DIAND agreed to exploratory discussions on some issues provided they did not pre-empt the claims policy review. The Tungavik Federation of Nunavut (TFN) and the Dene/Metis tabled papers for consideration and meetings between the native groups and the government claims negotiators resumed. The claims policy review was completed in December 1985 and the task force report was presented to the Minister. It is expected that the report will form the basis for consultations which will begin in 1986. These consultations will lead to a revised native land claims policy.

NORTHWEST TERRITORIES

Two mines closed in the Northwest Territories in 1985, leaving eight operating mines producing gold, silver, lead, zinc, cadmium, copper and tungsten. The mines that closed were small producers - the Terra silver mine and the Shear Lake gold mine of Cullaton Lake Gold Mines Ltd. - and, therefore, did not greatly affect the total mineral production capacity. Low metal prices continue to result in intermittent closures and cutbacks at various mines resulting in below capacity production. The value of mineral production in 1984 and 1985 remained constant at about $800 million.

Exploration expenditures were slightly higher in 1985 than the $40 million reported in 1984. Gold exploration accounted for about 60 per cent of the expenditures.

Although a number of new developments are on the horizon, including Terra Mines Ltd.'s Bullmoose gold property, Highwood Resources Ltd.'s Thor Lake beryllium - rare earth property, and Goldrich Resources Inc.'s Tom claims, the level of mineral production in the N.W.T. is very uncertain. Lead and zinc prices are very low and without significant improvement in sight, cutbacks or shutdowns can be expected at the Pine Point and Polaris mines.

YUKON

Mining activity in the Yukon in 1985 has been similar to that of the previous year. Both mine production and exploration activity remained modest compared with historical levels. This was the first year for work under the four-year Canada-Yukon Subsidiary Agreement on Mineral Resources signed on May 10, 1985.

Despite continuing low gold prices, placer mining remained strong with 190 operations, down only 5 from the previous year. No change is expected for 1986.

Although hardrock mining occurred at six sites during the year, only the Elsa mine of United Keno Hill Mines Limited produced significant ore. Employment, 184 people, was up from about 150 in 1984.

Mineral exploration activity increased in 1985. The Yukon Chamber of Mines estimates that $25 million to $30 million was spent on exploration, up about 15 per cent from 1984.

Mineral production and mining employment in the Yukon will change dramatically in the coming year with the reactivation of the Faro mine. Curragh Resources Corporation purchased the mine from Dome Petroleum Limited with an assistance package from the Territorial and federal governments. Also, two mines were under development during the year - The Mount Skukum gold mine and the Elsa silver mine of United Keno Hill Mines Limited.

On October 9 the Territorial government announced as part of its capital budget a new $1 million Yukon Mineral Development progam which will be used to promote exploration and development.

CANADA, PROVINCES AND TERRITORIES, LEADING MINERALS, 1984 and 1985

	Value of production		Proportion	Change
	1984f	1985p	of total	from 1984
	($ million)		(per cent)	(per cent)
Newfoundland				
Iron ore	851.4	835.6	90.1	-1.8
Zinc	59.9	37.6	4.0	-37.2
Asbestos	25.3	20.4	2.2	-19.4
Total	979.2	927.1	100.0	-5.3
Prince Edward Island				
Sand and gravel	.8	1.5	68.1	87.5
Total	1.9	2.2	100.0	15.8
Nova Scotia				
Coal	162.2	169.0	51.5	4.2
Gypsum	38.4	52.2	15.9	35.9
Sand and gravel	20.9	21.3	6.5	1.9
Cement	24.2	22.1	6.7	-8.7
Total	303.8	327.8	100.0	7.9
New Brunswick				
Zinc	327.5	292.8	53.2	-10.6
Lead	53.0	42.3	7.7	-20.2
Silver	75.6	52.2	9.5	-30.9
Coal	29.8	29.8	5.4	0.0
Total	612.9	550.3	100.0	-10.2
Quebec				
Gold	429.7	407.6	18.2	-5.1
Asbestos	278.6	241.1	10.8	-13.5
Cement	171.6	196.2	8.7	14.3
Total	2,167.1	2,236.8	100.0	3.2
Ontario				
Nickel	890.9	968.3	21.2	8.7
Copper	552.8	554.2	12.1	.3
Uranium	544.8	519.4	11.4	-4.7
Zinc	426.9	341.7	7.5	-19.9
Total	4,531.3	4,565.6	100.0	0.8
Manitoba				
Nickel	275.2	266.6	32.2	-3.1
Petroleum	169.8	180.4	21.7	6.2
Copper	127.8	133.9	16.2	4.7
Zinc	68.7	80.3	9.7	16.8
Total	812.2	828.5	100.0	2.0
Saskatchewan				
Petroleum	2,180.0	2,350.0	62.1	7.8
Potash	x	x	x	x
Uranium	356.8	438.2	11.6	22.8
Total	3,758.0	3,782.6	100.0	.6
Alberta				
Crude petroleum	14,987.2	15,786.9	57.7	5.3
Natural gas	7,332.7	7,278.5	26.6	-0.7
Natural gas byproducts	2,777.8	2,687.2	9.8	-3.2
Sulphur, elemental	591.8	851.7	3.1	43.9
Total	26,429.3	27,346.0	100.0	3.4

CANADA, PROVINCES AND TERRITORIES, LEADING MINERALS, 1984 and 1985 (Cont'd)

	Value of production		Proportion	Change
	1984f	1985p	of total	from 1984
	($ million)		(per cent)	(per cent)
British Columbia				
Coal	1,016.9	1,101.7	32.3	8.3
Copper	530.9	598.6	17.6	12.7
Petroleum	436.8	430.3	12.6	-1.4
Natural gas	436.1	431.7	12.7	-1.0
Total	3,345.6	3,406.4	100.0	1.8
Yukon Territory				
Gold	44.4	43.1	74.3	-2.9
Silver	18.8	12.6	21.7	-32.9
Sand and gravel	5.1	1.2	2.1	-76.4
Total	70.1	58.0	100.0	-17.2
Northwest Territories				
Zinc	386.8	341.9	40.5	-11.6
Gold	191.1	180.5	21.4	-5.5
Lead	66.6	44.8	5.3	-32.7
Total	777.1	843.8	100.0	8.5
Canada				
Petroleum	17,813.9	18,938.6	42.2	6.3
Natural gas	7,940.8	7,905.9	17.6	-0.4
Natural gas byproducts	2,849.8	2,747.9	6.1	-3.5
Coal	1,794.6	1,884.1	4.2	4.9
Iron ore	1,482.3	1,545.7	3.4	4.2
Zinc	1,495.2	1,316.8	2.9	-11.9
Copper	1,365.7	1,445.3	3.2	5.8
Gold	1,252.3	1,197.0	2.7	-4.4
Nickel	1,166.1	1,234.9	2.8	5.9
Uranium	901.5	957.6	2.1	6.2
Total	43,788.9	44,875.3	100.0	2.5

p Preliminary; x Confidential; f Final.

Canadian Reserves of Selected Mineral Commodities

(Data available in 1985)

J. ZWARTENDYK

Any assessment of future supply of a given mineral commodity from Canadian mines requires information on current working inventories, i.e., on the amounts of ore known to be present in operating mines and on additional known tonnages in deposits that are close to being mineable profitably. The tonnages that - in 1985 - were fairly well delineated and judged to be mineable are reported below as "reserves". The limits of what is included in reserves are further specified in each case.

	1985
(A) Copper	15 970 000 t[1]
Nickel	7 222 000 t
Lead	8 887 000 t
Zinc	26 204 000 t
Molybdenum	401 000 t
Silver	31 473 t
Gold	1 240 508 kg

The quantities of the metals listed above are contained in ore recoverable from current mines (including those "temporarily" closed) and from deposits that had been committed for production up to January 1, 1985.

These quantities represent proved and probable tonnages; any additional "possible" tonnages are not included.

[1] Metric tonne (2 204.62 pounds avoirdupois).

(B) Iron 1 775 million t

This is the quantity of iron contained in known crude ore in producing mines[2]. Ore in undeveloped deposits is not included.

(C) Asbestos 39.9 million t

This represents the fibre content (on average, a little over 5 per cent) of 722 million t of mineable ore reserves in producing mines.

(D) Potash 14 000 million t (K_2O equivalent), corresponding to 23 000 million t KCl product (standard fertilizer - exported product)

This amount would be recoverable by conventional mining (to a depth of about 1 100 m) from known potash deposits. At least an additional 42 000 million t (K_2O equivalent) would be recoverable from known deposits by solution mining at depths beyond 1 100 m; this would represent 69 000 million t of KCl product.

[2] Estimate updated to 1984 from "MR 170, A Summary View of Canadian Reserves and Additional Resources of Iron Ore", Energy, Mines and Resources Canada, 1977.

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(E) Uranium

	"Reasonably Assured"	
	Proven (Measured)	Probable (Indicated)
	(t U)	
Recoverable from mineable ore, at uranium prices of:		
$Cdn 100/kg U or less:	31 000	124 000
$100 to $150/kg U:	-	59 000

The tonnages refer to uranium recoverable from mineable ore[3]. Unless otherwise specified, uranium "reserves" in Canada refer to the tonnages mineable at uranium prices in the low range only.

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3 "Uranium in Canada: 1984 Assessment of Supply and Requirements", Sept. 1985, Energy, Mines and Resources Canada.

(F) Coal

- **Bituminous** 3 087 million t (of which 2 030 million t could be used for metallurgical purposes)
- **Sub-bituminous** 918 million t
- **Lignitic** 2 263 million t

These represent tonnages that could be profitably recovered as raw coal, given current technology and economics, from measured (proven) and indicated (probable) coal in deposits that are legally open to mining. For the purpose of making these estimates, it was assumed that coal sales would cover the costs of any required infrastructure not already in place[4].

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4 CANMET Report 83-2 OE, "Coal Mining in Canada: 1983", Energy, Mines and Resources Canada, 1984.

FIGURE 1

THE FLOW FROM RESOURCES TO RESERVES TO MINERAL SUPPLY

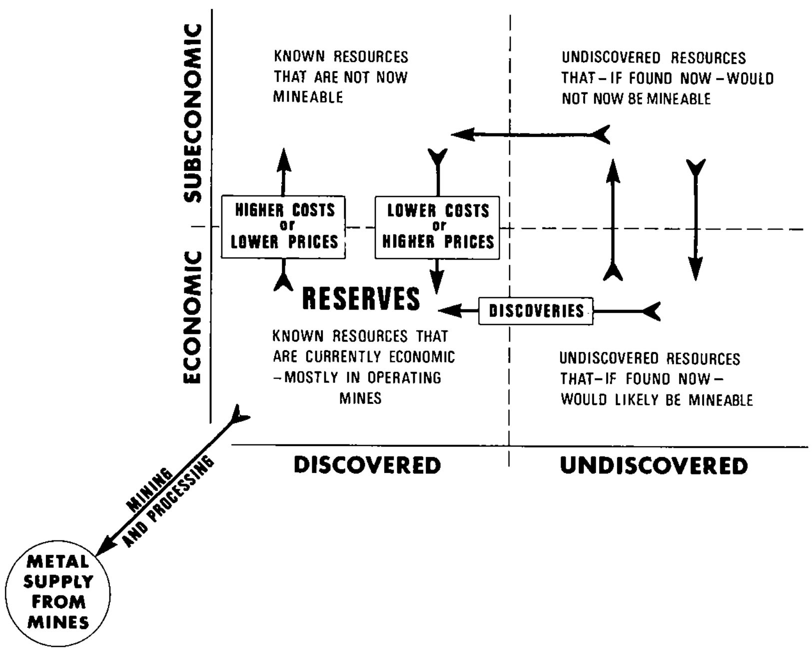
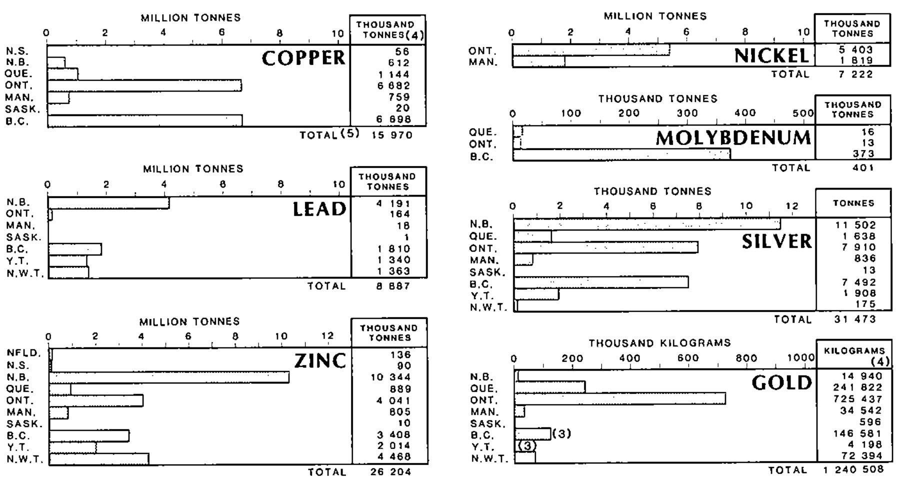


FIGURE 2

CANADIAN RESERVES OF COPPER, NICKEL, LEAD, ZINC, MOLYBDENUM, SILVER AND GOLD

Quantities of Metals Contained in Proven and Probable Mineable Ore (1) in Operating Mines and Deposits Committed for Production on January 1, 1985 (2)



(1) No allowance is made for losses in milling, smelting and refining.

(2) As well as in as yet unmined and uncommitted deposits if included in company reserves. Includes metal in deposits where production has been suspended indefinitely.

(3) Excludes metal in placer deposits.

(4) One tonne = 1.1023113 short tons. One kilogram = 32.150746 troy ounces

(5) Totals may not balance due to rounding at the provincial level. – Nil.

Canadian Reserves, Development and Exploration

ANDRÉ LEMIEUX, W.H. LAUGHLIN AND LO-SUN JEN

Table 1 illustrates the annually changing levels of Canadian reserves of seven major metals, in terms of the metal content of ore. These quantities were computed on the basis of information provided by mining companies. They pertain to ore tonnages that, as far as could be determined, were known at a level of assurance equivalent to "proven" (measured) and/or "probable" (indicated). Tonnages reported as "possible" (inferred) were not included. Table 2 shows a province-by-province breakdown for reserves on January 1, 1985.

While the term "reserves" is widely used to refer to that part of mineral resources that, on a given date, is well delineated and considered economically mineable, the reserves given here are confined to those in producing mines and in deposits that have been committed for production. These reserves constitute the reliable core of information. For other deposits, where concrete steps have not been taken by companies to prepare them for mining, judgments by outsiders regarding economic mineability would not form a consistent basis for reporting reserves. The purpose of the "reserves" restrictions used here is to avoid such subjective judgments.

The quantities of reserves reported cannot, by themselves, give any indication of whether or not Canada might be running out of economically mineable minerals. Future production will draw not only on the 1985 reserves but also on additional reserves yet to be developed -- from discoveries, from extensions to known orebodies and from known but currently marginal or uneconomic material.

Canada has a large number of potential supply sources that are less assured than current reserves. The most promising of these are listed in EMR's biennial mineral bulletin on Canadian reserves[1]. That publication tabulates the specific operations at which current reserves are reported. It lists also those deposits that are considered the likeliest for future development, with ratings on their relative promise. Another bulletin[1] deals with Canadian capability for metal production both from operating mines and from known deposits for which future production can be considered likely.

[1] André Lemieux and W.H. Laughlin, **Mine Reserves January 1985 and Currently Promising Deposits**, MR 209, Energy, Mines and Resources, Ottawa, in press.

GOLD

At the beginning of 1985, Canadian reserves of gold were 6 per cent higher than a year earlier. The dominant influence was the large addition to probable reserves (B Zone) reported by Lac Minerals Ltd. at its Williams mine in Hemlo, Ontario.

Reserves at two properties being prepared for production -- at BP Canada Inc.'s Selbaie mine (A-1 Zone) in Quebec, and at Kidd Creek Mines Ltd.'s Hoyle Pond deposit in Ontario -- were included for the first time in the national totals. Other noteworthy increases in reserves took place at two of Lac's producing properties in Quebec -- the Doyon mine (a joint venture with Société québécoise d'exploration minière (SOQUEM) and the Bousquet mine -- as well as at Dickenson Mines Limited and Sullivan Mines Inc.'s deposit in Ontario (the Arthur White mine). All of these additions, significant for individual mines, were small in comparison to the addition made at Hemlo.

During 1984, considerably more downward re-evaluations of reserves took place than were publicly announced. While some write-downs were based on purely technical data that became available during 1984, most appeared to involve the deletion of material no longer profitable to extract.

The largest downward re-evaluation of gold reserves took place at the Detour Lake mine in Ontario, a joint venture of Campbell

[1] André Lemieux, Lo-Sun Jen and W.H. Laughlin, **Canadian Mines: Perspective From 1985**, Energy, Mines and Resources, Ottawa, in preparation.

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Resources Inc. and Amoco Canada Petroleum Company Ltd. This single write-down of reserves was almost enough to cut the Hemlo gain in half.

SILVER

Overall, Canadian reserves of silver were about the same at the beginning of 1985 as they had been a year earlier. The largest gains resulted from the first-time inclusion in national totals of the large silver reserves in the Selbaie mine mentioned above, and from sizeable additions made to reserves at Cominco Ltd.'s Valley mine in British Columbia (from which silver is produced as a byproduct) and at the Brunswick Mining and Smelting Corporation Limited's No. 12 mine in New Brunswick. These gains were more than enough to offset the reserves mined and the reserves lost as a result of a number of sizeable downward re-evaluations and a few permanent mine closures during 1984.

ZINC

Canadian reserves of zinc were maintained at about the same levels from 1984 to 1985. The first-time inclusion in national totals of the zinc reserves from Selbaie (A-1 Zone) as well as material added to reserves at Cominco's Polaris mine in the Northwest Territories and at the No. 12 mine in New Brunswick were the major factors that more than offset the reserves mined out during 1984. But apparent re-evaluations of reserves that took place during the year, especially at one mine where the minimum grade of zinc ore profitably mineable was revised upward, consumed all of the gains.

COPPER

Canadian reserves of copper dropped only 1 per cent from 1984 to 1985. Overall, the amount added to metal reserves during the course of the year was more than enough to make up for the amount mined. Re-evaluation of reserves at a number of operations -- for example at Noranda Inc.'s Bell and Goldstream mines in British Columbia -- was the main cause of the slight decline in the national total.

As in the case of the other metals, there was considerable variation in net reserves changes from mine to mine. Increases in copper reserves occurred in about a quarter of the Canadian copper mines during 1984. The Valley mine again showed the largest net gains, followed by the Selbaie mine. In one-third of the deposits, only a portion of what was mined during the year was replaced. In the remainder, a portion of the mineralized material stopped being counted as reserves, or was written off on permanent closure.

NICKEL

Reserves of nickel in early-1985 were about 2 per cent lower than at the beginning of the previous year, because more metal was mined during 1984 than was replaced, and also because the underground portion of the Falconbridge Limited's mine in the Sudbury area was closed permanently as a result of difficult ground conditions.

LEAD

Reserves of lead also declined on the whole about 2 per cent from 1984 to 1985. The largest increases in lead reserves during the year were recorded at the No. 12 mine in New Brunswick and at the Polaris mine.

MOLYBDENUM

Molybdenum reserves were down 10 per cent from 1984 to 1985, a decline at almost the same rate as from 1983 to 1984. Additions to reserves were due almost totally to confirmation that Noranda, Goliath Gold Mines Ltd., and Golden Sceptre Resources Ltd. planned to recover molybdenum as a byproduct of their precious-metal operation at the Golden Giant mine at Hemlo. Re-evaluation of reserves was the largest contributor to the decline. Of the four British Columbia molybdenum producers that were closed throughout 1984, two wrote down their reserves. The largest such re-evaluation occurred at Placer Development Limited's Endako mine, where production has been suspended since 1982.

OUTLOOK

For reserves of these seven major metals, the outlook is not much different from last year's. Production at several major mines has been suspended indefinitely, in some cases since the early-1980s. Weak markets for their products make early resumption of production unlikely. For this reason, two reserves estimates are shown for 1986 -- one that includes the metal in mines that have been suspended indefinitely and one that does not. More mines are likely to close given the persistent weak markets.

Reserves of base-metals are unlikely to be built up substantially in the foreseeable future as long as the market and price outlook does not improve significantly. Should markets improve, some of the mineral material recently judged subeconomic might again be considered reserves, although some of it might become irretrievable by that time because of revised mining procedures.

The outlook for new commitments in 1986 to create additional production capability is not optimistic. This would suggest a decline in reserves in the near future. It is true that numerous gold properties are being actively developed, with many of the operators talking of production plans and announcing tentative production rates and capital costs, but only a few of these properties are expected to be in production soon, and all of these involve very modest outlays compared with the major expenditures committed over the past few years.

DEVELOPMENT

Figure 1(a) illustrates annual development expenditures since 1968. These have been consistently higher than the more widely publicized expenditures on exploration; the ratio of exploration to development expenditures fluctuates in the 0.5 to 0.8 range, Figure 1(b).

During 1984 a total of $873 million was spent on mine development. This record figure is due mainly to the rapid development of the three major new gold producers in Ontario's Hemlo area.

New commitments made in 1985 to develop additional capability for metal, ore and concentrate production in Canada amounted to $185 million; two-thirds of this was budgeted for gold developments. This is a sharp drop since 1983-84, a two-year span when new commitments amounted to nearly $2 billion because of several mega-projects, the likes of which were not launched during 1985 and none is expected to be during 1986.

In addition to such firm commitments to develop mines and build concentrators, many development projects were under consideration, with production objectives announced or reaffirmed during 1985. At the beginning of 1985 there were at least 40 such tentative projects with estimates of capital costs adding up to some $500 million. During 1985, many plans were changed and many new ones developed; by the end of the year, there were 43 tentative projects (21 listed for the first time) with capital costs of about $580 million. Gold projects dominate, accounting for 36 of the total 43.

The outlook for new deposits remains promising. Canadian mineral deposit discoveries have been at a high level for many years. The Department of Energy, Mines and Resources maintains a close watch on potential resources in Canada. Table 3 lists a selection of more than 130 deposits, from the many thousands that have been discovered over the years, that are particularly promising.[1] These selections were based upon the evaluation of cumulative exploration and development efforts made to date, tonnages, metal grades, the availability of infrastructure, and the probable mining methods. Each deposit selected as promising for future production was rated on a scale of 1 to 3, with 3 signifying the greatest relative promise. Because the information available on individual deposits varies greatly, this rating is largely subjective. Other deposits that may be widely regarded as promising are not included because the owners have not released sufficient information or because the deposit is not yet adequately outlined.

EXPLORATION

Between 1,200 and 1,500 companies are active in grassroots exploration for metallic minerals in Canada. Fewer than 15 per cent of these are mining companies with producing mines and these companies' affiliates, but these account for well over one-half of all expenditures on such exploration in Canada.

Figure 2 illustrates exploration activity in Canada expressed in terms of three yardsticks: total expenditures, new claims recorded and surface diamond drilling.[2] From 1983 to 1984, overall exploration expenditures rose 26 per cent; claim staking fell 23 per cent; and surface diamond drilling rose 35 per cent.

Exploration Expenditures. After two successive years of decline, exploration expenditures rebounded in 1984. Major contributors to the upsurge were Quebec (23

[1] André Lemieux and W.H. Laughlin, op. cit.

[2] Oil and gas are not covered by these mineral exploration statistics. In the case of new claims recorded, coal is excluded as well.

per cent rise) and Ontario (37 per cent rise). These two provinces alone accounted for nearly 50 per cent of total expenditures in Canada. Other regions with impressive gains were Manitoba, the Yukon and the Northwest Territories.

Preliminary information suggests that exploration expenditures fell slightly in 1985. Only Newfoundland, Quebec and Manitoba are expected to show gains when the data are complete. Modest declines are expected in Ontario, British Columbia, the Yukon and Northwest Territories.

Whereas gold has been credited with whatever buoyancy there has been regionally in recent years, the main contributor to growth in exploration activity is now identified as the flow-through shares market. This has attracted an unexpectedly high level of investment because of the tax deduction benefits it has made available to a wider spectrum of investors.

Claim Staking. There was a drop in total area of new claims staked in Canada during 1984 as compared with 1983, amounting to 22 per cent. The only regions to show gains were Newfoundland (145 per cent), Manitoba (16 per cent) and the Yukon (77 per cent). The greatest decline was in Saskatchewan where, for the second year in a row, new claim acquisitions dropped by about 50 per cent.

For 1985, preliminary data show that staking again declined nationally (6 per cent) due principally to a large decrease in British Columbia. This province dominates all other regions in Canada in terms of new claims staked. In the years 1982-85, British Columbia accounted for 30 to 45 per cent of all new claims; changes up or down are similarly large-scale. Thus, while significant gains were made in the Atlantic Provinces, Quebec, Saskatchewan and the Northwest Territories from 1984 to 1985, on a national count these gains were submerged in the 38 per cent drop in British Columbia.

Diamond Drilling. In 1984 there was a 30 per cent increase in surface diamond drilling compared with the 1983 Canadian total. Major increases were reported from Newfoundland (281 per cent), Quebec (169 per cent) and British Columbia (103 per cent). Ontario, while showing a gain of only 7 per cent, dominated the drilling activity (as it did in 1983) with 48 per cent of the surface drilling reported in Canada.

Exploration activities in 1984 and 1985 were sustained by interest in gold. While Ontario's Hemlo camp generated most of the exploration news in 1981-82, all provinces except Prince Edward Island and Alberta have since then recorded gold discoveries and gold-property developments constituting headline news. These activities were doubtless spurred on by the rapidity with which the Hemlo discoveries were brought to production. The principal areas of recent gold discoveries and developments are: Cinq Cerf (Newfoundland); Casa-Berardi (Quebec); Harker-Holloway townships (Ontario); Tartan Lake (Manitoba); La Ronge - Reindeer Lake (Saskatchewan); Lawyers' and Sulphurets (British Columbia); and Mount Skukum (Yukon).

A federal-provincial survey for 1984 showed that exploration expenditures in Canada were distributed as follows:

Precious metals	55 per cent
Copper, zinc, lead	27 per cent
Other metals	13 per cent
Nonmetallic minerals	5 per cent

As exploration in Canada is so heavily concentrated on gold these days, the outlook for exploration in 1986 depends heavily on the expected price movements of gold. Currently, most analysts of metal price trends believe that there is little danger of the price falling below $US 300 per ounce in the foreseeable future. Investors in gold exploration appear to share this confidence, so that this activity is likely to remain strong in 1986.

TABLE 1

CANADIAN RESERVES, 1977-85 AND ESTIMATES FOR 1986

Quantities of Metals Contained in Proven and Probable Mineable Ore[1]
In Operating Mines and Deposits Committed for Production on January 1[2]

Metal	Units[3]	1977	1978	1979	1980	1981	1982[4]	1983[4]	1984[4]	1985[4]	1986[4,5]	1986[5,6]
Copper	000 t	16 634	16 471	15 840	16 405	16 831	15 815	17 022	16 163	15 970	15 900	15 000
Nickel	000 t	7 326	7 389	7 070	7 245	8 304	8 013	7 581	7 339	7 222	7 200	7 200
Lead	000 t	9 028	8 934	8 911	9 557	10 119	10 244	9 029	9 048	8 887	8 800	8 500
Zinc	000 t	27 407	26 908	26 452	28 635	29 436	29 505	26 077	26 371	26 204	26 800	25 800
Molybdenum	000 t	377	384	462	554	550	514	494	446	401	400	130
Silver	t	30 490	29 085	29 398	31 564	33 614	32 154	31 381	31 359	31 473	32 400	30 700
Gold[7]	kg	396 012	366 421	409 582	540 493	769 889	842 215	837 707	1 166 677	1 240 508	1 343 500	1 316 000

[1] No allowance is made for losses in milling, smelting and refining. [2] As well as in as yet unmined and uncommitted deposits if included in company reserves. [3] One tonne = 1.1023113 short tons. One kilogram = 32.150746 troy ounces. [4] Includes metal in mines where production has been suspended indefinitely. [5] Includes metal in deposits expected to be committed for production by year-end 1985. [6] Excludes metal in mines where production has been suspended indefinitely. [7] Excludes metal in placer deposits.

TABLE 2

CANADIAN RESERVES BY PROVINCE

Quantities of Metals Contained in Proven and Probable Mineable Ore[1]
In Operating Mines and Deposits Committed for Production on January 1, 1985[2]

Metal	Units[3]	Nfld.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	B.C.	Y.T.	N.W.T.	Canada[5]
Copper	000 t	-	56	612	1 144	6 682	759	20	6 698	-	-	15 970
Nickel	000 t	-	-	-	-	5 403	1 819	-	-	-	-	7 222
Lead	000 t	-	-	4 191	-	164	18	1	1 810	1 340	1 363	8 887
Zinc	000 t	136	90	10 344	889	4 041	805	10	3 408	2 014	4 468	26 204
Molybdenum	000 t	-	-	-	16	12	-	-	373	-	-	401
Silver	t	-	-	11 502	1 638	7 910	836	13	7 492	1 908	175	31 473
Gold[4]	kg	-	-	14 940	241 822	725 437	34 542	596	146 581	4 198	72 393	1 240 508

[1] No allowance is made for losses in milling, smelting and refining. [2] As well as in as yet unmined and uncommitted deposits if included in company reserves. Includes metal in mines where production has been suspended indefinitely. [3] One tonne = 1.1023113 short tons. One kilogram = 32.150746 troy ounces. [4] Excludes metal in placer deposits. [5] May not balance due to rounding at the provincial level.
- Nil.

TABLE 3

TONNAGES AND GRADES OF ADDITIONAL DEPOSITS CONSIDERED IN LATE-1985 MOST PROMISING FOR FUTURE PRODUCTION

1. Individual deposits have been assigned one, two, or three stars on the basis of: (a) state of exploration and development, (b) tonnage and grade reported publicly, (c) available infrastructure, and (d) mining method and other factors affecting viability. In this judgment of relative merits, three stars imply the highest promise.
2. Where two or more companies are identified with a deposit, the first is the operator.

COMPANY AND DEPOSIT	TONNAGE	GRADE Cu	Ni	Pb	Zn	Mo	Ag	Au
	tonnes[1]	%	%	%	%	%	g/t	g/t
NEWFOUNDLAND								
BP Canada Inc. Chetwynd * * *	11 200 000	-	-	-	-	-	-	4.54[2]
Mascot Gold Mines Limited Cape Ray *	630 500	-	-	-	-	-	14.98	8.02
NOVA SCOTIA								
Barymin Explorations Limited Yava	680 000	-	-	5.46	-	-	n.a.	-
Northumberland Mines Limited Inco Limited Cochrane Hill * * *	907 200	-	-	-	-	-	-	2.06[2]
Seabright Resources Inc. Forest Hill *	272 000	-	-	-	-	-	-	18.86
Gays River *	982 000	-	-	5.4	9.4	-	-	-
NEW BRUNSWICK								
Anaconda Canada Exploration Ltd. Cominco Ltd. Caribou-Chaleur Bay Mine * * *	37 000 000	0.47	-	1.70	4.48	-	58.63	1.37
Cominco Ltd. Stratmat 61 (Tomogonops) * *	2 050 000	0.59	-	2.44	6.29	-	31.90	-
Gordex Minerals Limited Cape Spencer * * *[3]	671 300	-	-	-	-	-	-	3.29

Heath Steele Mines Limited North Boundary * *	453 600	-	-	3.70	8.30	-	-	-
Tomogonops Extension * *	544 300	0.5	-	3.50	9.60	-	78.86	-
Key Anacon Mines Limited Middle Landing *	1 690 000	0.20	-	3.03	7.43	-	91.54	-
Lincoln Resources Inc. Placer Development Limited Third Portage Lake * *	2 721 600	-	-	4.6	5.9	-	102.86	n.a.
Northumberland Mines Limited Kennecott Minerals Company Murray Brook * *	23 700 200	0.48	-	0.86	1.95	-	28.46	0.31
Texasgulf Inc. Bay Copper Mines Limited Halfmile Lake * *	12 350 000	0.19	-	2.52	7.50	-	30.86	-
QUEBEC								
Abcourt Mines Inc. Abcourt/Barvue (Barraute) * *	2 250 000	-	-	-	4.14	-	173.50	-
Amberquest Resources Ltd. New Goldcore Ventures Ltd. Société québécoise d'exploration minière (SOQUEM) Rouyn Merger/Heva (Joannès) *	1 650 000	-	-	-	-	-	-	5.95
Augmitto Explorations Limited Durbar (Beauchastel) * *	382 000	-	-	-	-	-	-	5.50[2]
Aur Resources Inc. Orenada No. 4 (Bourlamaque) * *	672 000	-	-	-	-	-	-	5.50
Devlin (Obalski) *	1 270 000	2.24	-	-	-	-	-	-
Main Mine Pillar (Obalski) *	209 000	1.48	-	-	-	-	-	0.75
Merrill Island (Obalski) *	2 000 000	0.85	-	-	-	-	-	0.10
S-3 (Lemoine/Roy) * * *[3]	352 000	0.54	-	-	-	-	-	6.34
Campbell Resources Inc. Meston Lake Resources Inc. Joe Mann (Rohault) * * *	762 000	0.39	-	-	-	-	-	6.86
Corporation Falconbridge Copper Ansil (Duprat) * * *	2 100 000	7.18	-	-	0.57	-	24.0	1.72

COMPANY AND DEPOSIT	TONNAGE	GRADE Cu	Ni	Pb	Zn	Mo	Ag	Au
	tonnes[1]	%	%	%	%	%	g/t	g/t
QUEBEC (cont'd)								
Dassen Gold Resources Ltd.								
Russian Kid (Dasserat) * *	1 200 000	-	-	-	-	-	-	8.57
Dome Mines, Limited								
Western Quebec Mines Co. Ltd.								
K-Zone Extension (Vassan) *	1 150 000	n.a.	-	-	-	-	-	4.11
D'Or Val Mines Ltd.								
Beacon/LeRoy (Louvicourt) * *	417 000	-	-	-	-	-	-	6.20
Falconbridge Limited								
Callaghan (Dubuisson) * *	2 300 000	-	-	-	-	-	-	6.51
Goldex Mines Limited								
Probe Mines Limited								
Dalton/Probe (Dubuisson) *	792 000	-	-	-	-	-	-	8.33[2]
Inco Limited								
Golden Pond (Casa Berardi) *	2 700 000	-	-	-	-	-	-	6.86
Golden Pond East * * *	2 800 000	-	-	-	-	-	-	7.20
Jonpol Explorations Limited								
Conigo (Dalquier) *	740 000	1.25	-	-	3.2	-	121.7	0.41
	1 766 000	1.26	-	-	-	-	0.7	-
Kewagama Gold Mines (Quebec) Ltd.								
CSA Minerals Corp.								
Granada-Rouyn (Rouyn) * *	320 000	-	-	-	-	-	-	12.0
Lac Minerals Ltd.								
Société québécoise d'exploration minière								
Doyon West (Bousquet) * * *	365 000	-	-	-	-	-	-	11.32
Louvem Mining Company Inc.								
Société québécoise d'exploration minière								
Chimo (Vauquelin) * * *[3]	862 000	-	-	-	-	-	-	8.57
Pascalis North (Pascalis) * *	571 000	-	-	-	-	-	-	9.60
New Quebec Raglan Mines Limited								
Falconbridge Limited								
Four main deposits (Ungava)	11 000 000	0.79	3.11	-	-	-	-	-
Cross Lake, C-1 and C-2	9 000 000	0.78	1.53	-	-	-	-	-

Noranda Inc. Nuinsco Resources Limited New Insco (Hébécourt) *	966 000	2.40	-	-	-	-	0.50[e]	-
Noranda Inc. Magusi River (Hebecourt) *	3 730 000	1.20	-	-	3.55	-	31.20	1.10
La Gauchetière * *	1 600 000	0.9	-	-	4.5	-	15.43	-
Northgate Mines Inc. Bateman Bay (McKenzie) * * *	680 000	1.76	-	-	-	-	13.71	3.38
Copper Rand No. 3 (McKenzie) * (Quebec Chibougamau)	460 000	2.2	-	-	1.2	-	17.14	-
Norbeau (McKenzie) * *	750 000	-	-	-	-	-	-	6.17
Perron Gold Mines Ltd. Noranda Exploration Company, Limited Sleeping Giant (Chaste) * *	1 043 000	-	-	-	-	-	-	8.92
Placer Development Limited Eldor Resources Limited Eastmain River	1 350 000	0.22	-	-	-	-	12.34	10.30
Preussag Canada Limited Corner Bay Explorations Ltd. Corner Bay (Obalski)	1 770 000	4.25	-	-	-	-	14.06	0.34
Audrey Resources Inc. Corporation Falconbridge Copper Mobrun (Dufresnoy) * *	3 630 000	0.70	-	-	2.20	-	21.60	1.78
Société québécoise d'exploration minière Pascalis South No. 1 *	350 000	-	-	-	-	-	-	6.17
Société québécoise d'exploration minière Sullivan Mines Inc. Eldrich/Flavrian (Duprat) * * *	1 250 600	-	-	-	-	-	-	5.94[2]
Sullivan Mines Inc. Dominion Explorers Inc. Croinor-Abigold (Pershing) *	386 000	-	-	-	-	-	-	5.50
Yorbeau Resources Inc. Ellison A-Zone (Bousquet) * *	781 000	-	-	-	-	-	-	7.03
Ellison C-Zone	1 500 000	-	-	-	-	-	-	10.29
Yorbeau Resources Inc. Energy & Resources (Cam) Limited Astoria (Rouyn) *	1 252 000	-	-	-	-	-	-	5.83

COMPANY AND DEPOSIT	TONNAGE	GRADE Cu	Ni	Pb	Zn	Mo	Ag	Au
	tonnes[1]	%	%	%	%	%	g/t	g/t
ONTARIO								
The Coniagas Mines, Limited Anglo Dominion Gold Exploration Limited Nudulama mine * *	454 000	-	-	-	-	-	-	5.01
Barrick Resources Corporation Lenora Explorations Ltd. McDermott * * *	1 180 000	-	-	-	-	-	-	6.17[2]
Canamax Resources Inc. CSA Minerals Corp. Bell Creek (3 Zones) * * *	1 103 000	-	-	-	-	-	-	6.11[2]
Canamax Resources Inc. Kremzar Gold Mines, Limited Kremzar * * *	790 000	-	-	-	-	-	-	7.89
Canamax Resources Inc. Procan Exploration Company Holloway Twp. - Mattawasaga	907 000	-	-	-	-	-	-	3.43
- East Zone * *	173 000	-	-	-	-	-	-	7.54
Corporation Falconbridge Copper Zenmac Explorations Limited Winston Lake * * *	3 100 000	1.0	-	-	16.1	-	32.57	1.06
Dome Mines, Limited Campbell Red Lake Mines Limited Dona Lake * * *	1 340 000	-	-	-	-	-	-	7.89
Dome Mines, Limited Inco Limited, et. al. Opapimiskau *	2 903 000	-	-	-	-	-	-	5.80[2]
Echo Bay Mines Ltd. Nuinsco Resources Limited Cameron Lake * *	1 452 000	-	-	-	-	-	-	5.49
Emerald Lake Resources Inc. Place Gas & Oil Company Limited Golden Rose * * *[3]	1 724 000	-	-	-	-	-	1.27[e]	7.0
Esso Resources Canada Limited Wilanour Resources Limited Wilmar * *	3 520 000	-	-	-	-	-	-	3.57

Getty Mines, Limited Davidson Tisdale Mines Limited Davidson Tisdale * * *	771 000	-	-	-	-	-	-	12.34
Golden Shield Resources Ltd. Mirado Nickel Mines Limited Cathroy-Larder *	395 000	-	-	-	-	-	-	7.0
Jerome Gold Mines Corporation E.B. Eddy Forest Products Ltd. Jerome	530 000	-	-	-	-	-	1.72	6.86[2]
Muscocho Explorations Limited Trans-Provincial Resources Inc. Magino * *	245 000	-	-	-	-	-	-	7.54[2]
Noranda Exploration Company, Limited Band-Ore Gold Mines Limited Shebandowan *	590 000	-	-	-	-	-	7.71	4.80
Northgate Exploration Limited Orofino Resources Limited Orofino mine * *	726 000	-	-	-	-	-	-	7.20[2]
Phoenix Gold Mines Limited McFinley Red Lake Mines Limited McFinley (Red Lake) * *	387 000	-	-	-	-	-	37.37	15.09
Prairie Pacific Energy Corporation Pango Gold Mines Limited Surluga mine * * *	1 452 000	-	-	-	-	-	-	4.80[2]
St. Andrew Goldfields Ltd. Quebec Sturgeon River Mines Limited St. Andrew mine * * *	668 000	-	-	-	-	-	-	4.63
Union Carbide Canada Limited Consolidated Professor Mines Limited Duport mine * * *	625 000	-	-	-	-	-	-	12.12
Union Minière Canada Limited Thierry (Pickle Lake)	9 000 000	1.6	0.16	-	-	-	-	-
Vedron Limited Vedron-Tisdale-Romfield * * *	745 000	-	-	-	-	-	-	5.14
MANITOBA								
Barrick Resources Corporation Zenco Resources Inc. Squall Lake *	681 000	-	-	-	-	-	-	3.43

COMPANY AND DEPOSIT	TONNAGE	GRADE Cu	Ni	Pb	Zn	Mo	Ag	Au
	tonnes[1]	%	%	%	%	%	g/t	g/t
MANITOBA (cont'd)								
Gränges Exploration Ltd. Aberford Resources Ltd. Tartan Lake * * *	726 000	-	-	-	-	-	-	15.43
Gränges Exploration Ltd. Homestake Mining Company Maverick Mountain Resources Limited Puffy Lake *	604 000	-	-	-	-	-	n.a.	6.52
Hudson Bay Mining and Smelting Co., Limited Namew Lake	2 851 000	0.90	2.44	-	-	-	-	-
Hudson Bay Mining and Smelting Co., Limited Nor-Acme Gold Mines, Limited Nor-Acme mine * *	2 511 000	-	-	-	-	-	-	5.49
Sherritt Gordon Mines Limited Agassiz Resources Ltd. MacLellan mine (Main Zone) * * *[3]	1 815 000	-	-	-	-	-	17.83	6.03[2]
SASKATCHEWAN								
Canadian Premium Resource Corporation Mahogany Minerals Resources Inc. Mallard Lake (three zones) * *	313 000	-	-	-	-	-	-	17.83
Golden Rule Resources Ltd. Saskatchewan Mining Development Corporation Weedy Lake * *	998 000	-	-	-	-	-	-	4.46
Gränges Exploration Ltd. Saskatchewan Mining Development Corporation Bigstone Lake *	3 357 000	2.11	-	-	1.89	-	9.94	0.45
Placer Development Limited Claude Resources Inc. Seabee (Laonil Lake) * * *	1 016 000	-	-	-	-	-	-	10.97[2]
Placer Development Limited Waddy Lake Resources Inc. Komis Zone * *	1 500 000	-	-	-	-	-	-	5.14
Saskatchewan Mining Development Corporation Starrex Mining Corporation Ltd. Star Lake (21 Zone) * * *	210 000	-	-	-	-	-	-	17.14[2]

BRITISH COLUMBIA

Cominco Ltd. Jersey Pit * *	42 800 000	0.42	-	-	-	0.004[e]	-	-
Consolidated Cinola Mines Ltd. Misty Gold Inc. Graham Island (open pit) *	7 000 000	-	-	-	-	-	3.43	3.43
Cyprus Anvil Mining Corporation Hudson's Bay Oil and Gas Company Limited Cirque * *	21 700 000	-	-	2.7	9.0	-	57.0	-
Dolly Varden Minerals Inc. North Star, Torbrit and Wolf * *	775 000	-	-	0.53	0.82	-	316.11	-
Dome Mines, Limited QR (Cariboo District) *	862 000	-	-	-	-	-	-	6.79
Esso Minerals Canada Sumac Mines Ltd. Kutcho Creek *	15 700 000	1.69	-	-	2.16	-	27.7	0.38
International Corona Resources Ltd. Mascot Gold Mines Limited Nickel Plate (open pit) * * *	3 500 000	-	-	-	-	-	-	5.21[2]
(underground)	1 361 000	-	-	-	-	-	-	6.86
Invermay Resources Inc. Ruth Vermont *	274 000	-	-	4.8	5.4	-	233.14	-
Kerr Addison Mines Limited Consolidated Barrier Reef Resources Ltd. Blackdome * * *[3]	184 200	-	-	-	-	-	128.9	27.10[2]
Mascot Gold Mines Limited Bralorne Resources Limited E & B Explorations Ltd. Bralorne mines * * *	960 000	-	-	-	-	-	-	9.26
Nanisivik Mines Ltd. Canamax Resources Inc. Procan Exploration Company Regional Resources Ltd. Midway * * *	6 078 000	-	-	6.62	12.14	-	394.97	1.03
Serem Inc. Agnico-Eagle Mines Limited Sudbury Contact Mines, Limited Lawyers * * *	1 270 000	-	-	-	-	-	229.72	6.17

COMPANY AND DEPOSIT	TONNAGE	GRADE Cu	Ni	Pb	Zn	Mo	Ag	Au
	tonnes[1]	%	%	%	%	%	g/t	g/t
BRITISH COLUMBIA (cont'd)								
Teck Corporation Pacific Cassiar Limited Porter-Idaho/Prosperity * * *	827 000	-	-	2.0^{e}	3.0^{e}	-	668.57	0.52^{e}
Westmin Resources Limited British Silbak Premier Mines Limited Silbak Premier * * *	4 536 000	n.a.	-	n.a.	n.a.	-	110.4	2.43
Westmin Resources Limited Tournigan Mining Explorations Ltd. Big Missouri *	1 966 000	-	-	-	-	-	-	3.36
YUKON TERRITORY								
Aberford Resources Ltd. Brinco Mining Limited, et. al. Jason *	14 062 000	-	-	7.09	6.57	-	56.60	-
Amoco Canada Petroleum Company Ltd. Tintina Mines Limited Red Mountain	21 300 000	-	-	-	-	0.176	-	-
Arctic Red Resources Corp. Ark La Tex Petroleum Corporation Discovery Mines Limited LaForma *	134 000	-	-	-	-	-	-	15.10
Canamax Resources Inc. Mt. Hundere * *	2 023 000	-	-	8.7	14.1	-	72.0	-
Canamax Resources Inc. Pacific Trans-Ocean Resources Ltd. Ketza River Mines Limited Iona Industries Inc. Peel and Ridge * * *	460 000	-	-	-	-	-	-	9.60
Key and Stump	175 000	-	-	12	-	-	583.0	-
Chevron Minerals Ltd. B.Y.G. Natural Resources Inc. Mt. Nansen * *	270 000	-	-	-	-	-	364.22	13.06

Cyprus Anvil Mining Corporation DY Zone	21 000 000	-	-	5.6	6.9	-	85.03	-
Swim Lake deposit	4 536 000	n.a.	-	4.0	5.5	-	51.43	n.a.
Erickson Gold Mines Ltd. AGIP Canada Ltd. Mt. Skukum * * *3	165 000	-	-	-	-	-	21.60	25.03[2]
Hudson Bay Mining and Smelting Co., Limited Tom deposit *	8 000 000	-	-	8.6	8.4	-	96.0	-
International Prism Exploration Ltd. Chieftain Development Co. Ltd., et. al. Vera (Kathleen Lakes) * *	1 361 000	-	-	3.0	3.0	-	308.57	-
United Keno Hill Mines Limited Venus * *	88 000	-	-	2.9	1.6	-	370.0	9.40
NORTHWEST TERRITORIES								
Cadillac Explorations Limited Prairie Creek (No. 3 Zone) * *	1 452 000	0.44	-	11.16	12.17	-	190.0	n.a.
Canuc Resources Inc. Coronation Gulf *	760 000	-	-	-	-	-	-	7.21
Cominco Ltd. Bathurst Norsemines Ltd. Hackett River * *								
East Cleaver Lake	3 630 000	0.46	-	1.04	7.07	-	183.1	0.48
Boot Lake Zone	4 540 000	0.29	-	0.99	4.97	-	200.9	1.71
Main "A" group	3 630 000	0.25	-	1.4	8.5	-	240.0	1.71
Total for seven deposits	19 100 000	0.41	-	0.75	4.98	-	149.8	0.45
Discovery Mines Limited Hydra Explorations Limited Baton Lake *	11 800 000	-	-	-	-	-	-	2.91
Kidd Creek Mines Ltd. Izok Lake *	11 023 000	2.8	-	1.4	13.77	-	70.3	-
Redstone Resources Inc. Coates Lake *	33 566 000	3.9	-	-	-	-	11.3	-
Terra Mines Ltd. Duke (Bullmoose Lake) * *	650 000	-	-	-	-	-	-	11.31[2]
Westmin Resources Limited Du Pont Canada Inc. Seven zones	7 260 000	-	-	3.3[e]	7.0[e]	-	-	-

[1] One tonne = 1.1023113 short tons; 1 gram per tonne (g/t) = 0.02916668 troy ounces per short ton. [2] Gold grade reported as "cut grade" (high sample assays reduced to standard level before calculation of overall grade). Does not imply that the grades in other gold deposits are uncut.
[3] Committed for production after January 1, 1985.
n.a. Not available; - Nil; [e] Author's estimate.

FIGURE 1

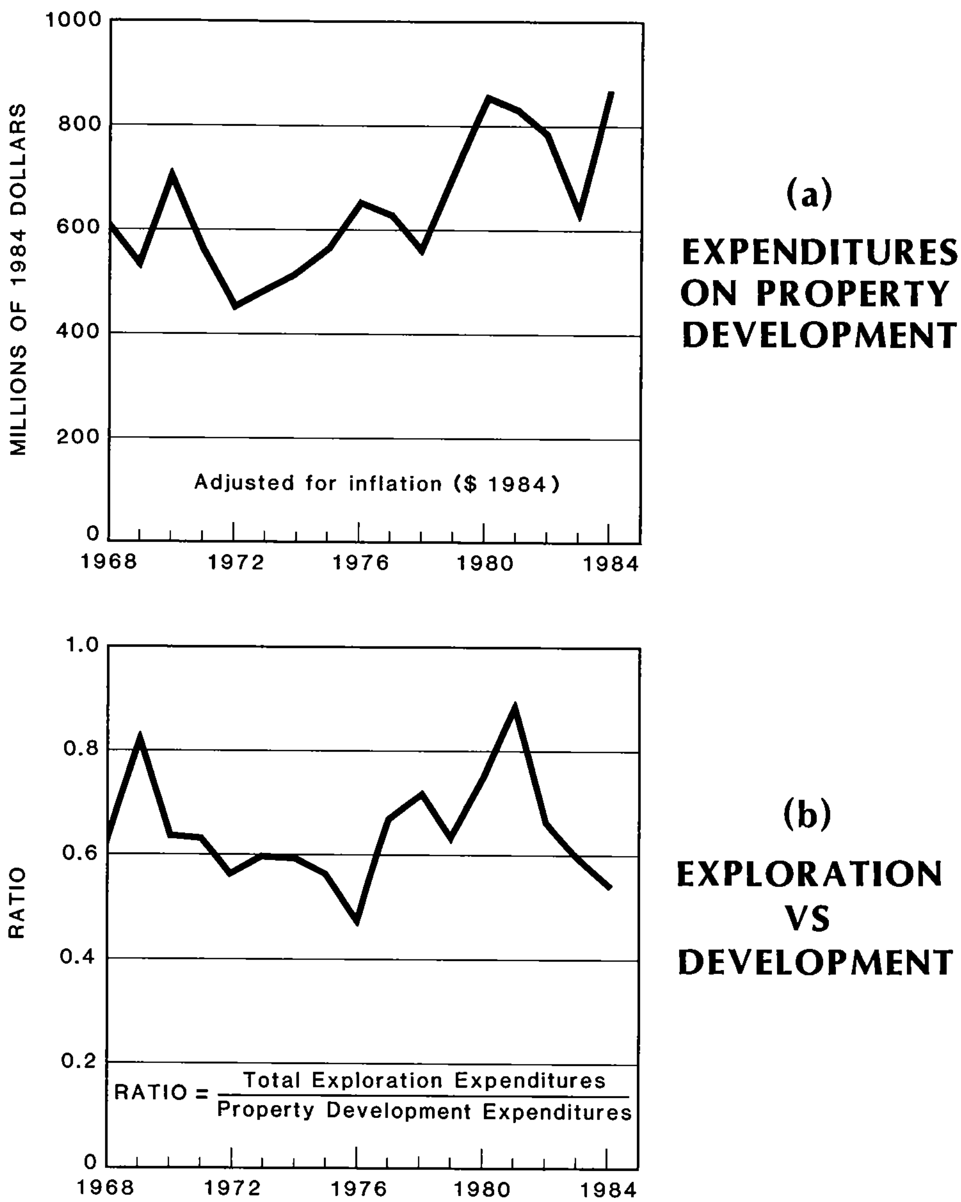
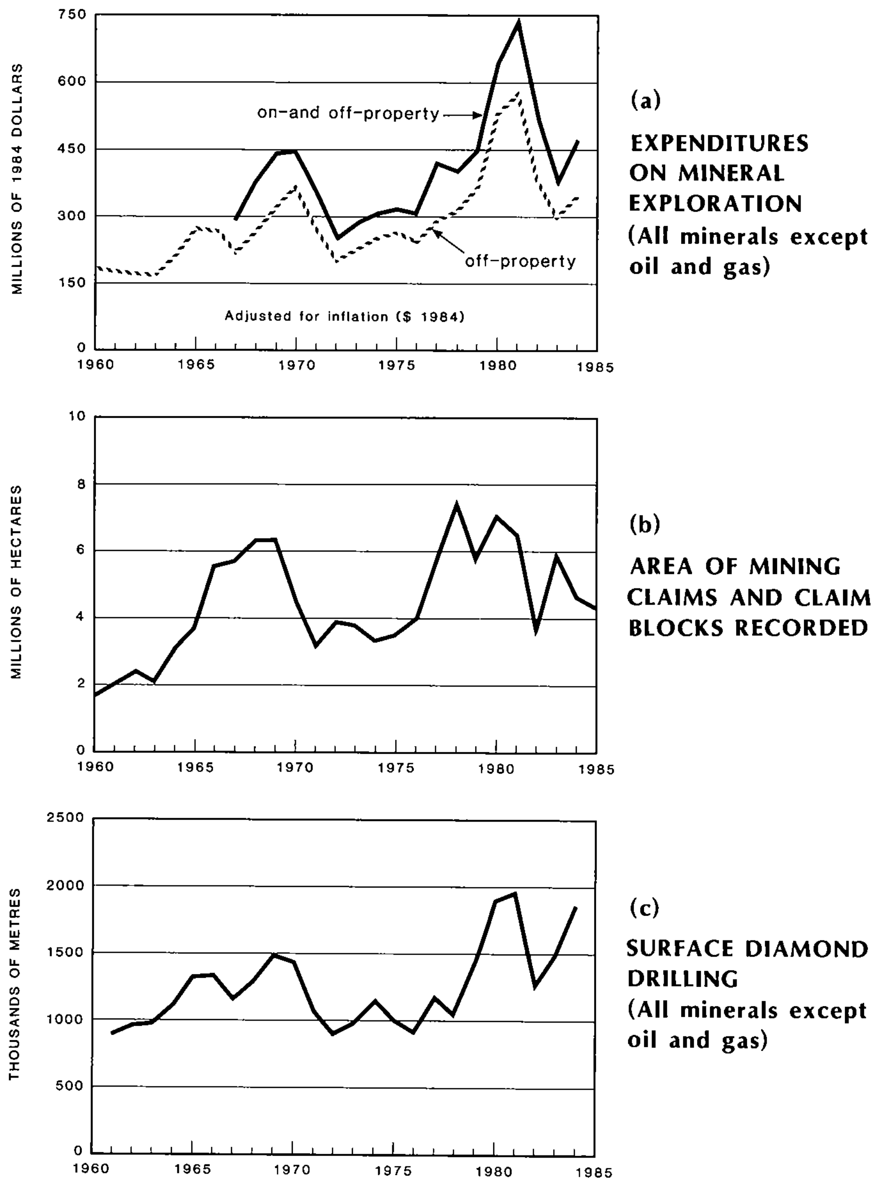

1000
800
600
400
200
0
MILLIONS OF 1984 DOLLARS
Adjusted for inflation ($ 1984)
1968
1972
1976
1980
1984
(a)
EXPENDITURES ON PROPERTY DEVELOPMENT
1.0
0.8
0.6
0.4
0.2
0
RATIO
RATIO = Total Exploration Expenditures / Property Development Expenditures
1968
1972
1976
1980
1984
(b)
EXPLORATION VS DEVELOPMENT

FIGURE 2

MEASURES OF EXPLORATION ACTIVITY



Aluminum

G. BOKOVAY

Despite a continuing decline in aluminum inventories and a relatively high level of aluminum consumption, metal prices declined through most of the second half of 1985. While the market did show some signs of recovery in December, reflecting a better balance between supply and demand, it is uncertain whether a sustainable price recovery will occur until further production cutbacks are implemented or consumer expectations of continued price weakness begin to change. A change in the latter will result in a boost to primary demand as consumers move to increase their inventories from current low levels.

Although recent market prices do not cover the full operating cost of a significant amount of world aluminum smelting capacity, the cost structure of the industry as a whole has improved somewhat in the last year. This improvement stems from additional permanent closures of certain high cost capacity in the United States and Japan, rigid cost cutting measures undertaken by producers, the general decline in the cost of alumina and to a lesser extent from a decline in power rates and the cost of labour. In addition, the increase in the value of the U.S. dollar over the last several years has reduced dollar costs for smelters outside the United States.

Lower production costs, together with depressed current market prices have slowed the pace of the industry's geographical restructuring that has seen a gradual shift of smelting capacity to areas with relatively abundant low cost energy resources. In this regard, several projects that seemed destined to proceed or were being seriously considered in Canada, were cancelled or postponed in 1985.

At the end of 1985, the outlook for aluminum consumption is reasonably optimistic given that no major slowdown in the major economies of the western world is forecast in the short-term and with the prospect of excellent growth in several key markets.

CANADIAN DEVELOPMENTS

Two companies produce primary aluminum in Canada - Canadian Reynolds Metals Company, Limited, a subsidiary of Reynolds Metals Company of the United States and the Aluminum Company of Canada, Limited (Alcan), a subsidiary of Alcan Aluminium Limited of Montreal. Alcan has smelters at Jonquière, Grande Baie, Isle Maligne, Shawinigan and Beauharnois in Quebec and at Kitimat in British Columbia, with a combined total capacity of 1 075 000 tpy while Canadian Reynolds operates one smelter at Baie Comeau, Quebec. With the completion of a major expansion to this facility during 1985, capacity increased from 158 760 tpy to 272 000 tpy.

At the end of 1985, all Canadian smelters were operating at capacity, with the exception of Alcan's Arvida works in Jonquière where 87 per cent of its installed capacity of 432 000 t was being utilized.

At Jonquière, Alcan operates the only alumina refinery in Canada. The plant has a capacity of 1.2 million tpy of metallurgical grade alumina and alumina derivatives. Bauxite is imported principally from Brazil, Guyana and Guinea. The output of metallurgical alumina from the Jonquière plant is consumed at Alcan's smelters in Quebec. Output during 1985 was reported to have been slightly less than the 1.017 million t produced in 1984, owing to a somewhat smaller level of aluminum production at the company's Arvida works in Jonquière. Alcan also imports alumina for its eastern Canadian smelters from Jamaica while Alcan's Kitimat smelter is supplied with alumina principally from Australia and Japan. Alumina for the Canadian Reynolds smelter in Baie Comeau is imported from West Germany, Jamaica and the United States.

Canadian production of aluminum in 1985 is estimated at about 1 285 000 t compared to 1 221 985 t in 1984. Canadian exports of primary smelter products for the first nine

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months of 1985 were up significantly to 785 825 t compared to 628 867 t recorded for the same period in 1984. The largest gains were recorded on exports to the United States which increased from 470 092 t to 513 977 t and to the Asian market which increased from 131 935 t to 217 413 t.

Due to depressed world aluminum markets, Alcan Aluminium Limited announced in September that it was postponing construction on its new 248 000 tpy aluminum smelter at Laterrière, Quebec. However, the company stated that it would continue engineering studies for the project.

In order to increase its overall competitiveness in aluminum markets, Alcan announced a series of measures designed to improve productivity and cut costs. This included a major reorganization which resulted in its Canadian and U.S. operations being grouped into four operating entities: raw materials, primary and secondary metals, rolled products, and fabricated and downstream operations. As part of this reorganization, Alcan also announced that it would reduce the size of its North American labour force by 1,100 before the end of 1985.

During 1985, the company also announced that it would layoff 150 employees at its Jonquière alumina plant over the next two years. In early-January 1986, Alcan stated that it would make a major writedown of its worldwide bauxite and alumina operations due to low prices and to the large world oversupply of these materials.

Alcan announced during 1985 that it would redeploy its assets to improve its earnings mix. This will include a greater emphasis on the development of new products, production of higher margin specialized finished goods and also the divestment of certain assets that were either unprofitable or ancillary to the company's principal activities.

Although Canadian Reynolds Metals substantially increased its aluminum output during 1985 with the completion of a new potline at its Baie Comeau smelter, the company announced in October that it was reducing its workforce at this plant by 300. The layoff was part of a cost reduction program that has also included certain technical improvements to the older potlines at the plant.

During 1985, work continued on the new aluminum smelter of Aluminerie de Bécancour Inc. in Quebec. At the end of the year, the $US 880 million project was reported to be under budget and slightly ahead of schedule. Production from the first 115 000 tpy potline is now expected to begin as early as May 1986 with full production being attained in the first quarter of 1987.

For the first year of operation, it is reported that alumina for the smelter will be supplied by Alcoa of Australia Ltd. In subsequent years, Aluminium Pechiney (50.1 per cent) and the Quebec government owned Société Generale de Financement du Quebec (SGF) (24.95 per cent) will purchase their share of alumina from Queensland Alumina Ltd. (QAL) of Australia. Meanwhile, Alumax Inc. of the United States (24.95 per cent) will continue to source its requirements from Alcoa of Australia Ltd.

Also during 1985, SGF signed marketing agreements for its share of the new smelter's output. This includes an agreement with Aluminium Pechiney for 40 000 tpy and one with Noranda Sales Corporation Ltd. for the remaining 17 500 tpy.

In September 1985, it was announced that Swiss Aluminium Ltd. (Alusuisse) had reached an agreement with the Government of Quebec to conduct a feasibility study for a 200 000 to 250 000 tpy aluminum smelter. The study, which is expected to take up to nine months to complete, will examine the sites of Lauzon, Bécancour and Sept-Iles as potential smelter locations. Meanwhile, it was reported that Kaiser Aluminum and Chemical Corporation had completed a feasibility study to assess a Quebec smelter proposal but that it had decided against such a project at this time.

WORLD DEVELOPMENTS

Non-socialist world consumption of primary aluminum in 1985 is expected to be marginally higher than the 12.5 million t recorded in 1984. Preliminary data indicated that primary aluminum production in 1985 is expected to be about 12.2 million t, compared to 12.7 million t in 1984.

While western world cutbacks since June 1984 have reduced primary capacity by about 1.65 million t, this has been effectively reduced to about 965 000 tpy due to the start-up of several new smelters.

According to a published report based on a study by Anthony Bird Associates, average production costs for aluminum have fallen from 58 cents (U.S.) per pound in 1982 to 48 cents in 1985. This increases to 63 cents after allowances are made for capital charges. According to the same report, the cost of production in Australia, Brazil and Norway is 40 cents (U.S.) followed by Canada at 41 cents, West Germany at 44, Japan 49, 50 in France and 57 cents in the United States. Alcan is the lowest cost producer in the world at 44 cents followed by Aluminium Pechiney and Alusuisse at 47 cents. Meanwhile, costs for Aluminum Company of America (Alcoa), Kaiser Aluminum and Chemical Corporation and Reynolds Metals Company are estimated at 50, 53 and 58 cents, respectively. The report also suggests that only 6.9 million t of capacity, which represents less than one half of total western world capacity can cover operating costs at a price level of 45 cents (U.S.) per pound.

While the utilization of aluminum smelting capacity in the United States fell from about 75 per cent at the beginning of 1985 to approximately 66 per cent in the fourth quarter, the stimulus for the modest recovery of aluminum prices which occurred in December appears to have come from announcements of permanent smelter closures by Reynolds and Alcoa totalling about 450 000 tpy. This includes two Reynolds smelters in Arkansas with a combined capacity of 107 000 tpy and several as yet unnamed Alcoa plants likely totalling about 350 000 tpy. Apart from the positive impact that these permanent closures may have had on aluminum markets, they are also important in that they signify a fundamental change in the philosophy of U.S. aluminum producers. This change relates to the apparent realization that in the long-term, it may be cheaper for aluminum companies to invest in new low cost offshore smelters or to purchase primary aluminum from foreign suppliers. In this regard, Alcoa announced at the end of 1985 that it would discontinue further development work on the Alcoa smelting process. While the major United States aluminum companies will stay in the business, there is a growing emphasis toward the production of finished goods that promise better rates of return. Alcoa like Alcan has adopted a policy of diversification including investment in advanced ceramics, plastics, fibre optics and advanced metals.

Also in the United States during 1985, ARCO Aluminum Co. sold its 163 000 tpy smelter at Columbia Falls, Montana to Montana Aluminum Investors Corp. The new owners hope to eventually operate the smelter as a toll conversion facility. Earlier in the year, ARCO sold the bulk of its U.S. aluminum assets, with the exception of the Columbia Falls plant, to Alcan Aluminium Limited.

At the end of the year, it was reported that Martin Marietta Aluminium Inc. was negotiating the sale of its idled Dalles, Oregon smelter to local investors, who would also operate this plant as a toll facility.

In the fall of 1985, Alcoa, with the support of other U.S. aluminum companies and The Aluminum Association Incorporated, announced that it would proceed with the filing of an unfair trade practices case against Japan. This action was being contemplated as a result of difficulties being experienced with sales of aluminum products to Japan and specifically at Japanese practices which allegedly subsidize its domestic aluminum industry. While there had been some suggestion that the U.S. government would proceed with a self initiated action with respect to aluminum trade with Japan, the Administration subsequently announced that it would not pursue such action at this time.

At the end of 1985, it was reported that Japan would eliminate its 9 per cent tariff on aluminum ingot and would reduce tariffs on some aluminum mill products by January 1, 1988, under the terms of an agreement between the United States and Japanese governments. It is expected that this tariff reduction will diminish the threat of United States retaliatory action.

Although the United States has become a high cost aluminum producing nation by virtue of its relatively expensive power rates, there has been some easing of electrical rates as utilities move to halt the erosion of demand from the important aluminum sector. In the Pacific northwest, aluminum producers accepted a new incentive rate structure whereby power rates will average 18.8 mills per kWh between September 1985 and June 1986. In addition, the Bonneville Power Authority was reported to be developing a new power rate schedule that would tie the price of electricity to aluminum prices and which would provide assistance to aluminum producers to support modernization and energy utilization improvements.

In Australia, aluminum producers operated at full capacity during 1985 on the strength of increased metal exports to

Japan, the People's Republic of China and South Korea. During 1985, Alcan Aluminium Limited brought the third potline of its Kurri Kurri smelter in production. While this potline had been completed in 1984, its start-up had been delayed by poor market conditions.

During 1985, work on the Portland smelter continued with the first of two 150 000 tpy potlines expected to be in production by November 1986. Although the two principal participants in the project, Alcoa of Australia Ltd. and the Government of Victoria had originally announced that they would proceed without additional investors, 10 per cent of the project has been taken by First National Resource Trust of Australia while the China International Trust and Investment Corp. has agreed in principle to take an additional 10 per cent.

Also in Australia, the proposed Western Australia smelter project was deferred during 1985. This setback was apparently brought about by the withdrawal of Reynolds Metals Company from the project and also to the failure of backers, which included the Western Australia government, to attract significant South Korean investment.

In Brazil, the first 80 000 tpy potline of the new Alumina Brasileiro SA (Albras) smelter near Belem was brought on-stream in July with the second potline expected to be completed in 1986. The project which is a joint venture between the Brasilian state owned Companhia Vale do Rio Doce (CVRD) and the Japanese consortium Nippon Amazon Aluminum Co. (NALCO) also includes plans for two additional 80 000 tpy potlines and the 800 000 tpy Alumina do Norte Brasil SA (Alunorte) alumina refinery. However, it is reported that the Japanese are somewhat reluctant to proceed with additional construction at this time in view of the current excess in world smelting and refinery capacity.

Also in Brazil, construction at the new Alumar smelter of Alcoa Aluminio S.A. and Billiton N.V. continued during 1985 with a second 135 000 tpy potline scheduled for completion in 1986. In addition the Brazilian producers Cia Brasileira de Aluminio announced that it would increase its smelting capacity from 150 000 tpy to 340 000 tpy by the end of the century and that Valesul Aluminio S.A., owned by CVRD, Shell Brasil SA and Reynolds Aluminio do Brasil Ltda. was studying a 90 000 to 110 000 tpy smelter expansion.

In Venezuela, Aluminio del Caroni S.A. (Alcasa) announced that it plans to increase its smelting capacity from 120 000 tpy to 320 000 tpy through the installation of two new potlines. In addition the company plans to increase rolling capacity as part of a joint venture with Venezuela's other producer, Venezolana de Aluminio SA (Venalum). Venalum also announced that it intends to add an additional potline with a capacity of between 80 000 tpy and 130 000 tpy. Meanwhile the Venezuelan wire producer, Sural, announced that it plans to establish a 90 000 tpy aluminum smelter with assistance from foreign investors.

Also in Venezuela, the new Bauxiven bauxite project at Los Pijiguaos is expected to come on-stream in 1986. When the project is completed in 1988, annual bauxite output is expected to be 2.5 million t.

In February 1985, Alcoa closed its 800 000 tpy Clarendon alumina refinery in Jamaica due to weak alumina markets. However in July, the Jamaican government reopened the plant with Alcoa operating the plant on the government's behalf. While the government was successful in placing a significant amount of alumina, it was reported that it was seeking tolling arrangements with several U.S. smelters for some of its material. It was also reported that Jamaica was pursuing certain countertrade possibilities and also considering an investment in an aluminum smelting facility.

On August 15, production at the 1.3 million tpy Alumina Partners of Jamaica (Alpart) refinery was suspended indefinitely due to large alumina inventories and the availability of alternate sources of competitively priced material.

In Guyana, it has been reported that the 300 000 tpy alumina refinery at Linden will be reopened. The plant was closed in 1982 due to weak alumina markets. It is also reported that Guyana and the U.S.S.R. will sign a long-term bauxite delivery contract in early-1986.

In Ghana, the Volta Aluminum Co. Ltd., owned 90 per cent by Kaiser Aluminum, restarted two of its five potlines during 1985 and plans to bring two more potlines into production in 1986. The smelter had been closed since 1983 due to shortages of electricity caused by low water levels in the region. Elsewhere in Africa, it has been reported that Libya has authorized the construction of a 120 000 tpy smelter.

This smelter, which has been under consideration for several years, could come on-stream by 1989.

In line with Japan's Ministry of Trade and Industry's (MITI) plan announced in 1984 to reduce that country's primary aluminum capacity to about 350 000 tpy, a number of permanent closures were implemented or announced in 1985. This includes the closure of the Chiba smelter of Showa Light Metal Company Ltd. by March 1986, a 30 per cent reduction of capacity of the Toyama smelter of Sumitomo Aluminium Smelting Co. Ltd., to 30 000 tpy by January 1986, and a 25 000 tpy cutback at the Sakaide smelter of Ryoka Light Metals Company. In addition, Nippon Light Metal Co. Ltd. announced the permanent closure of its Tomakomai smelter while Sumitomo Aluminium scrapped its Toyo plant. Also during 1985, Mitsui Aluminium Co. announced it intended to suspend operations at its 400 000 tpy Wakamatsu alumina refinery due to its high cost of operation.

As part of a strategy to become self sufficient in the production of aluminum, the People's Republic of China has embarked on an ambitious development scheme in that country. At present there are at least five different projects under way including alumina refineries in Shanxi and Guizhou and a 200 000 tpy smelter in Qinghai. Major projects being considered are the Pingguo aluminum complex in Guangxi province which could eventually include a 1 million tpy refinery and a 500 000 tpy smelter and the addition of more alumina refining capacity and the construction of a 200 000 tpy aluminum smelter in Shanxi.

In India, Bharat Aluminium Company Limited's (Balco) bauxite project in Orissa State, which was scheduled to begin production in 1985, is now expected to begin operations in mid-1987. The delay is being attributed to the failure to secure clearance for the project from the Department of the Environment. Meanwhile, the new 200 000 tpy smelter being constructed by the National Aluminum Co. Ltd. (Nalco) at Angul is expected to commence production in 1987. The Nalco project also includes a 2.4 million tpy bauxite mine and an 800 000 tpy alumina refinery.

Also in India, it has been reported that the U.S.S.R. has agreed to provide financial and technical help to establish a bauxite/alumina project in Andhra Pradesh State and will take delivery of 1 million tpy of bauxite and 200 000 tpy of alumina beginning in 1987.

Elsewhere in Asia, it has been reported that Malaysia is studying the feasibility of constructing a new integrated aluminum complex including a bauxite mine, alumina refinery and a 110 000 tpy aluminum smelter. Meanwhile it is also reported that both Indonesia and Bahrain were considering expansions to their smelting capacities.

In Europe, the Spanish Cabinet in 1985 approved plans for the merger of Spain's two aluminum producers Empresa Nacional del Aluminio SA (Endasa) and Aluminio de Galicia S.A. (Alugasa). The merger will permit the rationalization of existing operations including the closure of 45 000 tpy of smelting capacity.

In Norway, several smelter expansions were announced during 1985 totalling about 125 000 tpy of capacity. These include the Ardal smelter of Ardal Og Sunndal Verk (ASV), the Mosjoen smelter of Elkem A/S and Alcoa, the Lista smelter operated by Elkem and the Husnes smelter owned by Alusuisse and Norsk Hydro AS. Also in Norway, Norsk Hydro, Elkem and ASV held preliminary talks at the end of the year on the possible coordination of production, marketing and an eventual merger of aluminum operations.

Meanwhile in Italy, the program to nationalize and upgrade that country's aluminum industry continued in 1985 although the date for the closure of the Balzano and Porto Marghera smelters has been put back until at least 1987.

Elsewhere in Europe, it was reported that the China National Nonferrous Metal Industry Corporation is considering an investment in Alusuisse's Isal aluminum smelter in Iceland. This investment would supposedly go toward a new 42 000 tpy potline at the site.

PRICES AND STOCKS

Aluminum prices on the LME which were relatively stable for most of the first half of 1985 at around 50 cents (U.S.) per pound, fell through the second half to reach 42 cents (U.S.) in November. In December, there was a modest recovery with prices rebounding to 50 cents per pound. The average LME cash settlement price in 1985 was 47 cents, compared to 57 cents in 1984. The International Primary Aluminum Institute reported that total inventories of aluminum (including scrap, primary and secondary ingot, metal in process and finished mill products) stood at 4.025 million t in November 1985 compared to 4.470 million t in January.

With the fall of aluminum metal prices during 1985, alumina prices came under severe pressure with spot prices as low as $US 85-90 per t being reported. At such levels, it is estimated that no refinery in the world can cover operating costs and in fact may cover little more than bauxite costs.

Since bauxite levies by producing nations constitute a large part of bauxite costs ($13 out $35 for Guinean bauxite) and due to extremely low alumina prices, it is reported that aluminum companies were negotiating with the Governments of Guinea, Jamaica and Surinam in particular, to reduce or abolish these tariffs.

At the end of 1985, the International Bauxite Association recommended new minimum prices for bauxite and alumina. These are to be determined by reference to 99.5 per cent purity ingot prices, based 50 per cent on medium to long-term contracts and 50 per cent on spot prices in Europe and North America. For bauxite, the price will be 2.5 to 3.5 per cent of the reference price while for alumina, it will be 12 to 16 per cent.

USES

Aluminum has various characteristics including low density, high strength and corrosion resistance, which makes it suitable for use in alloyed and unalloyed forms, in a wide variety of products. In the building and construction industry, major uses for aluminum include residential siding; window and door frames; screens; awnings and canopes; bridge, steel and highway equipment and mobile homes. In the transportation sector, aluminum is widely used in the manufacture of buses, trucks, trailers and semi-trailers and is the principal metal in aircraft. In this regard, new aluminum-lithium alloys promise to deliver significant weight savings over traditional aircraft alloys. Aluminum is also being increasingly used in passenger cars as manufacturers move to reduce the weight of their vehicles. Since 1974 the amount of aluminum used in a typical American car has risen from 32 kg to around 63 kg in 1985.

In the electrical field, aluminum largely replaced copper in wiring and power transmission, in the 1960s. While aluminum has maintained the market for power transmission applications, local restrictions and consumer resistance have substantially lessened the demand for aluminum in electrical wiring. Aluminum has however gained acceptance in various communications and computer applications.

The fastest growing market for aluminum in the 1970s was containers and packaging, including cans and foil. In September 1985, the Government of Ontario unveilled its long awaited soft-drink container policy in which the use of aluminum cans has been approved for use in that province. However, this introduction will be delayed until September 1987 so as to provide steel producers sufficient time to develop a new lightweight steel can that will be able to compete with the aluminum container.

Aluminum is used to produce consumer goods and is also used in the manufacture of a wide variety of machinery and equipment, and in several important applications in the chemical industry.

Another application for aluminum is the new aluminum air cell which produces electricity from the oxidation of aluminum metal. While this battery is still in the design stage, it promises to deliver more energy than conventional batteries.

OUTLOOK

Although no major new uses for aluminum appear likely to be developed within the next few years, the recent improvement in cost competitiveness of the metal should help to somewhat lessen the impact of competing materials including plastics, composite materials and high strength steels. In this regard, it is expected that aluminum demand will grow at an average annual rate of between 1.5 and 2.0 per cent in the next decade.

While the packaging sector has been one of the largest growth areas for aluminum in the last decade, demand for aluminum in this application, particularly in the United States, is expected to slow due to increased recycling of beverage containers, the trend to reduce aluminum thicknesses, and most importantly due to the fact that plastics will continue to make important inroads in this area.

Although some of the projected growth for aluminum usage in the automobile industry has failed to materialize to date, demand has nonetheless grown with such recent successful applications as the production of wheels and radiators. This trend is expected to continue and even accelerate as innovative applications prove successful.

The new General Motors Corporation "Allantes" model will utilize a number of large aluminum body panels and power train parts. The company is also considering the construction of an all aluminum V-6 engine while Ford is examining the use of aluminum drive shafts in some of its pick-up trucks.

While the benefits of increased aluminum usage in automobiles are fully recognized the metal has been hampered to some extent by the lack of suitable fabrication methods. However, Alcan announced in 1985 that it had developed an adhesive bonding technology that will permit the economical, high volume production of vehicle structures in sheet aluminum. Meanwhile the Honda Motor Co. Ltd. announced that it had developed a new diecasting method to produce compact cylinders for car engines.

Elsewhere in the transportation sector, aluminum is expected to make inroads against other materials, particularly steel. In late-1985, the Thrall Car Manufacturing Co. and Alcan Aluminium Corporation in the United States announced that they had completed the construction and initial testing of a high-performance rotary dump aluminum railcar. Other designs, including an aluminum discharge hopper car, are also being developed.

Aluminum prices are expected to recover in 1986 with the average price for the year expected to reach 55 cents (U.S.) per pound. For the rest of the decade it is expected that aluminum will trade in the range of 60 to 65 cents (U.S.) (in constant 1985 U.S. cents) assuming that total aluminum inventories can be kept at a level of about 3 million t. This will require additional permanent smelter closures, particularly since several new smelter projects are scheduled for completion in the next few years.

With relatively inexpensive hydro-electric power, Canada is currently one of the lowest cost aluminum producing nations in the world and can cover operating costs at the low market price levels which were experienced in 1985. While Canadian labour costs are somewhat higher than other competing nations, the availability of additional hydro electric capacity will allow Canada to significantly increase its share of world aluminum production, which currently stands at about 10.5 per cent.

AVERAGE 1985 PRICES

Month	LME Cash	U.S. Market
	(¢ U.S./pound)	
January	48.8	50.1
February	49.8	51.3
March	49.7	51.2
April	50.2	52.0
May	50.1	51.7
June	46.8	47.9
July	45.9	46.9
August	46.2	47.5
September	44.7	46.3
October	44.0	45.7
November	43.1	45.1
December	47.1	50.0
1985 Average	47.9	48.8
1984 Average	56.5	61.1

Source: Metals Week.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
32910-1	Bauxite	free	free	free	free
35301-1	Aluminum pigs, ingots, blocks, notch bars, slabs, billets, blooms and wire bars, per pound	free	.3¢	5¢	free[1]
35302-1	Aluminum bars, rods, plates, sheets, strips, circles, squares, discs and rectangles	free	2.2	9	free
35303-1	Aluminum channels, beams, tees and other rolled, drawn or extruded sections and shapes	free	9.1	30	free
35305-1	Aluminum pipes and tubes	free	9.1	30	free
92820-1	Aluminum oxide and hydroxide; artificial corundum (this tariff includes alumina)	free	free	free	free

MFN Reductions under GATT (effective January 1 of year given)	1985	1986	1987
		(%)	
35301-1	.3¢	.1¢	free
35302-1	2.2	2.1	2.1
35303-1	9.1	8.6	8.0
35305-1	9.1	8.6	8.0
92820-1			

UNITED STATES (MFN)		1985	1986	1987
417.12	Aluminum compounds: hydroxide and oxide (alumina)	Remains free		
601.06	Bauxite	Remains free		
618.01	Unwrought aluminum in coils, uniform cross section not greater than 0.375 inch, per pound	2.8	2.7	2.6
618.02	Other unwrought aluminum, excluding alloys, per pound	0.2¢	0.1¢	free
618.04	Aluminum silicon, per pound	2.2	2.2	2.1
618.06	Other aluminum alloys, per pound	0.2¢	0.1¢	free
618.10	Aluminum waste and scrap, per pound	2.0	2.0	2.0

Sources: Customs Tariff 1985, Revenue Canada, Customs & Excise; Tariff Schedules of the United States Annotated 1985, USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241.

[1] Pending passage by Parliament of the Notice of Ways and Means Motion tabled on November 12, 1981.

TABLE 1. CANADA, ALUMINUM PRODUCTION AND TRADE, 1983-85

	1983		1984		1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production	1 091 213	..	1 221 985	..	1 282 316	..
Imports					(Jan.-Sept.)	
Bauxite ore						
Brazil	1 263 507	47,225	1 511 219	59,826	1 022 012	42,696
Guinea	614 095	19,263	154 106	9,172	91 665	7,087
Guyana	337 482	11,574	586 928	20,358	349 096	15,099
Surinam	57 178	7,363	13 197	1,129	4 990	276
United States	24 829	4,499	40 341	6,936	29 897	4,962
Australia	17 923	1,845	74 743	10,001	37 375	4,887
People's Republic of China	14 803	900	56 531	5,610	40 768	3,891
Other countries	93	11	14 477	527	200	44
Total	2 329 910	92,680	2 451 542	113,558	1 575 993	78,941
Alumina						
Jamaica	423 782	93,542	549 316	121,313	537 655	115,348
Japan	261 340	57,705	276 696	63,966	213 263	43,857
Australia	256 852	54,308	308 389	71,167	128 795	24,942
West Germany	108 186	29,026	132 408	40,986	160 386	39,254
United States	12 822	6,133	56 288	20,814	50 893	15,625
Other countries	199	135	26 116	4,697	40 033	7,870
Total	1 063 181	240,849	1 349 213	322,942	1 131 025	246,896
Aluminum and aluminum alloy scrap	54 666	53,984	59 249	59,593	40 233	36,152
Aluminum paste and aluminum powder	1 624	5,870	1 848	7,390	989	4,982
Pigs, ingots, shot, slabs, billets, blooms and extruded wire bars	30 581	55,361	43 633	84,805	46 056	84,719
Castings	729	8,956	991	13,142	1 047	13,247
Forgings	456	7,187	807	13,831	764	13,774
Bars and rods, nes	3 250	10,046	7 402	22,235	4 938	14,677
Plates	6 010	17,906	9 562	33,818	7 418	25,323
Sheet and strip up to .025 inch thick	18 894	54,335	17 918	59,591	18 634	58,076
Sheet and strip over .025 inch up to .051 inch thick	12 356	37,693	14 083	50,834	12 253	43,268
Sheet and strip over .051 inch up to .125 inch thick	44 922	100,942	90 388	227,261	53 179	110,901
Sheet over .125 inch thick	27 618	61,141	38 048	103,176	28 552	65,043
Foil or leaf	666	2,248	902	3,518	660	2,561
Converted aluminum foil	..	11,169	..	15,105	..	12,229
Structural shapes	2 595	9,775	2 907	12,639	3 082	14,124
Pipe and tubing	1 430	6,267	1 564	7,575	1 930	8,494
Wire and cable, not insulated	1 459	4,414	1 576	5,606	1 241	4,089
Aluminum and aluminum alloy fabricated materials, nes	..	56,093	..	69,049	..	64,771
Exports						
Pigs, ingots, shot slabs, etc.						
Western Europe	18 700	32,370	23 380	46,029	11 273	19,301
Middle East	11 515	18,916	4 830	9,895	33 528	53,175
Other Africa	2 028	3,526	500	1,095	3 628	6,311
Other Asia	302 689	466,191	184 091	307,714	217 413	324,095
Oceania	134	176	781	1,079	-	-
South America	5 751	9,619	4 316	8,389	3 275	6,047
Central America	3 461	6,422	3 793	7,667	2 731	4,731
United States	581 124	993,205	612 502	1,165,829	513 977	833,439
Total	925 402	1,530,423	834 193	1,547,696	785 825	1,247,099
Castings and forgings						
United States	7 141	52,173	8 032	64,944	5 373	48,856
Total	7 696	64,404	8 570	76,072	5 514	55,335
Bars, rods, plates, sheets and circles						
United States	38 672	97,816	67 215	194,313	33 019	89,572
Total	45 365	111,132	72 181	208,565	40 825	106,534
Foil or Leaf						
United States	1 338	4,495	1 309	5,174	1 082	3,444
Total	1 443	4,895	1 335	5,289	1 102	3,546
Fabricated materials, nes						
United States	8 842	27,999	11 098	39,969	7 428	26,978
Total	10 603	33,371	18 055	62,359	9 258	32,808
Ores and concentrates						
United States	40 347	17,804	46 505	22,019	37 402	17,913
Total	44 992	20,427	50 641	24,760	40 238	19,833
Scrap						
United States	71 925	84,859	97 821	129,565	75 031	82,987
Total	80 911	95,572	105 169	138,561	87 126	97,322

Sources: Statistics Canada; Energy, Mines and Resources Canada.
P Preliminary; - Nil; .. Not available; nes Not elsewhere specified.

TABLE 2. CANADA, CONSUMPTION OF ALUMINUM AT FIRST PROCESSING STAGE, 1982-84

	1982	1983	1984
		(tonnes)	
Castings			
Sand	1 241	964	1 676
Permanent mould	9 541	12 490	12 832
Die and other	19 629	27 511	49 424
Total	30 411	40 965	63 932
Wrought products			
Extrusions, including tubing	70 116	86 162	93 730
Sheet, plate, coil and foil	99 633	133 271	155 242
Other wrought products (including rod, forgings and slugs)	67 638	62 786	72 712
Total	237 387	282 219	321 684
Other uses			
Destructive uses (deoxidizer), non-aluminum base alloys, powder and paste	5 725	14 396	26 156
Total consumed	273 523	337 580	411 772
Secondary aluminum[1]	35 938	62 801	47 298
Aluminum shipments	..	43 265	90 623

	Metal entering plant			On hand December 31		
	1982	1983	1984	1982	1983	1984
Primary aluminum ingot and alloys	225 156	324 933	411 774	78 191	79 944	84 744
Secondary aluminum	35 255	44 166	70 862	2 090	3 947	6 742
Scrap originating outside plant	44 271	79 493	75 562	1 483	2 819	3 729
Total	304 682	448 592	558 198	81 764	86 710	95 215

[1] Secondary metal totals not included in above consumptions.
.. Not available.

TABLE 3. ESTIMATED NON-COMMUNIST WORLD PRODUCTION OF ALUMINA

	1982	1983	1984	1st Qtr 1985	2nd Qtr 1984	3rd Qtr 1984
			(million tonnes)			
Europe[1]	4.46	4.35	5.24	1.28	1.22	1.17
Africa	0.58	0.56	0.55	0.16	0.11	0.16
Asia	1.81	1.89	2.12	0.52	0.47	0.54
North America	5.27	5.07	5.75	1.24	1.16	1.11
Latin America	3.48	4.17	4.60	1.17	1.16	1.14
Oceania	6.63	7.31	8.80	2.15	2.09	2.23
Total	22.23	23.35	27.06	6.51	6.21	6.34
of which nonmetallic uses	1.97	2.06	2.31	0.58	0.60	0.55

Source: International Primary Aluminum Institute.
[1] Excludes Yugoslavia.

TABLE 4. CANADA, ALUMINUM SMELTER CAPACITY

(as of December 31, 1985)

	Annual tonnes
Aluminum Company of Canada, Limited	
Quebec	
Grande Baie	171 000
Jonquière	432 000
Isle-Maligne	73 000
Shawinigan	84 000
Beauharnois	47 000
British Columbia	
Kitimat	268 000
Total Alcan capacity	1 075 000
Canadian Reynolds Metals Company, Limited	
Quebec	
Baie Comeau	272 000
Total Canadian capacity	1 347 000

Source: Compiled from company reports by Energy, Mines and Resources Canada.

TABLE 5. ESTIMATED WORLD PRODUCTION OF BAUXITE, 1982-84

	1982	1983	1984P
	(million tonnes)		
Australia	23.6	29.6	29.3
Guinea	11.8	13.0	13.0
Jamaica	8.2	7.7	8.7
Brazil	4.2	5.2	5.2
Surinam	3.3	3.0	3.4
Greece	2.9	2.4	2.3
India	1.9	1.8	1.9
Guyana	1.8	1.1	1.7
France	1.7	1.7	1.5
Other market economy countries	7.3	3.1	3.9
Total market economy countries	63.1	68.6	70.9
Central economy countries[1]	15.0	15.0	..
World total	78.1	83.7	..

Source: World Bureau of Metal Statistics.
[1] Includes Yugoslavia.
P Preliminary; .. Not available.

TABLE 6. WORLD PRIMARY ALUMINUM PRODUCTION AND CONSUMPTION, 1982-84

	Production			Consumption		
	1982	1983	1984	1982	1983	1984
	(000 tonnes)					
Europe	3 306.7	3 322.3	3 502.2	3 491.1	3 627.8	3 776.0
United States	3 274.0	3 353.2	4 099.0	3 649.5	4 218.9	4 572.8
Canada	1 064.8	1 091.2	1 222.0	273.5	337.6	411.8
Japan	350.7	255.9	286.7	1 639.3	1 800.7	1 743.9
Australia-New Zealand	547.6	695.2	997.7	236.0	285.4	295.4
Asia (excluding Japan and People's Republic of China	675.1	725.1	905.5	751.8	949.4	891.2
Africa	501.2	423.9	413.0	171.4	177.6	196.5
America's (excluding United States and Canada)	801.2	937.3	1 041.7	475.3	531.8	603.8
Subtotal	10 521.3	10 804.1	12 467.8	10 687.9	11 929.2	12 491.4
Centrally Planned Economies	3 468.8	3 501.4	3 432.6	3 496.2	3 520.7	3 464.2
Total	13 990.1	14 305.5	15 900.4	14 184.1	15 449.9	15 955.6

Sources: World Bureau of Metal Statistics; Energy, Mines and Resources Canada.

Asbestos

G.O. VAGT

Shipments of asbestos (chrysotile) in 1985 were lower as a result of relatively weak demand by the construction industry, foreign exchange shortages in the developing countries, uncertainties regarding future environmental regulations, and adverse publicity associated with past exposure to asbestos dust in the workplace. Total shipments in 1985 were 743 678 t valued at $352.3 million compared to 836 654 t valued at $379.3 million in 1984, according to preliminary figures.

Since 1981, greatly reduced mine production coupled with high inventories of more than 150 000 t, have resulted in shortened work periods, layoffs, prolonged shutdowns, and closures. Employment in the mining sector of this industry has decreased to about 3,000 from over 8,000 in 1979. Exports, generally accounting for about 95 per cent of production, amounted to 554 000 t valued at $343 million during the first 9 months of 1985, compared to 604 000 t valued at $378 million during the same period in 1984.

The initial phase of a plan to consolidate mining and milling operations was implemented by four companies in the Thetford Mines-Black Lake region. The resulting partnership, with its stated goals of reducing production costs and improving international competitiveness, now controls about 50 per cent of asbestos production in Quebec.

Canada takes the position that with enforcement of appropriate regulations to rigourously control exposure to asbestos dust the risks associated with chrysotile in mining, milling, product manufacture, transportation and handling can be reduced to acceptable levels.

CANADIAN DEVELOPMENTS

Companies in the industry continued to operate at about 50 per cent of overall capacity with Quebec accounting for 80-85 per cent of total output.

The consolidation of operations in the Thetford Mines-Black Lake region involved closure in early-November of the Beaver and National mines with plans to close the King mine at the end of 1986. The Normandie mill and National mill were also closed as part of the plan. The Beaver mine, King mine and Normandie mill are owned by Asbestos Corporation Limited (ACL) and the National mine and mill are owned by Lake Asbestos of Quebec, Ltd. (LAQ). With the consolidation, annual production from Asbestos Corporation Limited (ACL), controlled by Société nationale de l'amiante (SNA), will be reduced from 120 000 t to 70 000 t. Lake Asbestos of Quebec, Ltd. (LAQ), a joint venture of ASARCO Incorporated and Campbell Resources Inc., will reduce output from 180 000 t to 160 000 t. Bell Asbestos Mines Ltd., also Quebec controlled, will increase output from 50 000 t to 70 000 t. The overall effect will be a decrease in planned output from 350 000 t to 300 000 t. About 725 employees are being affected.

At the Jeffrey mine, owned by J M Asbestos Inc., the present mining plan assures continued operation until the end of this decade and future steps will be planned as needed. Layoffs in 1985 affected about 225 employees.

Following a favourable feasibility study last year, it is expected that development of the McDame asbestos deposit in British Columbia will proceed. A new company, Cassiar Mining Corporation, resulting from the re-organization of Brinco Mining Limited, would phase in production by block caving of the McDame orebody, replacing open-pit operations. With no stripping involved, mining costs are expected to be no higher than by open-pit methods.

Baie Verte Mines Inc. (BVM) reopened in mid-February following a one and one-half month shutdown. Operations then continued nearly uninterrupted throughout most of 1985.

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The Asbestos Institute, operating since mid-1984 from headquarters in Montreal, is dedicated to promoting the proper use of asbestos in Canada and throughout the world. Joint financing is provided by the Canadian and Quebec governments and the Canadian asbestos mining industry. Some recent initiatives of the Institute include publication of a quarterly bulletin, organization of an asbestos workshop supported by the United Steelworkers of America to bring together representatives of Canadian labour, and staging the First International Conference on Asbestos-Cement to be held in France in April 1986. Also, the Institute headed a mission to southeast Asia to establish linkages with asbestos-consuming industries and government officials. Participation of partners in other countries is considered essential for an international perspective on the proper use of asbestos.

SNA continued its research and development on new products and processes involving chrysotile. Substantial efforts have been directed toward modifying the surface characteristics of asbestos, or other materials, to attenuate physiological response. Shipments for testing purposes went to several potential consumers throughout the world.

Consumption of asbestos in Canada decreased from 34 483 t in 1982 to 26 813 t in 1984. The statistics in the table are reported in three categories to protect company confidentiality. Currently reported consumption is less than one-half of estimated consumption in the late-1970s.

HEALTH AND REGULATIONS

Federal emission regulations pursuant to the Clean Air Act as defined by Environment Canada require that the concentration of asbestos fibres contained in emissions to the ambient air at a mine or mill from crushing, drying or milling operations, or from dry rock storage, shall not exceed 2 fibres per cubic centimetre (f/cm^3).

The Ontario Ministry of Labour filed in mid-December its "Regulation Respecting Asbestos on Construction Projects and in Buildings and Repair Operations". This regulation will come into effect on March 16, 1986 and culminates a program to establish a safe, practical construction-related asbestos regulation under the Ontario Occupational Health and Safety Act. The law requires all employers and building owners to maintain the lowest practical exposure limits at applicable work sites.

Levels of asbestos in ambient air are some thousand fold less than concentrations in the occupational environment. According to Health and Welfare Canada, it is likely that the health risks associated with exposure to these low levels are minimal. However, this federal authority states that concentrations in the vicinity of asbestos-emitting industries may be elevated and it is prudent to limit exposure through reduction of controllable emissions.

There was misplaced concern about wines filtered and bottled through asbestos filters by the Sociêté des Alcools du Quebec. The controversy ceased when a laboratory analysis commissioned by the Montreal Gazette concluded there are as many asbestos fibres in tap water as in the wines tested. The subject of ingested asbestos was discussed in 1984 by the Royal Commission on Matters of Health and Safety Arising from the Use of Asbestos in Ontario (ORCA report). In this comprehensive three-volume report it was stated that ingestion is not a health risk and that concern about asbestos in drinking water, beverages and food is not justified.

WORLD DEVELOPMENTS AND INTERNATIONAL REGULATIONS

Based on an estimated 1984 world production of 4.1 million t of fibre, major producers and their approximate percentage share of production are: U.S.S.R., 56; Canada, 20; and Republic of South Africa, Zimbabwe and China, each 4.0. Canada and the U.S.S.R. provide about 45 per cent and 20 per cent respectively of world imports of asbestos. Expansions to production facilities in the Soviet Union are reportedly to serve domestic needs of industrial and residential construction.

Considerable effort is being applied to developing international regulatory instruments on asbestos. Texts of a Draft Convention and a Draft Recommendation on asbestos were drawn up on the basis of conclusions adopted at the 71st Session of the International Labour Conference in June, 1985. Proposals for a final Convention and a Recommendation will be examined at the Conference in June 1986.

In the United States the Occupational Safety and Health Administration (OSHA) continued its normal rule-making route in 1985 following an earlier court ruling invalidating the Agency's Emergency Temporary Standard (ETS) for exposure to asbestos.

Publication of the final workplace rule is expected in early-1986 and may specify a permissible exposure limit in the range of 0.2-0.5 f/cm^3. A second rule for construction and demolition will be issued at the same time. The Environmental Protection Agency (EPA) proposal in 1983 to ban asbestos in some products immediately and in all products eventually, had not been published by year-end 1985. Current initiatives are to combine the ban and phase-out proposals into a new proposed rule. EPA reissued guidelines on "Asbestos in Schools" indicating that removal of asbestos should now be a last resort measure. Exposure is considered unlikely as long as asbestos-containing material remains in good condition and is not disturbed.

Also in the United States, fifty asbestos producers and insurance companies reached an agreement to open claims facilities seeking to settle related lawsuits brought by individuals. The goal of this approach is to avoid costly litigation that has plagued asbestos for years. Estimates indicate about $1 - billion has been spent on cases in the past 10 years, but only one-third of this amount has gone to the injured.

In the European Community the EC Council Directive, approved in 1983 on Protection in the Workplace (DGV), provides the basis on which member states are to adopt compliance laws before January 1, 1987. The control limit for exposure to asbestos other than crocidolite over an eight-hour sampling period will be 1 f/cm^3; for crocidolite the limit value will be 0.5 f/cm^3. In the case of mining, the compliance date is January 1, 1990.

Regarding the EC Council Directive on Marketing and Use (DGIII), there was agreement prohibiting a limited number of asbestos-containing products as follows: toys; materials for spray-on application, except undercoatings for cars; products distributed in powder form (spackling compounds); articles for smokers (filters); and as requested by the United Kingdom, certain catalytic heaters. Fibre fixity tests may be required on some remaining product categories, although more evaluation is needed. Prohibitions of many crocidolite-containing products will apply to products manufactured after March 21, 1986. However, member states may exclude from these prohibitions certain products including asbestos-cement pipe, acid and heat resistant seals, packings and gaskets, and torque converters.

The U.K. Health & Safety Commission published the report by Sir Richard Doll and Professor Julian Peto on the effects of exposure to asbestos. This report was undertaken particularly with a view to studying further the epidemiological factors associated with asbestos as reported by the U.K. Advisory Committee on Asbestos in 1979 (Simpson Report). Research concentrated on potential hazards in the workplace, as current evidence relating to non-occupational exposure was considered too unquantifiable to justify a major review. By using detailed comparisons of risk, it was demonstrated that exposure to asbestos in buildings results in health risks very small compared with other hazards faced. The report concludes that the risk to non-smokers is relatively small, even after relatively heavy exposure to asbestos dust. Clearly, the views expressed may be influential in determining the nature of final regulatory approaches taken by numerous countries.

In the Federal Republic of Germany, the current trend is toward progressive elimination of numerous asbestos-based products rather than by following a controlled-use approach. Asbestos-cement pipe and certain specialty products may be exceptions but substitutes for friction materials are being promoted aggressively.

In France there has been agreement for some time that it is possible to work safely with asbestos, provided the strictest of measures are applied to ensure that controlled-use prevails.

Sweden gave official notice to the GATT Committee on Technical Barriers to Trade of its intent to prohibit sale of newly manufactured cars and motorcycles with asbestos-containing brake linings. The prohibition would be effective January 1, 1987 and would also apply to supplying asbestos-containing replacement brake linings for vehicles having passed a type of inspection for asbestos-free brake linings. Statements submitted by corporations apparently disagree that eliminating asbestos-containing brake linings from passenger cars would significantly reduce exposure. It was emphasized that abrasion dust produced from friction linings during vehicle operation contains practically no asbestos fibres in a form damaging to health. Thus, no detectable health risk from the environment could arise from this source.

In Denmark, proposed but unconfirmed new threshhold limit values were to become effective in January, 1985. These were as follows: for asbestos fibres excluding crocidolite which is banned, 0.5 f/cm^3; for natural mineral fibres including wollastonite, attapulgite and zeolites, 0.5 f/cm^3; and for synthetic mineral fibres including glass, mineral and slag wool, 1.0 f/cm^3.

The World Health Organization completed a criteria document on asbestos and natural mineral fibres. These types of documents are highly regarded for their objectivity and are particularly relevant to many countries in the process of establishing regulations for fibrous minerals.

The Air Management Policy Group of the Organization for Economic Cooperation and Development (OECD) continued to review its policy document on asbestos in the ambient air.

In Australia, Woodsreef Mines Ltd. continued efforts toward building a wet-milling operation to extract asbestos from tailings. Considerable adverse publicity continued to be associated with removal and disposal of asbestos from buildings.

An eight-member Canadian delegation from the mining industry, the Asbestos Institute and the Canadian government visited Indonesia, Singapore, Malaysia and Thailand in August, 1985. It was obvious that the importance of asbestos-cement products for use in housing and water works projects should not be underestimated. Clearly, the availability of alternate products capable of providing equivalent socio-economic benefits to the populations was not always apparent. A return mission to Canada followed in early-December to study control technologies, regulatory procedures and the general safe use of asbestos.

PRICES AND CONSUMPTION

Average unit prices received for asbestos have remained about the same since the 1980-81 period, but in fact have declined in real terms. Weak demand by the construction sector, along with some emphasis on using asbestos-free products where possible, have increased competition for available markets. An estimated 75 per cent of all demand is construction product related. Friction materials account for an estimated 20 per cent of demand in the industrialized countries.

Price competition has led to much discounting as a result of excess supply and increased competition from Brazil, Zimbabwe and Greece.

Alternate Fibres and Materials

The controversy over health and stricter regulations on use have resulted in much promotion of alternate fibres and products. These have made significant inroads although the cost/performance ratio may often favor asbestos.

Following an intensive study on substitution by the Japanese industry there are indications that no technically and economically viable alternatives have been found for asbestos-cement and friction products.

OUTLOOK

Weak demand and prices along with high inventories are expected to remain near-term problems, at least. Future requirements for asbestos will greatly depend on success in stemming the negative public perception of asbestos in the industrialized countries and the emerging concerns in developing countries.

Canadian mine production during this decade is forecast to continue at today's depressed level, or even decrease further to about 700 000 tpy. The partial consolidation of mining and milling operations in Quebec is expected to keep production costs down allowing companies to sell more competitively. Although there are well-established requirements for asbestos-cement products in construction and irrigation projects in the developing countries, foreign exchange and debt problems will probably continue to be major obstacles hindering potential growth.

Coordinated research and development efforts are striving to improve the performance, safety and reliability of existing asbestos products and technologies. The First International Conference on Asbestos-Cement will stimulate more awareness of opportunities in this field.

Also on a positive note, the 'controlled-use' regulatory approach advocating that most potential exposure to asbestos can be controlled is standing up to the scientific evidence as more detailed studies become available. Many regulatory authorities view this approach as being more sensible than introducing stringent decrees against asbestos. There is also increasing concern over the safety of substitutes as research continues to demonstrate that most respirable-size fibrous materials proposed as substitutes are **not** biologically inert.

TABLE 1. CANADA, ASBESTOS PRODUCTION AND TRADE, 1983-85

	1983		1984		1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production (shipments)[1]						
By type						
Crude, groups 1, 2 and other milled	-	-	-	-	..	..
Group 3, spinning	13 599	17,252	15 502	19,771	..	..
Group 4, shingle	271 374	199,019	251 546	180,383	..	..
Group 5, paper	163 980	89,584	175 455	95,960	..	..
Group 6, stucco	157 958	49,090	167 429	50,121	..	..
Group 7, refuse	250 593	36,348	226 722	33,040	..	..
Group 8, sand	-	-	-	-	-	-
Total	857 504	391,293	836 654	379,275	743 678	352,275
By province						
Quebec	744 486	321,212	690 678	278,640	601 000	241,054
British Columbia	81 653	53,396	92 123	75,296	93 278	90,779
Newfoundland	31 365	16,686	53 853	25,339	49 400	20,442
Total	857 504	391,294	836 654	379,275	743 678	352,275
Exports					(Jan. - Sept.)	
Crude						
Japan	772	267	1 442	548	522	164
United States	96	14	164	45	20	17
United Kingdom	34	8	53	11	-	-
Singapore	18	19	-	-	-	-
Argentina	11	14	-	-	20	15
Belgium-Luxembourg	-	-	17	4	-	-
West Germany	-	-	53	62	-	-
Other	-	-	-	-	19	5
Total	931	323	1 729	670	581	201
Milled fibre (groups 3, 4 and 5)						
West Germany	23 243	23,865	21 672	21,237	18 403	17,686
Japan	30 099	23,511	34 028	25,915	23 668	17,312
United States	33 150	30,254	48 176	45,473	25 714	25,073
France	29 525	27,588	29 089	24,101	8 368	8,142
India	27 955	23,324	27 147	23,366	24 605	18,591
United Kingdom	20 916	21,266	21 529	21,619	11 537	12,084
Mexico	12 616	11,526	17 041	16,296	15 502	12,944
Italy	14 122	14,325	18 493	18,853	16 683	15,955
Australia	8 473	8,740	11 876	12,392	6 170	6,436
Malaysia	13 847	11,649	16 639	14,567	4 266	4,007
Thailand	14 527	11,796	19 166	13,832	15 269	10,437
Spain	2 854	2,632	3 689	3,752	6 113	5,613
Belgium-Luxembourg	9 329	8,690	8 442	8,298	5 616	5,602
Austria	12 228	9,772	11 857	10,519	7 280	6,600
Other countries	131 184	121,553	141 651	129,767	113 268	107,675
Total	384 068	350,491	430 495	389,987	302 462	269,157
Shorts (groups 6, 7, 8 and 9)						
United States	149 451	33,279	137 022	31,574	81 184	17,674
Japan	59 531	18,114	65 513	19,839	49 978	15,625
United Kingdom	12 351	3,606	11 123	3,321	9 419	2,843
West Germany	17 630	5,736	14 722	4,927	8 431	3,133
France	8 546	2,129	6 279	1,553	3 528	751
Mexico	6 307	1,525	8 229	2,036	6 693	1,770
India	15 719	5,549	9 639	3,345	9 215	3,404
Thailand	9 096	3,474	16 199	7,233	10 217	4,242
Taiwan	11 739	4,693	15 772	6,917	8 485	3,714
South Korea	12 539	3,416	14 263	3,323	13 559	3,845
Belgium-Luxembourg	5 449	2,123	7 621	3,276	4 636	1,545
Venezuela	2 506	548	4 727	1,091	1 383	327
Argentina	4 185	1,474	6 773	2,026	1 207	322
Nigeria	6 094	1,934	1 618	499	2 073	723
Switzerland	997	262	136	28	329	78
Other countries	46 772	16,226	43 993	15,429	40 595	13,944
Total	368 912	104,088	363 629	106,417	250 932	73,940
Grand total crude, milled fibres and shorts	753 911	454,902	795 853	497,074	553 975	343,298

TABLE 1. (cont'd)

	1983		1984		(Jan. - Sept.) 1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Manufactured products						
Asbestos cloth, dryer felts, sheets						
United States		1,879		1,233		679
United Kingdom		217		462		250
Japan		93		2		70
Other countries		1,085		620		167
Total	..	3,274	..	2,317		1,166
Brake linings and clutch facings						
United States		8,069		8,602		7,064
Australia		112		111		54
Hong Kong		108		76		3
West Germany		72		60		17
France		21		-		45
Other countries		99		91		56
Total	..	8,481	..	8,940		7,239
Asbestos and asbestos cement building materials						
United States		10,416		7,555		4,893
United Kingdom		467		363		208
Australia		204		164		129
Singapore		66		129		22
Venezuela		-		165		152
Egyptian A.R.		100		23		-
Indonesia		171		57		117
South Africa		10		43		-
Malaysia		364		48		24
Other countries		791		1,651		617
Total	..	12,589	..	10,198		6,162
Asbestos basic products, nes						
United States		3,731		2,842		1,759
West Germany		117		704		71
Australia		119		16		-
Mexico		18		134		96
Other countries		223		523		759
Total	..	4,208	..	4,219		2,685
Total exports, asbestos manufactured	..	28,552	..	25,674		17,252
Imports						
Asbestos, unmanufactured	454	483	326	505	302	464
Asbestos, manufactured						
Cloth, dryer felts, sheets, woven or felted		898		1,114		515
Packing		2,803		2,741		2,061
Brake linings		12,020		21,245		16,276
Clutch facings		1,348		2,078		1,586
Asbestos-cement shingles and siding		55		91		30
Asbestos-cement board and sheets		670		515		602
Asbestos building materials, nes		1,025		1,495		915
Asbestos basic products, nes		1,590		1,022		991
Total asbestos, manufactured	..	20,409	..	30,301		22,976
Total asbestos, unmanufactured and manufactured	..	20,892	..	30,806		23,440

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Value of containers not included.
P Preliminary; - Nil; nes Not elsewhere specified; .. Not available.

TABLE 2. CANADIAN ASBESTOS PRODUCERS, 1985

Producers	Mine Location	Mill Capacity ore/day	Mill Capacity fibre/year	Remarks
		(tonnes)		
Baie Verte Mines Inc.	Baie Verte, Nfld.	6 600	80 000	Open-pit.
Carey Canada Inc.	East Broughton, Que.	6 800	210 000	Open-pit. Mainly produces groups 6 and 7. Closure in 1986.
Asbestos Corporation Limited				(SNA) Quebec Crown corporation. Consolidation with Lake Asbestos.
British Canadian mine	Black Lake, Que.	12 000		Open-pit.
King-Beaver mine	Thetford Mines, Que.	7 000	160 000	Underground. Beaver mine closed.
Normandie mill	Black Lake, Que.			Mill closed.
•Bell Asbestos Mines, Ltd.	Thetford Mines, Que.	2 700	80 000	Underground. (SNA) Quebec Crown corporation. Consolidation with Lake Asbestos.
Lake Asbestos of Quebec, Ltd.	Black Lake, Que.	9 000	210 000	Open-pit.
National Mines Division	Thetford Mines, Que.	4 000		Mine/mill closed.
J M Asbestos Inc.				
Jeffrey mine	Asbestos, Que.	15 000	300 000	Open-pit (effective capacity reduced by one-half).
Cassiar Mining Corporation	Cassiar, B.C.	5 000	100 000+	Open-pit.

TABLE 3. CANADA, ASBESTOS PRODUCTION AND EXPORTS, 1979-85

	Crude	Milled	Shorts	Total
		(tonnes)		
Production[1]				
1979	4	725 649	767 066	1 492 719
1980	-	690 493	632 560	1 323 053
1981	10	567 288	554 547	1 121 845
1982	-	394 554	439 695	834 249
1983	-	448 953	408 551	857 504
1984	-	394 151	442 503	836 654
1985P	..	..	..	743 678
Exports				
1979	20	719 075	741 947	1 461 042
1980	-	653 358	564 379	1 217 737
1981	10	519 777	542 402	1 062 189
1982	555	454 440	425 701	880 696
1983	931	384 068	368 912	753 911
1984	1 729	430 495	363 629	795 853
1985 (Jan.-Sept.)	581	302 462	250 932	553 975

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Producers' shipments.
P Preliminary; .. Not available; - Nil.

TABLE 4. WORLD ASBESTOS PRODUCTION, 1984

Country	Tonnes[e]
U.S.S.R.[e]	2 300 000
Canada	836 654
Rep. of South Africa	170 000
Zimbabwe	165 000
Brazil	160 000
Italy	140 000
China	110 000
Greece	45 000
United States	57 422[1]
India	25 000
Cyprus	16 000
Korea	15 000
Turkey	4 000
Swaziland	30 000[1]
Mozambique	800
Yugoslavia	10 400
Japan	4 000
Taiwan	2 500
Argentina	1 250
Bulgaria	600
Egypt	325
	4 093 951

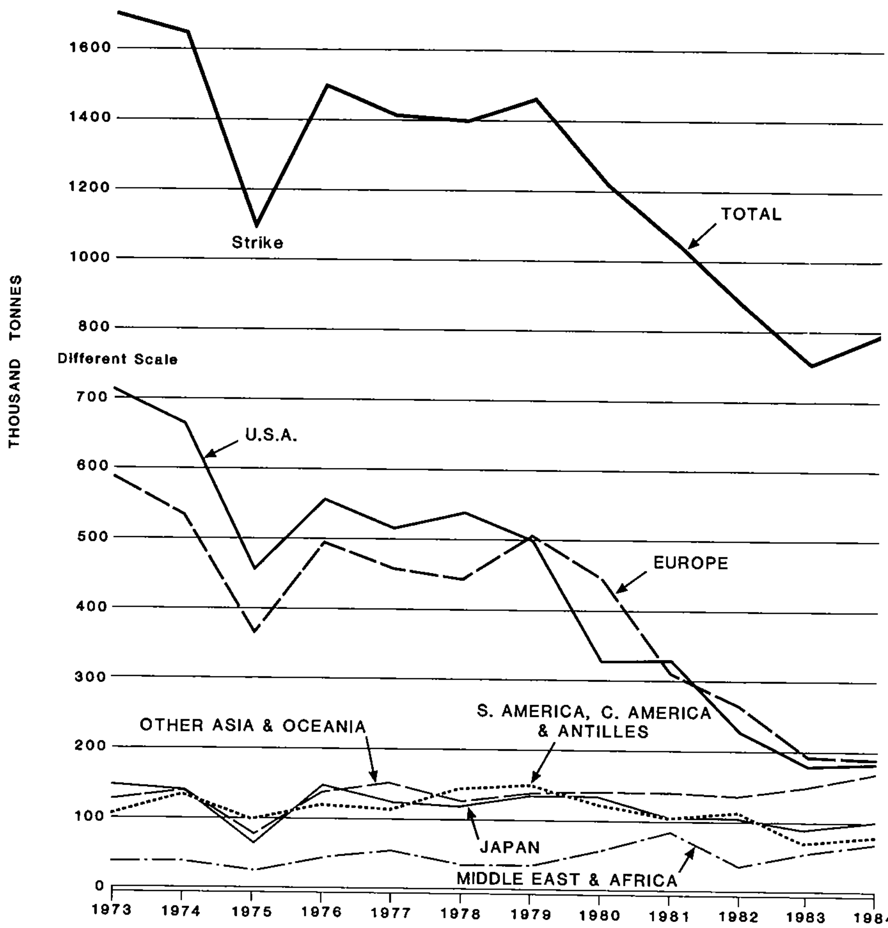
Sources: United States Bureau of Mines and Energy, Mines and Resources Canada.
[1] Reported figure.
[e] Estimated.

TABLE 5. CANADIAN ASBESTOS CONSUMPTION

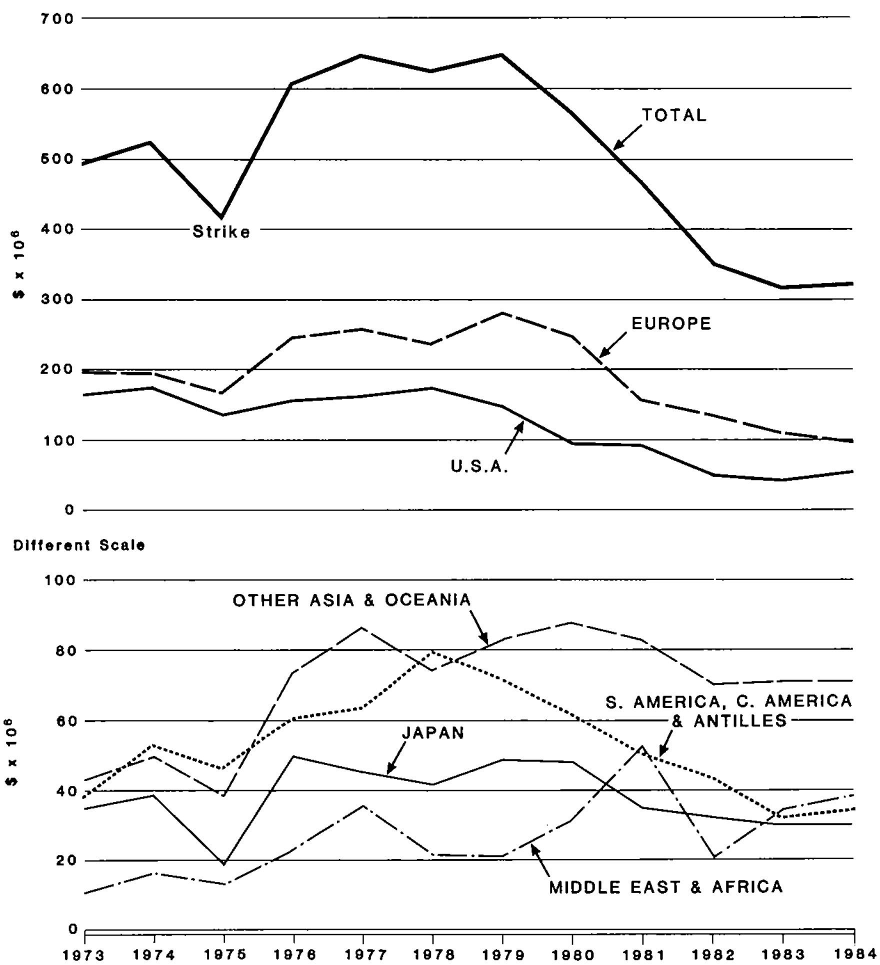
	1982		1983[r]		1984	
	(tonnes)	(%)	(tonnes)	(%)	(tonnes)	(%)
Paper; textiles; a/c sheet; a/c Pipe; insulation; roofing	20 092	58	13 128	48	11 792	44
Flooring products; plastics; coatings and compounds	7 467	22	9 246	34	8 898	33
Friction products; packing and gaskets	6 924	20	4 816	18	6 123	23
Total	34 483	100	27 190	100	26 813	100

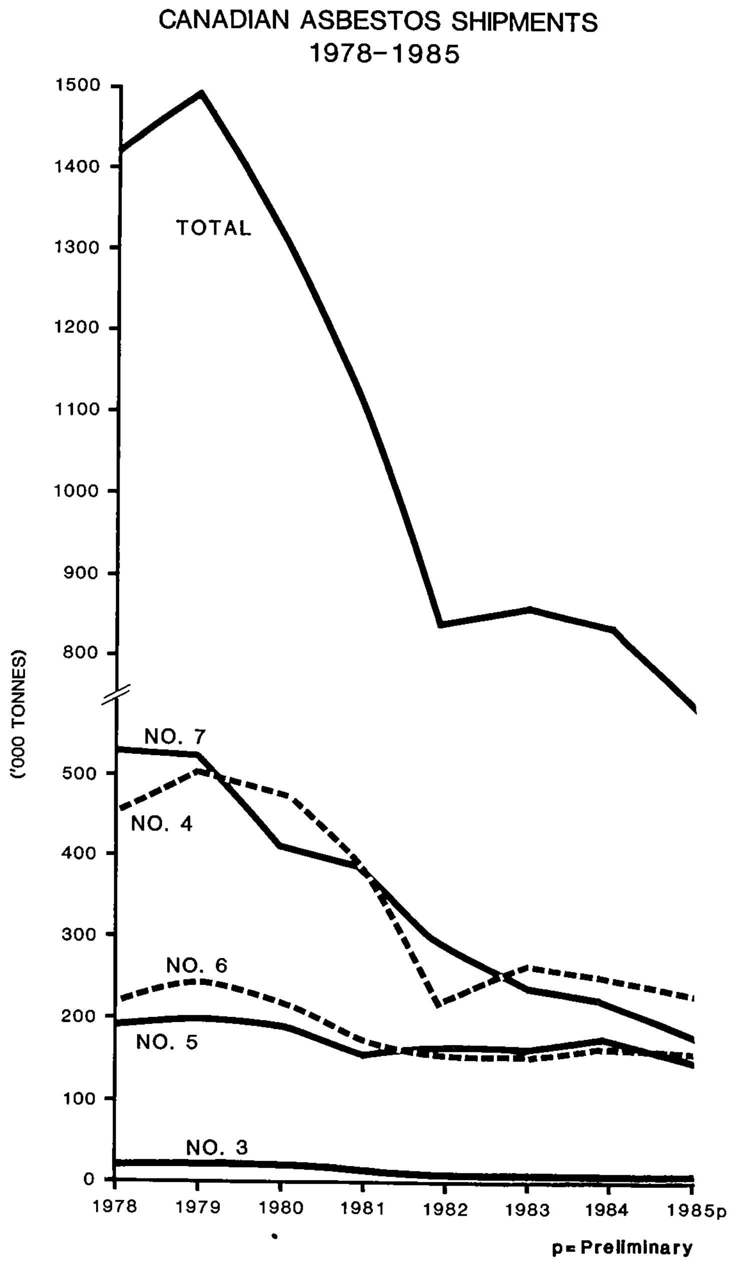
[r] Revised.

CANADIAN EXPORTS OF ASBESTOS (ALL GROUPS) BY COUNTRY OR REGION (1973-1984) (TONNES)



CANADIAN EXPORTS OF ASBESTOS (ALL GROUPS) BY COUNTRY OR REGION (1973-1984) (CONSTANT 1979 $)




CANADIAN ASBESTOS SHIPMENTS
1978-1985
('000 TONNES)
1500
1400
1300
1200
1100
1000
900
800
500
400
300
200
100
0
TOTAL
NO. 7
NO. 4
NO. 6
NO. 5
NO. 3
1978
1979
1980
1981
1982
1983
1984
1985p
p= Preliminary

Barite and Celestite

G.O. VAGT

SUMMARY

Canadian shipments of barite in 1985 amounted to 69 721 t valued at an estimated $6.33 million. This compares to 64 197 t valued at $6.97 million shipped in 1984. The industry has experienced moderate recovery since 1982 when shipments dropped substantially following a decline in oil- and gas-well drilling activity, particularly in western Canada. Imports of refined barium carbonate in 1985, one of the most important barium chemicals derived from barite, amounted to an estimated 3 100 t valued at $1.2 million.

Barite ($BaSO_4$) is a valuable industrial mineral because of its high specific gravity (4.5), low abrasiveness, chemical stability and lack of magnetic and toxic effects. Its dominant use is as a weighting agent in the oil- and gas-well drilling muds required to counteract high pressures confined by the substrata.

This mineral is found in many countries of the world and is the raw material from which nearly all other barium compounds are derived. The major world producers of barite are: China, United States, U.S.S.R., India, Mexico, Morocco, Ireland, Federal Republic of Germany and Thailand. In recent years, China has become very important in world trade and is the leading exporter of barite to the United States.

CANADIAN DEVELOPMENTS

Barite was produced during 1985 from operations in British Columbia, Ontario, Nova Scotia and Newfoundland.

Mountain Minerals Co. Ltd., in eastern British Columbia, shipped barite from its Parson mine. All of the crude barite is shipped to the company's grinding plant at Lethbridge, Alberta. Magcobar Minerals Division of Dresser Canada, Inc., continued seasonal mining and milling at its British Columbia Fireside deposit near kilometre 588 of the Alaska Highway. The semi-portable mill is located at Watson Lake, Yukon. NL Chem Canada, Inc. processed small quantities of old tailings at the Silver Giant property near Spillimacheen. At intervals, Baroid has also processed crude barite at its grinding plant in Onoway, Alberta.

Extender Minerals of Canada Limited mines barite near Matachewan, Ontario. Production of the high-quality dry-ground product, by open-pit mining, is used for filler and extender pigments in paints and plastics.

In Newfoundland, mining by several companies since 1980 has been intermittent at Collier Point on the Avalon Peninsula. There was no recovery of barite at the Buchans mine in 1985.

In Nova Scotia, Nystone Chemicals Ltd. produced pharmaceutical-grade barite from its deposit 2 km northeast of Brookfield. Novex Mining and Exploration Company Ltd. ceased operations in mid-1984 after operating for about one year at its Lake Uist mine, in Richmond County. The Magcobar Division of Dresser Canada, Inc. continued to process barite from several sources at a grinding mill situated at Walton.

Scotsville Mineral Resources began operations in mid-1984 at its Scotsville, Cape Breton property. Reserves and grades are reported to be adequate for use by the drilling market as well as the extender market requiring barite for plastics, paints, paper and pharmaceutical products. Provincial and federal government guarantees and loans helped establish the project.

CONSUMPTION

In 1984 consumption of barite in Canada was 78 565 t based on estimates. About 90 per cent was used for well drilling. The balance of Canada's barite consumption was in the

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manufacture of paint and varnish, rubber, chemicals, brake linings and other products. Growth in demand is expected in the automotive primer paint markets and also in new plastic applications in flooring and firewall parts.

WORLD DEVELOPMENTS

World production of barite in 1985 was an estimated 5 652 million t, according to preliminary estimates by the United States Bureau of Mines. This compares to 5 727 million t in 1984.

China, firmly established as the world's leading producer since 1983, accounted for about 1.0 million t or 17 per cent of world output in 1984. The United States, by far the second largest producer, accounted for 0.70 million t in 1984 and also imported 1.6 million t, more than half of which was sourced from China. Net import reliance, as a per cent of apparent consumption is now about 65 per cent.

Minworth Ltd. began surface mining operations and exploration for barite in the Clydesdale district of southern Scotland. This company plans a 30 000 tpy washing and heavy media separation plant to produce oil-well drilling grade material.

PRICES

Overcapacity and low ocean-freight rates continued to depress published prices to less than $US 50 a t. Low-cost crude barite exported from China to the United States played an important role in depressing western world prices. Prices in the range of $US 200-400 for barite used in smaller quantities in chemical and filler/extender markets remained about the same.

USES

Principal specifications for barite used in well-drilling usually require a minimum specific gravity of about 4.2, a particle size of 90-95 per cent minus 325 mesh, and a maximum of 250 ppm soluble alkaline earths, as calcium.

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. Specifications for barite used in 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. Final "wet milled" and "floated" products result in smooth micro-crystalline surfaces that prevent agglomeration, thus allowing easy dispersal in water as well as in oil-soluble binders. When barite is used in highly pigmented distemper or latex paints, a degree of light scattering is attributed to the barite, thereby allowing it to function as a pigment.

The glass industry uses barite to increase the workability of glass, to act as a flux, assist decolouration and increase the brilliance or lustre of the product. Specifications call for a minimum of 96 to 98 per cent $BaSO_4$, a particle size range of 40 to 140 mesh and usually a magnetically separated ore is used with iron often reduced to 0.1 per cent. However, producers of fine glassware use precipitated barium carbonate to circumvent impurity problems often associated with natural barite.

PRICES

United States prices of barite as reported in Engineering and Mining Journal[1], of December 1985.

	$ per short ton
Unground	
Chemical and glass grade:	
Hand picked, 95% $BaSO_4$, not over 1% Fe	90.00
Magnetic or flotation, 96-98% $BaSO_4$, not over 0.5% Fe	106.00
Imported drilling mud grade, specific gravity 4.20 - 4.30, cif Gulf ports	39.00-44.00
Ground	
Water ground, 95% $BaSO_4$ 325 mesh, 50-lb bags	80.00-165.00
Dry ground, drilling mud grade, 83-93% $BaSO_4$, 3-12% Fe, specific gravity 4.20-4.30	80.00-115.00
Imported	
Specific gravity 4.20-4.30	55.00-75.00

[1] Published by McGraw-Hill.

The specifications for natural barite used as a filler in rubber goods vary, but the main factors are whiteness and particle size range. For general filler and extender uses most manufacturers want a product that is virtually all minus 325 mesh. Colour is important to many users.

OUTLOOK

The demand for barite in 1986 is expected to increase based on recent strength in oil- and gas-well drilling activity. In 1985, 11,471 wells or 12.7 million m were drilled in Canada according to preliminary statistics. This compares with 9,149 wells drilled or 10.4 million m in 1984. Industry officials are optimistic about future activity based on changed regulatory and tax regimes at both federal and provincial levels of government. The major uncertainties relate to world oil prices in the shorter term and good access to export markets.

With more delineation drilling needed to confirm reserves offshore, additional supplies of barite will be required. There is potential for discovery and development of barite deposits in most regions and several companies are involved at various stages of property development from drilling to small-scale production. However, sources from abroad will likely continue to compete with domestic producers as long as excess capacity and low ocean-freight rates prevail.

CELESTITE

SUMMARY

There has been no Canadian production of celestite ($SrSO_4$), the main source of strontium, since Kaiser Celestite Mining Limited, a subsidiary of Kaiser Aluminum & Chemical Canada Investment Limited, closed its mining operation at Loch Lomond, Nova Scotia and its strontium products plant at Point Edward, Nova Scotia, in 1976. In 1984 the provincial government opened the property to bids and it was confirmed in July 1985 that Timminco Limited was the new owner of the McCrae deposit. Exploration work is planned next year to define the limits of the deposit. Timminco is the only producer of strontium in North America and currently purchases concentrate from the United States and Europe.

NORTH AMERICAN SCENE

North American consumers continue to depend totally on imports of strontium minerals. The strontium mining industry in the United States has been dormant since 1959 and Mexico and West Germany are the major suppliers of celestite and strontium compounds to the U.S. market.

Consumption of strontium compounds in the United States in 1985 was an estimated 4 354 t. From a 1979 base, demand for strontium in the United States is expected to increase at an annual rate of about 1.2 per cent through 1990, according to the United States Bureau of Mines.

USES

Celestite is used to produce commercial strontium compounds, principally strontium carbonate and strontium nitrate. In the sulphate form it is used for purifying electrolytic zinc. Strontium carbonate is primarily used in glass faceplates for colour television picture tubes where it improves the absorption of X-rays emitted by the high voltage tubes. Other uses include pyrotechnics and signals, and ferrite ceramic permanent magnets used in small electric motors.

PRICES

United States prices of celestite according to Chemical Marketing Reporter, December 30, 1985

	$ per short ton
Strontium carbonate glass grade, bags, truckload, works	$ 715.00
	$ per 100 pounds
Strontium nitrate, bags, carlot, works	$ 51.50

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
49205-1	Drilling mud and additives	free	free	free	free
68300-1	Barytes	free	10	25	free
92818-1	Barium oxide, hydroxide peroxide	3.8	3.8	25	5
92842-1	Barium carbonate	10	13.1	25	8.5
93207-5	Lithopone	free	11.0	25	free

MFN REDUCTIONS UNDER GATT (effective January 1 of year given)	1985	1986	1987
		(%)	
92818-1	3.8	1.9	free
92842-1	13.1	12.8	12.5
93207-5	11.0	10.8	10.5

UNITED STATES (MFN)

	Barium carbonate:	
472.02	Natural, crude (witherite)	free
472.06	Precipitated	0.4¢ per pound
	Barium sulfate:	
472.10	Natural, crude (barytes)	$1.27 per ton
472.12	Natural, ground (barytes)	$3.25 per ton
472.14	Precipitated (blanc fixe)	0.2¢ per pound
473.72	Lithopone	2.3%
473.74	Lithopone	4.2%

		1985	1986	1987
			(%)	
472.04	Barium carbonate, natural ground (witherite)	4.7	4.4	4.2

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise. Tariff Schedules of the United States Annotated 1985, USITC Publication 1610. U.S. Federal Register Vol. 44, No. 241.

TABLE 1. CANADA, BARITE PRODUCTION AND TRADE, 1983-85 AND CONSUMPTION, 1982-84

	1983		1984		1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production (mine shipments)	45 465	4,869	64 197	6,974	69 721	6,335
					(Jan.-Sept.)	
Imports						
United States	4 602	697	6 483	645	5 185	569
Ireland	24 690	900	-	-	8 011	381
Netherlands	655	204	610	167	435	151
Morocco	-		10 593	890	11 020	808
Other	5	1	-	-	34	13
Total	29 952	1,802	17 686	1,702	24 685	1,922
Exports						
United States	795	155	1 247	314	948	322
Total	795	155	1 247	314	948	322
	1982		1983		1984P	
Consumption[1]						
Well drilling[e]	20 000		60 000		71 000	
Paint and varnish	1 737		1 484		1 451	
Other[2]	2 794		4 200		6 114	
Total[e]	25 477		65 684		78 565	

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Available data reported by consumers with estimates by Energy, Mines and Resources Canada. Does not include inventory adjustments. [2] Other includes bearings and brake linings, chemicals, floor covering, adhesives, explosives, asbestos products, etc.
P Preliminary; e Estimated; - Nil.

TABLE 2. CANADA, BARITE PRODUCTION TRADE AND CONSUMPTION, 1970, 1975, AND 1980-85

	Production[1]	Imports	Exports	Consumption[e]
	($)	(tonnes)		
1970	1,388,125	6 827	90 305	50 106
1975	2,305,819	4 479	45 606	40 229
1980	4,380,000	45 157	645	138 829
1981	5,124,000	16 278	405	94 027
1982	2,359,000	23 457	482	25 477
1983	4,869,000	29 952	795	65 684
1984	6,974,000	17 686	1 247	78 565P
1985P	6,335,000			
1985P (9 months)		24 685	948	

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Mine shipments.
P Preliminary; e Estimated; .. Not available.

Bentonite

DANIEL J. SHAW

Bentonite is a clay of varied chemical composition consisting primarily of the mineral montmorillonite a member of the smectite group of clay minerals. "Smectite", as a group name, replaces confusing terminology that includes "montmorillonite" as both mineral species and group names.

Bentonite may originate from smectitic clays formed from volcanic ash, tuff or glass, other igneous rocks, or from rocks of sedimentary or uncertain origin. The deposits occur in relatively flat-lying beds of various chemical compositions and impurities; the latter consisting of quartz, chlorite, biotite, feldspar, pyroxenes, zircon and various other minerals. Natural clay may be creamy white, grey, blue, green or brown; and, in places, beds of 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.

Montmorillonite is a hydrated aluminum silicate with weakly-attached cations of sodium and calcium which impart different properties to bentonite depending on amounts and proportions present. One method of classifying bentonite is based on its swelling capacity when wet. With sodium as the dominant or abundant exchangeable ion, swelling of about 10 times the original dry volume will occur, and when added to water, gel-like masses result. Sodium bentonite also possesses a high dry-bonding strength, especially at high temperatures, a feature important in the pelletizing of iron ores and in the manufacture of some ceramic products.

Montmorillonite clays have 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", also contains mainly smectic-group clay minerals and is very similar to non-swelling bentonite. These clays are non-plastic, usually high in magnesia and have natural bleaching and absorbent properties allowing their use for decolourizing and purifying.

Known 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 in Canada, none of these has been identified as bentonite.

CANADIAN INDUSTRY AND DEVELOPMENTS

Three companies presently mine and process bentonite in Canada. For confidentiality reasons, statistics on production and exports are not available for publication.

Pembina Mountain Clays Incorporated mines non-swelling bentonite from the Upper Cretaceous Vermillion River Formation, 30 km northwest of Morden, Manitoba, which is 130 km 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 company's 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. Highly sorptive properties also make this bentonite suitable for pet litters and floor sweeping compounds. Control of Pembina was acquired in 1979 by Filtrol Corporation who, in turn, was acquired in 1982 by Kaiser Aluminum & Chemical Corporation.

In Saskatchewan, Avonlea Mineral Industries Ltd. operates a bentonite processing plant in Wilcox, approximately 30 km south of Regina. Raw material is

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transported a distance of approximately 20 km to the 60 000 tpy plant. Major uses of the final product are for well-drilling muds by the oil industry, as a binder in foundry sands, for civil engineering applications such as reservoir sealing, and for pelletizing animal feeds. In June, 1981 Noranda Mines Limited acquired 34.5 per cent (controlling) equity interest in Avonlea, however this was sold in 1985 and the company is now privately owned.

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, 14 km south of Rosalind, the site of the company's processing plant. The 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 the plant for drying, pulverizing and bagging. This bentonite, of intermediate swelling quality, may be used as a foundry clay, as a sealer for farm reservoirs, as feed pelletizing material, as a drilling-mud additive, as an additive to water for fire fighting and as a soil stabilizer.

USES, CONSUMPTION AND TRADE

Bentonite, in addition to having many uses by itself, is used as a minor constituent to impart favourable characteristics to many products.

Select swelling bentonite has found widespread use as a binder in the pelletizing of iron ore concentrates. Currently 55 per cent of the reported total consumption of bentonite in Canada was used for this purpose. About 8 kg is used in every tonne of concentrate to provide pellets 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.

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 forming a mud cake on the wall of the drill hole. Of equal importance, swelling bentonite acts as a suspension agent to carry drill cuttings in water-based muds to the surface. Synthetic bentonite (sodium-exchanged calcium bentonites) may also be used in special muds, depending upon the cost and availability of natural swelling bentonites. As can be seen in Table 1, bentonite use in well drilling has more than doubled in the last two years and currently represents about 19 per cent of Canadian consumption.

Swelling bentonite serves as a binder in moulding sands used in iron and steel foundries. This application accounts for approximately 23 per cent of total Canadian bentonite consumption.

Swelling bentonite is also used as a binder in stock feeds. Small quantities are used as a plasticizer in abrasive and ceramic mixes and as a filler in paints, paper, rubber, pesticides, cosmetics, medicinal products, and cleaning and polishing compounds. Engineering applications are: in grout for sealing subsurface water-bearing zones, dams and reservoirs; as additives to cements, mortars and concretes to suppress bleeding of the mixing water; as a compacting agent for gravels and soils; and as a ground stabilizing medium for excavations when used in a bentonite-water suspension. Bentonite slurry is also effective in fighting forest fires.

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

Activated bentonite is used in decolourizing mineral and vegetable oils, animal fats, waxes, beverages and syrups. It is also used in some countries as a catalyst in the refining of fluid hydrocarbons. Quantities of activated clays and fuller's earth are imported mainly from the United States. Some activated bentonite from Manitoba is exported to the United States.

Bentonite consumption in Canada had increased substantially in the 1970s, largely because of increased consumption as a binder in iron concentrate pelletizing. However, the first half of the 1980s has witnessed a rapid decline in bentonite consumption, to levels of about one half the former peak achieved in 1977, as the Canadian iron ore industry suffered from reduced demand. Consumption of bentonite in the oil and gas industry is subject to considerable fluctuation that is not necessarily directly related to the footage drilled. Factors such as age and degree of compaction of the rock formations encountered as well as the severity of subsurface geopressures and temperatures that vary from region to region are also important determinants. Nevertheless, consumption from this use has more than doubled in the last decade and currently accounts for 19 per cent of Canadian consumption.

Bentonite production in the United States was 3.2 million t in 1984. While this represents an increase of 21 per cent over 1983 production of 2.6 million t, it is approximately 25 per cent below 1980 production of 3.8 million t. Deposits from Wyoming and Montana account for more than 80 per cent of total United States production. In Wyoming, where the Cretaceous Fort Benton Formation is located, lie the world's most outstanding swelling bentonite occurrences and the specifications and standards 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. Canada is by far the main importer from the United States, which also ships some bentonite to numerous countries throughout the world. It is interesting to note that the distribution of United States consumption contrasts significantly with that of Canada. Estimates of bentonite uses in the United States reveals drilling mud accounts for 40 per cent of market demand, foundry sand bond accounts for 20 per cent, while iron ore pelletizing accounts for no more than 10 per cent.

A variety of fuller's earth, mainly comprising attapulgite, a lath-shaped clay mineral, was produced primarily in Florida and Georgia. Additional types of fuller's earth, mainly comprising montmorillonite, were produced in seven other states.

OUTLOOK

Demand for pelletizing grade bentonite is expected to be flat beyond 1985. Over the first half of this decade Canadian iron ore producers closed two pelletizing operations and it is expected that existing capacity is sufficient to meet demand for the rest of the decade. Transportation costs to distant pelletizing plants often add considerably to the cost of natural swelling Wyoming bentonite. For this reason, Quebec-based iron ore producers have imported increasingly from offshore sources, primarily Greece. In recent years, more attention has been directed toward the use of soda-activated bentonites.

Demand for well-drilling grade bentonite has been very volatile in the past, however it is expected that most of the increase in North American bentonite consumption, forecast between 2 and 4 per cent to 1990, will come from this use.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
29500-1	Clays, not further manufactured than ground	free	free	free	free
93803-2	Activated clay	10	13.1	25	8.5
20600-1	Fuller's earth, in bulk	free	free	free	-

		1985	1986	1987
MFN Reductions under GATT (effective January 1 of year given)			(%)	
93803-2	Activated clay	13.1	12.8	12.5
UNITED STATES (MFN)			(cents per long ton)	
521.61	Bentonite	40	40	40
521.51	Fuller's earth - not beneficiated	25	25	25
521.54	Fuller's earth, bulk	50	50	50
			(cents per lb + % ad valorem)	
521.87	Clays, artificially activated etc.	0.01 3.4%	0.01 2.9%	- 2.5%

Sources: The Customs Tariff, 1985, Revenue Canada; Customs and Excise. Tariff Schedules of the United States Annotated (1985), USITC Publication 1610. U.S. Federal Register Vol. 44, No. 241.

TABLE 1. CANADA, BENTONITE IMPORTS 1981-1985[1] AND CONSUMPTION, 1981-1984

	1981		1982		1983		1984		1985[1]	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Imports										
Bentonite										
United States	208 884	7,756	160 050	7,991	109 720	5,213	243 746	10,050	182 683	9,522
Greece	102 580	5,536	77 981	4,320	77 472	4,318	93 194	5,226	41 151	2,366
West Germany	-	-	-	-	36	14	91	29	176	85
Greenland	-	-	-	-	-	-	23	2	72	13
Total	311 464	13,292	238 031	12,311	187 228	9,545	337 054	15,307	224 082	11,987
Activated clays and earths										
United States	13 110	7,529	10 700	7,259	9 319	7,691	10 270	8,244	7 894	8,416
France	1 150	1,073	2 500	2,325	2 574	2,306	2 398	2,062	374	324
West Germany	162	153	168	129	256	248	1	1	34	83
Greece	172	-	1	1	-	-	-	-	-	-
Italy	-	-	-	-	21	33	-	-	-	-
Guyana	-	-	-	-	14	17	-	-	-	-
United Kingdom	-	-	-	-	19	7	-	-	51	55
Mexico	-	-	-	-	-	-	-	-	-	-
Total	14 422	8,755	13 369	9,714	12 203	10,304	12 669	10,307	9 599	9,984
Fuller's earth										
United States	784	56	1 081	75	536	75	4 152	525	3 865	460

Consumption[2] (available data)	1981	1982	1983	1984
	(tonnes)			
Pelletizing iron ore	209 763	120 538	112 181	138 328
Foundries	37 862	29 042	46 173	58 513
Well drilling	35 224	21 860	34 917	46 472
Fertilizer stock and poultry feed	72	158	221	2 420
Refractory brick, mixes	1 655	928	1 058	1 025
Other products[3]	1 783	2 541	2 879	3 285
Total	286 359	175 067	197 429	250 043

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Figures for 1985 include first 9 months only. [2] Does not include activated clays and earths or fuller's earth. [3] Rubber products, ceramic products, heavy clay products, paint and varnish, chemicals, paper products and other miscellaneous minor uses.
- Nil.

TABLE 2. CANADA, BENTONITE IMPORTS[1] AND CONSUMPTION[2], 1970, and 1975-85

	Imports		Consumption
	(tonnes)	($)	(tonnes)
1970	351 066	5,590,000	285 671
1975	287 886	9,388,000	286 109
1976	367 162	10,244,000	335 553
1977	481 213	13,757,000	346 698
1978	367 931	14,893,000	264 894
1979	655 043	29,571,000	345 083
1980	490 714	27,982,000	248 585
1981	326 456	22,088,000	286 359
1982	252 481	22,100,000	182 462
1983	199 967	19,924,000	204 761
1984	353 875	26,139,000	250 043
1985[3]	237 546	22,431,000	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Includes bentonite, fuller's earth and activated clays and earths. [2] Includes only bentonite and fuller's earth. [3] First 9 months of 1985 only.
.. Not available.

PRICES

United States bentonite prices according to **Chemical Marketing Reporter**, September 23, 1985

	$
Bentonite, domestic, bulk, carlots, fob mines West Coast, per short ton	43.50

Cadmium

M.J. GAUVIN

Cadmium metal is recovered principally as a byproduct of zinc smelting and refining. In 1984 zinc metal production in the non-socialist world was at an all-time high surpassing the previous high reached in 1979. Similarly cadmium metal production in 1984 exceeded the previous high attained in 1979.

Cadmium is a relatively rare element in the earth's crust, occurring most commonly as the sulphides greenockite and hawleyite which are found associated with zinc sulphide ores, particularly sphalerite. There are no ores specifically mined for cadmium. Reserves at any time are a function of zinc reserves.

Smelter residues from which cadmium is extracted may be stockpiled in times of low demand with the result that refined cadmium production is not always directly related to production of the principal metals. During the past six years, cadmium production in Canada has varied from 2.1 to 2.6 kg of cadmium to each tonne (t) of zinc metal produced.

Cadmium metal is produced in varying shapes and degrees of purity for various uses. The most common forms are balls, sticks, slabs, ingots, rods and sponge.

Cadmium is toxic, and care must be taken during production and use, of cadmium and its compounds, to ensure that exposure to fumes, dusts and effluents is minimized.

Canada is the non-socialist world's third largest producer of cadmium metal, after Japan and the United States. The next three largest producers were Belgium, the Federal Republic of Germany and Australia. Production of cadmium in the non-socialist world, as reported by the World Bureau of Metal Statistics, increased in 1984 to 15 123 t from 13 589 t in 1983. While data is not yet available, 1985 non-socialist world production is estimated to be about the same as that of 1984 and Canadian production is estimated at 1 700 t.

Consumption of refined cadmium in Canada, as reported by consumers to Statistics Canada, dropped to 28 810 kg in 1984 from the 32 885 kg reported in 1983. However, consumption, as measured by producers shipments to domestic consumers in 1985 is estimated at 76 000 kg compared with 78 000 kg in 1984 which was a 14 per cent decrease from that reported for 1983.

USES

Cadmium is a soft, ductile, silver-white electropositive metal with a valence of two. It is used mainly for coating iron and steel products to protect them against oxidation. Cadmium coatings may be applied by electroplating, mechanical plating or vacuum and ion deposition. The high ductility of cadmium is an advantage where the plated parts are to be formed. The good soldering characteristics of cadmium plate is an advantage in electrical applications. A cadmium coating, like a zinc coating, protects metals that are 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, can be applied more uniformly in recesses of intricately shaped parts, has a more aesthetic appearance and gives greater protection with the same thickness of plating than with zinc plating. Cadmium coatings are particularly useful in the electrical, electronic, automotive and aerospace industries.

The second largest use, according to the Statistics Canada survey, is in the manufacture of pigments and chemicals. Cadmium sulphides are used for yellow to orange colours and cadmium sulphoselenides for pink, red and maroon. Cadmium-containing pigments demonstrate good reflectance, heat stability and colour intensity. Cadmium compounds are used as stabilizers in the production of plastics, and cadmium phosphors are used for picture tubes in television sets.

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Cadmium-bearing rechargeable alkaline batteries - such as nickel-cadmium, silver-cadmium and mercury-cadmium - have the advantage of long life, maximum current delivery with a low voltage drop, small size, excellent performance under a wide temperature range, and a low rate of self-discharge. They find wide use in aircraft, satellites, missiles, calculators, and a broad assortment of portable tools and appliances.

Other uses of cadmium are for catalysts in the production of primary alcohols and esters; low-melting point alloys used in fire detection; bearing alloys, brazing alloys and solders; and copper hardeners for railway catenary and trolley wires.

PRICES

North American prices, which are quoted on a delivered basis, are best represented by the "U.S. Producer" quotations published in Metals Week - European prices by the "European sticks, free market price" quoted by Metal Bulletin. All quoted prices are for cadmium having a minimum purity of 99.95 per cent.

Published U.S. producer prices were $1.25 a pound at the beginning of 1984, rose to a high of $2.25 during the April to June period and dropped to $1.40 a pound in December. This price was maintained during the first six months of 1985, but dropped to $1.00 a pound in August and remained at this level for the balance of the year.

OUTLOOK

In the long-term, cadmium supply will continue to be dependent on trends established by the zinc industry. As the level of metal production is determined by the amount of zinc metal production, periods of oversupply will develop. It is expected that greater usage in its traditional markets, particularly that of rechargeable nickel-cadmium batteries, and possible new uses would gradually absorb the excess supply.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
32900-1	Cadmium in ores and concentrates	free	free	free	free
35102-1	Cadmium metal, not including alloys, in lumps, powders, ingots, or blocks	free	free	25	free
UNITED STATES					
601.66	Cadmium in ores and concentrates		free		
632.14	Cadmium metal, unwrought, waste and scrap		free		
632.86	Cadmium alloys, unwrought containing by weight 96% or more but less than 99% of silicon		9		

		1985	1986	1987
			(%)	
632.88	Cadmium alloys, unwrought, other	6.4	5.9	5.5
633.00	Cadmium metal, wrought	6.4	5.9	5.5

EUROPEAN ECONOMIC COMMUNITY (MFN)

		1985	Base Rate	Concession Rate
			(%)	
26.01	Cadmium in ores and concentrates	free	free	free
81.04	Cadmium metal, unwrought, waste and scrap	4	4	4
	Cadmium metal, other	6	6	6

JAPAN (MFN)

		1985	Base Rate	Concession Rate
			(%)	
26.01	Cadmium in ores and concentrates	free	free	free
81.04	Cadmium metal:			
	Unwrought	5.1	10	5.1
	Waste and scrap	4.8	10	4.8
	Powders and flakes	5.8	10	5.8
	Cadmium metal, other	6.5	15	6.5

Sources: The Customs Tariff, January, 1985. Revenue Canada, Customs & Excise; Tariff Schedules of the United States Annotated 1985, USITC Publication 1610; U.S. Federal Register, Vol. 44, No. 241; Official Journal of the European Communities, L 320, Vol. 27; 1985; Customs Tariff Schedules of Japan, 1985.

TABLE 1. CANADIAN PRIMARY CADMIUM STATISTICS, 1982-85

	1982	1983	1984p	Jan.-Sept. 1985e
		(tonnes)		
Mine production[1]	886	1 107	1 605	1 683
Metal production	1 162	1 296	1 768	1 276
Metal capacity	1 800	1 800	1 800	1 800
Metal shipments:				
Domestic	85	91	78	57
Exports	731	1 365	1 369	1 077

Sources: Statistics Canada; Energy, Mines and Resources Canada.
p Preliminary; e Estimated; [1] All forms.

TABLE 2. CANADA, CADMIUM METAL CAPACITY, 1985

Company and Location	Annual Capacity
	(tonnes)
Cominco Ltd. Trail, British Columbia	640
Canadian Electrolytic Zinc Limited Valleyfield, Quebec	550
Kidd Creek Mines Ltd. Timmins, Ontario	450
Hudson Bay Mining and Smelting Co., Limited Flin Flon, Manitoba	160
Total Canada	1 800

Sources: Mining & Mineral Processing Operations in Canada, 1983. Energy, Mines and Resources, Canada.

TABLE 3. CANADA, CADMIUM PRODUCTION AND EXPORTS 1983-85 AND CONSUMPTION 1982-84

	1983		1984P		1985P	
	(kilograms)	($)	(kilograms)	($)	(kilograms)	($)
Production						
All forms[1]						
Ontario	793 000	2,432,000	929 606	4,489,997	872 829	3,169,242
British Columbia	138 000	423,000	114 420	552,649	240 045	871,603
Manitoba	102 000	311,000	149 132	720,308	161 316	585,738
Quebec	85 000	262,000	89 932	434,372	116 346	422,452
New Brunswick	55 000	169,000	89 519	432,377	73 254	265,985
Saskatchewan	13 000	38,000	16 925	81,747	7 680	27,886
Northwest Territories	3 000	10,000	213 956	1,033,407	208 861	758,374
Newfoundland	2 000	6,000	-	-	-	-
Yukon	2 000	6,000	1 796	8,674	2 580	9,368
Total	1 193 000	3,657,000	1 605 286	7,753,531	1 682 911	6,110,648
Refined[2]						
Exports					(Jan.-Sept.)	
United States	776 432	2,978,000	824 666	3,458,000	626 346	2,069,000
United Kingdom	495 481	1,078,000	511 340	1,754,000	340 085	860,000
Netherlands	87 996	128,000	28 060	85,000	110 962	348,000
Others	5 202	48,000	5 356	64,000	35	17,000
Total	1 365 111	4,232,000	1 369 422	5,361,000	1 077 428	3,294,000

	1982	1983	1984P
		(kilograms)	
Consumption			
Cadmium metal[3]			
Plating	15 846r	15 641	13 327
Solders	247	148	226
Other uses[4]	17 725r	17 096	15 257
Total	33 818	32 885	28 810

Sources: Statistics Canada; Energy, Mines and Resources 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; .. Not available; r Revised.

TABLE 4. CANADA, CADMIUM PRODUCTION, EXPORTS AND DOMESTIC SHIPMENTS, 1970, 1975 AND 1980-85

	Production		Exports	Producers'
	All Forms[1]	Refined[2]	Cadmium Metal	Domestic Shipments
		(kilograms)		
1970	1 954 055	836 745	702 630	157 307
1975	1 191 674	1 142 508	637 797	98 820
1980	1 033 000	1 302 955	1 095 825	88 232
1981	833 788	1 293 265	1 452 904	131 175
1982	886 055	1 162 390	769 530	84 910
1983	1 107 000	1 296 000	1 365 111	91 000
1984	1 605 300	1 768 000	1 369 422	78 000
1985[3]	1 683 900	1 276 000	1 077 428	57 000

Sources: Statistics Canada; Energy, Mines and Resources 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] For period January-September.

TABLE 5. CADMIUM METAL PRICES, 1984 AND 1985

	Average Monthly Prices			
	Metals Week		Metal Bulletin	
	U.S.	New York	European Sticks	
Month	Producer	Dealer	free market	Cominco
1984	($US/lb)		($US/lb	($Cdn/lb)
January	1.25	0.910	0.86-0.90	1.25
February	1.25	1.056	1.05-1.13	1.25
March	1.50	1.320	1.45-1.56	1.67
April	2.25	1.705	1.68-1.74	1.75
May	2.25	1.687	1.61-1.67	2.13
June	2.25	1.543	1.51-1.60	2.25
July	1.82	1.326	1.25-1.35	2.25
August	1.55	1.285	1.27-1.33	1.78
September	1.55	1.324	1.29-1.34	1.75
October	1.55	1.204	1.18-1.23	1.75
November	1.44	1.160	1.15-1.20	1.75
December	1.40	1.134	1.13-1.20	1.75
Average	1.67	1.305	1.29-1.35	1.78
1985				
January	1.40	1.179	1.19-1.24	1.75
February	1.40	1.168	1.12-1.17	1.75
March	1.40	1.053	0.90-0.98	1.75
April	1.40	1.001	0.92-0.98	1.75
May	1.40	0.917	0.84-0.90	1.75
June	1.40	0.821	0.73-0.79	1.75
July	1.10	0.838	0.76-0.82	1.25
August	1.00	0.864	0.83-0.88	1.25
September	1.00	0.808	0.81-0.86	1.25
October	1.00	0.806	0.82-0.86	1.25
November	1.00	0.777	0.77-0.82	1.25
December	1.00	0.797	0.77-0.81	1.25
Average	0.21	0.919	0.87-0.93	1.50

Sources: Metals Week, Cominco Ltd., Metal Bulletin.

TABLE 6. WESTERN WORLD CADMIUM METAL PRODUCTION, 1981-85

Continent and Country	1981	1982	1983	1984	(Jan.-June) 1985P
			(tonnes)		
Europe					
Austria	55	49	46	48	24
Belgium	1 176	1 001	1 217	1 450	659
Finland	621	566	616	614	307
France	664	580	447	447	196
Germany, F.R.	1 192	1 030	1 094	1 111	520
Italy	489	475	386	515	400
Netherlands	518	497	513	636	305
Norway	117	102	117	152	69
Spain	303	286	278	290	148
United Kingdom	278	354	340	390	177
Yugoslavia	208	174	48	48	24
Africa					
Algeria	30	30	30	24	12
Namibia	-	110	51	41	-
Zaire	230	281	308	300	156
Asia					
India	113	131	131	143	97
Japan	1 977	2 021	2 215	2 400	1 228
Republic of Korea	300	320	460	460	228
Turkey	10	10	10	12	6
America					
Canada	1 293	1 162	1 296	1 774	904
Mexico	633	674	847	894	457
Peru	312	425	443	n.a.	-
United States	1 871	1 351	1 382	2 066	934
Other America	28	94	210	249	118
Australia	1 031	1 010	1 104	1 061	447
Western World	13 449	12 733	13 589	15 123	7 416

Sources: World Metal Statistics, August 1985. Energy Mines and Resources Canada.
P Preliminary; - Nil; n.a. Not available.

Calcium

G. BOKOVAY

With sustained growth of the major economies in the western world during 1984 and 1985, demand for calcium metal is reported to have been strong and increasing. While calcium metal has a variety of uses, metallurgical applications, particularly within the iron and steel industry, are expected to offer the best growth opportunities for the metal in the next decade.

Calcium is a light element (specific gravity of 1.55) with a low tensile strength (48 MPa) and a melting point of 839° C. It is the fifth most abundant element and third most abundant metal in the earth's crust, occurring in limestones, gypsum, fluorite and apatite, and in solution in sea water. This element is essential to all plant and animal life. Calcium metal is highly reactive and therefore does not occur in nature in the pure state. The metal is soft, ductile and easily shaped. Metallic calcium is used as a reducing agent and as an alloying element with other metals.

Metallic calcium can be produced either by electrolysis or by the aluminothermic reduction of lime. The latter method is used exclusively by the four producers in the non-communist world.

CANADIAN DEVELOPMENTS

Since Timminco Limited is the only producer in Canada, data on Canadian production and trade are no longer published for reasons of confidentiality. This company produces a number of metals and alloys at its metallurgical plant at Haley, near Renfrew, Ontario. To make calcium, high-purity quicklime (CaO) and commercially pure aluminum are briquetted, and the briquettes are charged into horizontal retorts. Under vacuum, the aluminum reduces the quicklime so that calcium is liberated as a vapour which crystallizes in a water-cooled condenser section of the retort at about 700°C. The crystallized product, known as "crowns", is about 98 per cent Ca. Higher purities are obtained by subsequent refining operations.

Timminco markets four calcium products. There is a commercial grade, which is 98.0 per cent minimum calcium with maximum contents of 0.5 per cent aluminum and 1.5 per cent magnesium. The battery grade is 98.5 per cent minimum calcium with maximum contents of 0.45 per cent aluminum, 0.5 per cent magnesium and 0.015 per cent nitrogen. The redistilled grade is 99.4 per cent minimum calcium with maximum contents of 0.01 per cent aluminum, 0.5 per cent magnesium, 0.006 per cent nitrogen, 0.005 per cent iron, 0.005 per cent manganese, 0.0006 per cent chromium, 0.001 per cent combined chromium/copper/nickel and 0.003 per cent silicon. Finally, there is a 75/25 calcium alloy nominally 75 per cent calcium (ranging from 72 to 78.5 per cent) with 0.5 to 1.5 per cent magnesium and the balance, nominally 25 per cent, aluminum.

WORLD DEVELOPMENTS

According to the U.S. Bureau of Mines, total world production of calcium metal in 1983 was estimated at about 1 800 t. The largest producers are thought to include Canada, the People's Republic of China, France, the U.S.S.R., Japan and the United States.

The sole U.S. producer is Pfizer Inc. which operates a calcium metal plant at Canaan, Connecticut. According to the U.S. Bureau of Mines, Pfizer accounts for about 50 per cent of western world production or about 680 tpy.

The remaining major non-socialist producer, in addition to Canada, is the Bozel Electrométallurgie subsidiary of Aluminium Pechiney in France. The company has reported that the capacity of the Bozel plant has been expanded to about 1 000 tpy and that this will increase to 2 000 tpy in 1986. Pechiney also reports that this expansion will incorporate a new low cost production process that will also improve product quality.

For 1983, the U.S. Bureau of Mines reported that U.S. imports for calcium metal totalled 113 t of which 81 t originated in the

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People's Republic of China (PRC) while 25 t came from Canada. In 1984, U.S. imports were reported at 111 t of which 97 t came from the PRC.

PRICES

The United States producer list price for calcium metal crowns was raised to $US 3.76 per lb. from $3.25 per lb. effective January 1, 1985. On Nov. 1, 1985 prices were increased to $US 3.92 per pound. These prices apply to minimum shipments of 20,000 lbs.

Meanwhile, the U.S. producer list price for calcium-silicon alloy (28-32 per cent Ca, 62-67 per cent Si, maximum 0.3 per cent Fe) remained steady throughout 1984 and 1985 at 72 cents (U.S.) per lb. This price applies to minimum shipments of 4,000 lbs.

USES

Calcium's powerful reducing properties make it valuable in the manufacture of many of the less common metals such as columbium, tantalum, chromium, plutonium, titanium, thorium, tungsten, uranium, yttrium, vanadium and zirconium. In nonferrous metallurgy, its uses are in debismuthizing lead; as an alloying additive to harden lead plate storage battery grids in the "maintenance free" battery; and as an alloying element with magnesium and aluminum. Calcium metal, calcium compounds and ferrosilicon alloys containing calcium are widely used in ferrous metallurgy to control grain size, inhibit carbide formation, improve ductility and reduce internal flaws in castings. In addition, some calcium metal is used as a reducing agent in manufacturing rare earth magnetic alloys, in the preparation of Vitamin B, and in a number of chemicals. The U.S. Bureau of Mines reports that calcium metal also has certain nuclear applications.

OUTLOOK

Demand for calcium metal is expected to remain strong particularly from the iron and steel industry where it is used as a desulphurizing and deoxidizing agent. Although the same results in the steel making process can be achieved in other ways, calcium has proved to be an efficient and cost effective agent in these applications.

While the production of maintenance-free lead-calcium alloy batteries has gained wide acceptability in North America, penetration in other markets is expected to be fairly slow. As such, calcium consumption in this application is expected to grow at about 2 per cent per annum in the next decade.

TARIFFS

Item No.	British Preferential	Most Favoured Nation	General	General Preferential
		(%)		
CANADA				
92805-1 Calcium Metal	10	10.7	25	7

MFN Reductions under GATT (effective January 1 of year given)	1985	1986	1987
		(%)	
92805-1	10.7	9.9	9.2
UNITED STATES (MFN)			
632-16 Calcium, unwrought, waste and scrap	4.1	3.6	3.0
633-00 Calcium, wrought	6.4	5.9	5.5

Sources: The Customs Tariff, 1985, Revenue Canada Customs and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241.

Cement

D.H. STONEHOUSE

SUMMARY 1985

During 1985 both residential and non-residential construction in Canada continued an upward trend begun in the latter part of 1984. Demand for cement followed a similar trend and consumption, in the range of 7 million t, was its highest since 1981. Total cement shipments increased to over 9.5 million t as exports to the United States of both cement and clinker rose by nearly 23 and 17 per cent respectively. The Canadian cement industry showed the third best performance relative to 1984 of all industry sectors, behind gold and coal mines.

Although business investment is being encouraged, no major contracts in the mega-project range have been awarded. Except for projects in British Columbia triggered by Expo 86, the increased construction activity during 1985 was confined to eastern Canada. Canadian cement production capacity was not changed during 1985 and remained at 16.54 million tpy. Plant closures for extended periods were again common during 1985.

Exports of Canadian cement and clinker are mainly to the United States, in particular to the states of New York, Vermont, Michigan and Minnesota. An economic recovery, begun in late-1982 in the United States, created strong demand for many construction materials. Canadian cement production efficiencies and the strong American dollar combine to make Canadian cement and clinker competitive in bordering states, quite different than being imported as a supplement to United States production. Imports from Mexico, Spain and Venezuela have added to the concerns of the United States cement producers. Protectionist measures have been considered. Of particular concern to Canadian exporters is the Buy America provision within the United States Surface Transportation Assistance Act, 1982 (STAA). STAA provides substantial funding for highway and bridge projects in the United States, representing about 6 per cent of total United States cement consumption. Through 1983 and early-1984, Canadian exporters were effectively excluded from supplying these projects by Buy America restrictions on foreign cement. Congress lifted these restrictions in March, 1984 and Canadian cement now enjoys full access to STAA-funded projects. The United States cement industry reaction to lowering domestic production in favour of imports has led to the formation of an American Cement Trade Alliance (ACTA) to lobby against dumped or subsidized product. The United States Commerce Department has undertaken to conduct a "Competitive Assessment Study" of the cement industry in that country.

Major Canadian cement producers strengthened their United States position during the 1980s with acquisitions ranging from cement storage and distribution facilities and clinker grinding plants to full clinker producing and grinding capacity. In 1985, Lafarge Corporation, which wholly owns both Canada Cement Lafarge Ltd. in Canada and General Portland Inc. in the United States, announced its decision to close General Portland's Florida plants and to make up the lost production with imports from Mexico. The Florida plants account for 19 per cent of General Portland's capacity of 6 million t. The company is planning to accommodate further imports into Texas and on both the east and west coasts.

Between 1980 and 1984 St. Lawrence Cement Inc. spent some $180-million on capital investment about $100-million of which was to acquire cement production and terminal facilities in northeastern United States. In 1985, the company announced the planned acquisition of the Hagerstown, Maryland cement plant, along with a distribution terminal at the port of Baltimore, from Lone Star Industries Inc. of Greenwich, Connecticut for $US 65 million. During the year St. Lawrence also acquired Custom Concrete Ltd. of Toronto, with six ready-mix plants and three aggregate quarries.

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Lake Ontario Cement Limited, the only Canadian controlled public cement company, continued its policy of integration through its Building Products Group during 1985 with the acquisition of three ready-mix operations - Hoffman (North) Concrete of North Bay, Bertrand Concrete of Ottawa and Maitland Redi-Mix Concrete Products Limited.

CANADIAN DEVELOPMENTS

The Canadian cement industry is strongly regionalized on the basis of market availability. Capacity is concentrated near growth areas and, fortunately for some, these areas are convenient to foreign market access as well. Some plants were located to take advantage of existing United States markets and to be in a position to utilize waterborne, high-bulk transportation facilities.

St. Lawrence Cement's acquisition of Lone Star's Hagerstown, Maryland plant is a continuation of the company's expansion policy. In 1984, the company purchased the Catskill, New York plant of Lone Star for $US 30 million and earlier had purchased a terminal operation at Wilmington, Massachusetts to improve service to the Boston area and had added to its terminal facility at Oswego, New York. St. Lawrence now has about 1.1 million t of capacity in the United States and continues to ship into the northeastern region from its Canadian plants.

With the acquisition of General Portland Inc. of Dallas, Texas in 1982, Canada Cement Lafarge Ltd. became the largest cement producer in North America with an annual capacity of 11.663 million t. Early in 1983 a corporate reorganization established Dallas-based Lafarge Corporation which wholly-owns both Canada Cement Lafarge Ltd. and General Portland Inc. The move was designed to give the corporation access to the United States money market and to maintain the overall 52 per cent control of both companies by Lafarge Coppée of Paris, France.

St. Marys Cement Company has two United States affiliates - St. Marys Wyandotte Cement Inc. and St. Marys Wisconsin Cement Inc. The former operates a 300 000 tpy grinding plant near Detroit, the latter a 150 000 tpy grinding plant in Milwaukee and distribution terminals in Green Bay, Wisconsin and Waukegan, Illinois.

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

Lake Ontario Cement Limited, for example, is well integrated into the concrete products field. In 1984 it brought three companies into its corporate structure: Soil Protection Systems Inc. of Milton, Ontario; Euclid Chemical Canada Inc. of Markham, Ontario; and United Aggregates Ltd. of Brampton, Ontario. The company also began a $1.5 million expansion program at its Vibrapipe Ltée operation in Quebec. With the 1985 acquisitions the company now has two cement subsidiary operations in the United States, five operations in its Pipe Group, six in its Building Products Group and two operations attached to the corporate offices.

Cement manufacture is energy-intensive. It is obvious that research should be concentrated in this area, and specifically within the pyroprocessing sector where over 80 per cent of the energy is consumed. Raw material grinding and finish grinding are being studied to determine optimum particle size for energy consumed. Energy conservation programs adopted by the Canadian cement industry more than reached the goal of a 9 to 12 per cent reduction in energy consumption per unit of production, based on 1974 calculations. In 1984 the Canadian cement industry on average consumed 4,931 megajoules a tonne of production of which 4,347 megajoules was derived from fossil fuels.

The fuel mix has changed quite dramatically from that in 1974 when natural gas, petroleum products and coal/coke accounted for 49.5, 39.7 and 10.8 per cent respectively. In 1985, in the same order, the respective percentages were 37.8, 6.9 and 55.4. The dry process now accounts for over 70 per cent of Canadian portland cement capacity. In 1984 dry process plants accounted for 81 per cent of total Canadian cement production.

Energy conservation demonstration projects have been funded through the Conservation and Non-Petroleum Sector of Energy, Mines and Resources. The industry is represented on the Industrial Minerals Task Force on Energy Conservation and continues to play an active role in this voluntary organization. Through the Canada Centre for Mineral and Energy Technology, a branch of Energy, Mines and Resources and through the Building Research Division of the National Research Council a continuing program of concrete research is managed. Concrete research has generally been confined to strength determination, durability, placement and curing. Recently much research has been done on the use of superplasticizers, a group of admixtures described chemically as naphthalene or melanine sulphonate polymers, which have been found to provide greater workability over short time spans or to provide high strength by permitting lower water-cement ratios.

Energy, Mines and Resources research on the use of blast furnace slag from the steel industry to manufacture a slag cement will be applied by Reiss Lime Company of Canada, Limited. The company will produce 200 000 tpy of slag cement at Spragg, Ontario, using granulated slag from The Algoma Steel Corporation, Limited, Sault Ste. Marie plant. Principal use for the cement will be in mine backfill.

Two major research projects currently sponsored through CANMET deal with the use of fly ash in concrete and with the alkali reactivity of certain concrete aggregates.

Research in the private sector is conducted on behalf of all cement producers by the Portland Cement Association (PCA), a non-profit research group sponsored by the cement industry. Individual producers generally have research facilities varying in size from a customer service unit to a large laboratory, mandated, as in the case of Canada Cement Lafarge's new Montreal-based facility, "to develop new manufacturing processes and improve cement and concrete products tailored to the Canadian and United States markets."

The three plants in the **Atlantic region** constitute just over 5 per cent of total clinker producing capacity. All three obtain raw materials at or near the plant site. North Star Cement Limited is undergoing extensive renovation at its Corner Brook, Newfoundland plant to improve fuel efficiency. Canada Cement Lafarge's plants at Brookfield, Nova Scotia and at Havelock, New Brunswick were closed for periods in 1985 despite regional consumption being increased over 1984 levels of just over 400 000 t.

In the **Quebec region** the five clinker-producing plants have 25 per cent of the Canadian total in an area that has 26.1 per cent of Canadian population and which, in 1984, consumed about 1.6 million t of portland cement or 25 per cent of total consumption. At its St. Constant plant, south of Montreal, CCL has experimented with the use of waste tires and rubber as an alternate fuel, as part of a program administered by the federal departments of Environment and Energy, Mines and Resources.

Miron Inc. investigated the use of methane gas from a garbage disposal project on its property with the goal of eventually securing as much as 40 per cent of its fuel requirements from this source. The plant's boiler room was operated in 1983 on methane gas. Input garbage has the energy potential to operate the company's two kilns. Miron is actively investigating new plant sites south of Montreal as time runs out for their quarry-cement plant operation in the heart of Montreal. St. Lawrence Cement Inc. also continued its energy-saving programs during 1985 but concentrated its expenditures on expanding further into the United States market through plant and distribution acquisitions. Ciment Quebec Inc. began full operation of its new suspension-preheater-precalciner system in 1983, adding about 735 000 tpy to capacity.

Portland cement consumption increased in the **Ontario region** where 40 per cent of the nation's clinker-producing capacity is concentrated. Canada Cement Lafarge Ltd. has brought into production about 3 million t of new cement capacity over the past seven years and currently over half of its operating kilns are less than 10 years old. The limestone for CCL's Bath, Ontario plant is quarried on-site while silica is supplied from Potsdam sandstone at Pittsburgh about 65 km east of Bath and iron oxide is purchased from Hamilton. Gypsum is from Nova Scotia. The Woodstock plant has experimented with the use of selected, processed garbage as fuel. The plant obtains limestone on site, silica from Indusmin Limited, iron oxide from Stelco Inc. and gypsum from southern Ontario mines.

At Picton, Lake Ontario Cement Limited operates one of the largest cement plants in North America. The four-kiln plant supplies cement and clinker to its United States subsidiaries - Rochester Portland Cement Corp. in New York state and Aetna Cement Corporation in Michigan - and cement to its Ontario markets.

For its Mississauga plant, St. Lawrence Cement Inc. obtains limestone from Odgen Point, 160 km east of Toronto on the shore of Lake Ontario and gypsum is purchased from Nova Scotia or from southern Ontario mines.

The Bowmanville plant of St. Marys Cement Limited was expanded in 1973 with the addition of a second kiln. With the acquisition of Wyandotte Cement Inc., the company began shipments of clinker through a newly constructed lakefront loading facility at Bowmanville. The original plant at St. Marys, constructed in 1912 to serve the Toronto area, has been expanded and modernized over the years, most recently with the installation of a 680 000 tpy kiln and four-stage suspension preheater.

Federal White Cement's plant at Woodstock, can produce up to 100 000 tpy of white cement.

Two companies, Canada Cement Lafarge Ltd. and Genstar Cement Corporation operate a total of five clinker producing plants in the **Prairie region** and three in the **Pacific region** along with two clinker grinding plants. This **Western region** has 30 per cent of clinker producing capacity, including the recently completed expansion at Genstar's Edmonton, Alberta plant. Consumption of portland cement in the western provinces accounted for 33 per cent of Canadian total. Recent expansions at Edmonton and at Exshaw increased capacity by about 1.3 million tpy through 1981.

Genstar Cement Corporation continued to increase the productive capacity at its Cadomin limestone property which supplies the Edmonton plant through a 4 500 t unit train and materials handling system. A limestone quarry at Mafeking, Manitoba, near the Manitoba-Saskatchewan border, supplies limestone to Genstar's Regina plant, while the Winnipeg plant is supplied from Steep Rock, Manitoba.

CCL's Winnipeg plant obtains limestone from the company's quarry at Steep Rock on Lake Manitoba, gypsum from Westroc Industries Limited at Amaranth, silica from Beausejour and clay adjacent to the plant site at Fort Whyte. Raw material for the Exshaw plant is mainly from the plant site but for gypsum from Westroc and iron oxide from Cominco Ltd. Limestone from Texada Island supplies the company's Vancouver plant at Richmond. Their Kamloops plant is supplied from resources close to the plant site.

WORLD DEVELOPMENTS

Cement markets are regional and centred in developing urban areas where construction activity is concentrated, or in areas where mining or heavy engineering construction projects are being carried out. The normal market area of a given cement-producing plant depends 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.

Because raw materials for cement manufacture are generally widespread, 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 surplus cement production in order to operate facilities economically. The strong American dollar vis-a-vis European and other currencies has been the principal reason for a major increase in imports of cement and clinker to the United States from as far as Spain and Venezuela. A current glut of shipping bottoms has had an influence on this situation as well.

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 country and by company.

USES

Portland cement is produced by burning, usually in a rotary kiln, an accurately proportioned, finely ground mixture of limestone, silica, alumina and iron oxide. The three basic types of portland cement, Normal Portland, High-Early-Strength Portland, and Sulphate-Resisting Portland, are produced by most Canadian cement manufacturers.

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 projects, or used in the form of delicate precast panels or heavy, prestressed columns and beams in building construction.

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, the burning conditions and of the use of additives in the clinker-grinding procedure, finished cements displaying various desirable properties can be produced.

Moderate Portland Cement and Low-Heat-of-Hydration Portland Cement, designed for use in concrete to be poured in large masses, such as in dam construction, are manufactured by several companies in Canada. Masonry cement (generic name) includes such proprietary names as Mortar Cement, Mortar Mix (unsanded), Mason's Cement, Brick Cement and Masonry Cement. The latter product produced by portland cement manufacturers, is a mixture of portland cement, finely ground high-calcium limestone (35 to 65 per cent 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.

Portland cement used in Canada should conform to the specifications of CAN 3-A5-M83, published by the Canadian Standards Association (CSA). This standard covers the five main types of portland cement. Masonry cement produced in Canada should conform to the CAN 3-A8-M83. Blended hydraulic cements are covered by CAN 3-A362-M83. The cement types manufactured in Canada, but not covered by the CSA standards, generally meet the appropriate specifications of the American Society for Testing and Materials (ASTM).

OUTLOOK

Canada's economic recovery has lagged uncommonly far behind recovery in the United States since 1982. The construction industry in the United States became very active following the 1980-81 recession and demand for the materials of construction presented opportunities for Canadian producer-exporters of cement, clinker, gypsum and gypsum wallboard. Canadian business investment remained low and construction expenditures, particularly in engineering projects actually decreased. Housing starts dropped to 125,860 in 1982, rebounded to 162,645 in 1983, dropped again in 1984 to 134,900 and will be in the range of 150,000 in 1985. Residential, commercial and institutional building construction have been more active, accounting for steady but slow increases in the building construction sector as a whole. A few indicators provide a positive outlook for the building construction sector: housing starts are increasing, inflation is relatively low, and the unemployment rate is falling. However, direct spending on construction could be tempered by increased taxes on building materials and by government spending cuts. On a regional basis the construction outlook is fairly good in eastern Canada but less encouraging in the western region where the effects of depressed world oil prices will likely mean less investment.

The Canadian Construction Association is predicting increases in the non-residential contract construction industry constant dollar expenditures of 4.5 per cent through 1986 to 1995 based upon the influences of the Western Accord and the May 1985 budget. The construction industry as a whole has expressed concern that Canada's large infrastructure network needs attention, leading to major renovation and upkeep projects similar to those begun on the United States highway system. Such a program would permit the construction industry and that portion of the mining industry which depends on it to plan five to ten years ahead with obvious benefits in efficiency, rather than to invest with short-term survival as the main incentive.

The cement industry in Canada is capable of meeting immediate demands and is also capable of expansion to meet even greater demand from domestic and foreign markets should opportunities be presented. The pattern of consumption of portland cement established during 1983-84 will likely persist for a few years or until the development of mega projects once again alters the current demand for cement.

Conservation of energy and raw materials within the cement industry is of worldwide concern and provides a theme around which major developments in the industry have taken place. Of particular note is the emphasis on blended cements and the utilization of slag, ash and other byproducts. Even greater additions to production capacities than those witnessed during the past few years will be needed to meet demand in many developing countries.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(cents per hundred pounds)		
CANADA					
29000-1	Portland and other hydraulic cement, nop; cement clinker	free	free	6	free
29005-1	White, nonstaining Portland cement	3.8	3.8	8	2.3

MFN Reductions under GATT (effective January 1 of year given)	1985	1986	1987
	(cents per hundred pounds)		
29005-1	3.8	3.7	3.7

UNITED STATES (MFN)

Item No.		
511.11	White, nonstaining Portland cement per 100 pounds including weight of container	1¢
511.14	Other cement and cement clinker	free
511.21	Hydraulic cement concrete	free

		1985	1986	1987
		(% ad valorem)		
511.25	Other concrete mixed, per cubic yard	5.6	5.2	4.9

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated 1985, USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241.

TABLE 1. CANADA, CEMENT PRODUCTION AND TRADE, 1983-85

	1983		1984		1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production[1]						
By province						
Ontario	2 901 000	203,242	3 654 153	256,084	3 870 500	292,225
Quebec	2 171 000	127,567	2 728 097	171,651	3 053 000	196,200
Alberta	1 190 000	126,860	989 619	120,071	1 006 600	118,779
British Columbia	763 000	66,282	939 354	69,939	990 239	77,239
Manitoba	290 000	31,983	335 988	34,192	311 250	33,148
Saskatchewan	184 000	21,154	..	18,852	..	16,729
Nova Scotia	..	10,014	..	24,252	..	22,094
New Brunswick	..	8,965	..	14,567	..	15,134
Newfoundland	..	10,034	..	7,675	..	8,462
Total	7 871 000	606,101	9 240 257	717,282	9 771 764	780,050
By type						
Portland	7 615 000	..	..	..	..	..
Masonry[2]	256 000	..	..	..	..	..
Total	7 871 000	606,101	9 240 257	717,282	9 771 764	780,050
					(Jan.-Sept.)	
Exports						
Portland cement						
United States	1 451 232	69,435	2 104 171	104,895	1 843 620	94,829
Cameroon	-	-	3 740	330	1 016	87
Algeria	19 076	1,112	1 510	290	5 166	360
Other countries	42 254	2,021	3 961	397	1 177	107
Total	1 512 562	72,568	2 113 382	105,912	1 850 979	96,385
Cement and concrete basic products						
United States	..	44,443	..	57,972	..	40,677
Other countries	..	1,935	..	1,714	..	262
Total	..	46,378	..	59,686	..	40,939
Imports						
Portland cement, standard						
United States	212 505	16,119	208 122	16,735	167 892	12,547
Other countries	170	14	757	66	383	44
Total	212 675	16,132	208 879	16,801	168 275	12,591
White cement						
United States	1 457	240	2 201	245	1 035	129
Japan	1 167	187	1 013	184	484	81
Other countries	249	31	915	118	1 470	145
Total	2 873	458	4 129	547	2 989	355
Aluminous cement						
United States	3 338	1,173	6 200	2,055	3 705	1,420
Other countries	-	-	-	-	-	-
Total	3 338	1,173	6 200	2,055	3 705	1,420
Cement, nes						
United States	19 069	2,776	16 414	2,337	25 056	2,360
United Kingdom	32	11	370	81	2 903	612
Japan	200	33	80	11	366	54
West Germany	7	1	29	7	55	14
Italy	13	3	13	3	19	5
France		-	-	-	530	31
South Africa	5	9	-	-	-	-
Other countries	4	1	-	-	2	1
Total	19 330	2,835	16 906	2,438	28 931	3,077
Total cement imports	238 216	20,598	236 114	21,841		
Refractory cement and mortars						
United States	..	13,374	..	16,497	..	13,368
France	..	9	..	174	..	452
West Germany	-	239	..	153	..	128
United Kingdom	..	111	..	78	..	10
Yugoslavia	..	14	..	74	..	37
Other countries	..	709	..	35	..	49
Total	..	14,456	..	17,011	..	14,044
Cement and concrete basic products, nes						
United States	..	3,969	..	3,914	..	2,905
France	..	1	..	28	..	6
West Germany	..	-	..	26	..	143
United Kingdom	..	1	..	17	..	66
Belgium-Luxembourg	..	-	..	14	..	-
Other countries	..	30	..	1	..	40
Total	..	4,001	..	4,000	..	3,210
Cement clinker						
Spain		-	-	-	38 562	1,132
Belgium-Luxembourg	-	-	-	-	24 503	791
Venezuela	-	-	-	-	31 876	1,052
United States	53	2	119	4	-	-
Total	53	2	119	4	94 941	2,975

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Producers' shipments plus quantities used by producers. [2] Includes small amounts of other cement.
P Preliminary; .. Not available; - Nil; nes Not elsewhere specified.

TABLE 2. CEMENT PLANTS, APPROXIMATE ANNUAL GRINDING CAPACITY, END OF 1985

Company	Plant	Wet, Dry, Pre-heater	Fuel (Coal Oil Gas)	No. of Kilns	Grinding Capacity	Clinker Capacity
					(000 tpy)	
Atlantic						
Canada Cement Lafarge Ltd.	Brookfield, N.S.	D	C,O	2	485	458
	Havelock, N.B.	D	C,O	2	315	300
North Star Cement Limited	Corner Brook, Nfld.	Dx	O	1	250	120
Atlantic Region Total				5	1 050	878
Quebec						
Canada Cement Lafarge Ltd.	St. Constant	D	O,G	2	955	902
Ciment Quebec Inc.	St. Basile	W,Dc	O	3	575	1 106
Miron Inc.	Montreal	D	O,G	2	1 000	840
St. Lawrence Cement Inc.	Beauport	W	C,O	2	550	598
(Independent Cement Inc.)	Joliette	D	C,O	4	1 000	976
Quebec Region Total				13	4 080	4 422
Ontario						
Canada Cement Lafarge Ltd.	Woodstock	W	C,G	2	535	505
	Bath	Dx	O,G	1	1 000	943
Federal White Cement	Woodstock	D	O	1	100	100
Lake Ontario Cement Limited	Picton	D,Dx	C,G	4	744	1 419
St. Lawrence Cement Inc.	Clarkson	W,Dc	C,O,G	3	2 400	1 700
St. Marys Cement Limited	Bowmanville	W	C	2	790	600
	St. Marys	W,Dx	O,G	3	800	990
Ontario Region Total				16	6 270	6 257
Prairies						
Canada Cement Lafarge Ltd.	Fort Whyte, Man.	W	O,G	2	565	532
	Exshaw, Alta.	D,Dc	G	3	1 230	1 184
	Edmonton, Alta.				220	
Genstar Cement Corporation	Winnipeg, Man.	W	O,G	1	325	310
	Regina, Sask.	D	O,C	1	375	214
	Edmonton, Alta.	W,Dc	G	4	2 040	1 186
Prairies Region Total				11	4 755	3 426
British Columbia						
Canada Cement Lafarge Ltd.	Kamloops	D	G	1	190	180
	Richmond	W	O,G	2	555	522
Genstar Cement Corporation	Tilbury Island	Dx	O,G	1	1 000	855
B.C. Region Total				4	1 745	1 557
CANADA TOTAL (9 companies)				49	17 900	16 540

Source: Market and Economic Research Department, Portland Cement Association.

TABLE 3. CANADA, CEMENT PLANTS, KILNS AND CAPACITY UTILIZATION, 1977-85

	Clinker Producing Plants	Kilns	Approximate Cement Grinding Capacity[1]	Portland and Masonry Cement Production[2]	Clinker Exports[3]	Approximate Total Production[4]	Capacity Utilization
			(tpy)	(t)	(t)	(t)	(%)
1977	22	49	14 885 000	9 639 679	775 145	10 414 824	72
1978	24	51	15 985 000	10 558 279	1 077 274	11 635 553	72
1979	24	51	15 985 000	11 765 248	1 530 537	13 295 785	83
1980	23	47	16 363 000	10 274 000	726 087	11 000 087	67
1981	23	48	16 771 000	10 145 000	524 006	10 669 006	64
1982	23	48	16 771 000	8 418 000	290 329	8 708 329	50
1983	23	49	17 900 000	7 870 878	404 793	8 275 671	46
1984	23	49	17 900 000	9 387 466	440 297	9 827 763	55
1985	23	49	17 900 000	9 771 764P	500 000e	10 271 764e	57

Sources: Statistics Canada, U.S. Bureau of Mines, Portland Cement Association (PCA)
[1] Includes two plants that grind only. [2] Producers' shipments and amounts used by producers. [3] Imports to United States from Canada. [4] Cement shipments plus clinker exports.
e Estimated; P Preliminary.

TABLE 4. CANADA, HOUSE CONSTRUCTION, BY PROVINCE, 1983 AND 1984

	Starts			Completions			Under Construction		
	1983	1984	% Diff.	1983	1984	% Diff.	1983	1984	% Diff.
Newfoundland	3 281	2 720	-17.1	3 176	3 134	-1.3	3 494	3 000	-14.1
Prince Edward Island	673	643	-4.4	548	581	5.7	316	379	19.9
Nova Scotia	5 697	4 598	-19.3	5 069	5 082	0.3	2 984	2 466	-17.4
New Brunswick	4 742	2 873	-39.4	3 487	3 923	12.5	2 346	1 242	-47.1
Total (Atlantic Provinces)	14 393	10 834	-24.7	12 280	12 720	3.6	9 140	7 087	-22.5
Quebec	40 318	41 902	3.9	35 681	43 410	21.7	18 320	16 309	-11.0
Ontario	54 939	48 171	-12.3	55 287	54 642	-1.2	30 243	23 529	-22.2
Manitoba	5 985	5 308	-11.3	4 076	5 865	43.9	3 048	2 474	-18.8
Saskatchewan	7 269	5 221	-28.2	8 090	5 722	-29.3	3 667	3 187	-13.1
Alberta	17 134	7 295	-57.4	24 693	12 057	-51.2	8 336	2 943	-64.7
Total (Prairie Provinces)	30 388	17 824	-41.3	36 859	23 644	-35.9	15 051	8 604	-42.8
British Columbia	22 607	16 169	-28.5	22 901	18 596	-18.8	12 176	8 370	-31.3
Total Canada	162 645	134 900	-17.1	163 008	153 012	-6.1	84 930	63 899	-24.8

Source: Canada Mortgage and Housing Corporation.

TABLE 5. CANADA, VALUE OF CONSTRUCTION[1] BY TYPE, 1983-85

	1983	1984	1985
		($ millions)	
Building Construction			
Residential	16,851	16,497	16,912
Industrial	2,450	2,707	2,967
Commercial	6,482	7,034	7,374
Institutional	3,065	3,028	3,186
Other building	1,905	2,068	2,143
Total	30,753	31,334	32,582
Engineering Construction			
Marine	426	459	500
Highways, airport runways	4,326	4,345	4,873
Waterworks, sewage systems	2,229	2,222	2,292
Dams, irrigation	291	294	288
Electric power	4,397	3,691	3,483
Railway, telephones	2,469	2,552	2,732
Gas and oil facilities	8,128	8,339	8,879
Other engineering	2,929	2,894	3,333
Total	25,195	24,796	26,380
Total construction	55,948	56,130	58,962

Source: Statistics Canada.
[1] Actual expenditures 1983, preliminary actual 1984, intentions 1985.

TABLE 6. CANADA, VALUE OF CONSTRUCTION[1] BY PROVINCE, 1983-85

	1983			1984			1985		
	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total
					($000)				
Newfoundland	500,406	966,856	1,467,262	499,344	955,432	1,454,776	545,809	937,967	1,483,776
Nova Scotia	862,518	1,243,189	2,105,707	947,772	1,230,719	2,178,491	1,040,607	1,244,812	2,285,419
New Brunswick	724,935	429,475	1,154,410	714,228	493,606	1,207,834	707,603	475,935	1,183,538
Prince Edward Island	112,102	69,861	181,963	119,655	66,139	185,794	124,646	68,880	193,526
Quebec	6,798,160	4,194,350	10,992,510	7,689,032	3,978,144	11,667,176	7,922,247	4,050,275	11,972,522
Ontario	10,114,265	4,856,478	14,970,743	11,323,048	5,287,148	16,610,196	12,130,421	5,428,646	17,559,067
Manitoba	1,025,322	620,076	1,645,398	1,082,729	712,903	1,795,632	1,178,621	803,656	1,982,277
Saskatchewan	1,383,238	1,333,645	2,716,883	1,293,247	1,492,889	2,786,136	1,345,724	1,771,544	3,117,268
Alberta	4,640,878	6,441,239	11,082,117	3,416,105	6,257,861	9,673,966	3,436,296	7,398,700	10,834,996
British Columbia, Yukon and Northwest Territories	4,590,837	5,039,937	9,630,774	4,249,136	4,320,995	8,570,131	4,150,391	4,199,396	8,349,787
Canada	30,752,661	25,195,106	55,947,767	31,334,296	24,795,836	56,130,132	32,582,365	26,379,811	58,962,176

Source: Statistics Canada.
[1] Actual expenditures 1983, preliminary actual 1984, intentions 1985.

Cesium

W.J. McCUTCHEON

Cesium consumption in the western world appears to have increased significantly in the past few years and presently is estimated at about 45 tpy. Medical, electrical and chemical research applications are considered to be one of the major uses for cesium. Cesium is found in only a few locations in the non-communist world and Canada has by far the most extensive known reserves.

CANADIAN DEVELOPMENTS

The only known domestic deposit of significance is operated by the Tantalum Mining Corporation of Canada Limited (TANCO) at Bernic Lake, northeast of Winnipeg, Manitoba. This deposit is the sole source of Canadian cesium production.

TANCO is owned 37.5 per cent by Hudson Bay Mining and Smelting Co., Limited (HBM&S), 37.5 per cent by Cabot Corporation of the United States and 25 per cent by the provincial government.

TANCO's principle resources at Bernic Lake are tantalum and lithium but it also has 300 000 t of pollucite reserves grading 24 per cent Cs_2O. Given the low production rate and the size of the present reserves, TANCO has not attempted to delineate additional reserves, although other mineralized areas are known. A more complete description of the ore zones and mine may be found in the Cesium chapter of the 1978 edition of the Canadian Minerals Yearbook.

The mine has basically been on standby since 1982 due to low prices for its principal products. Some experimental work has been undertaken to assess the establishment of a spodumene upgrading plant. The main cesium orebody is accessible from an adit and ramp and cesium is mined as required to fill orders.

Due to the high-grade of the ore, there is no need to concentrate the pollucite prior to shipment. Unlike cesium metal and various cesium chemical compounds, no special handling requirements are necessary in order to transport pollucite ore.

Given the small international demand for cesium metal and cesium compounds, there are only a few centres where pollucite is processed. The majority of cesium recovery takes place in the Federal Republic of Germany (FRG) and to a lesser extent in the United States (where most of the world's cesium is consumed). There are no processing facilities in Canada, hence pollucite is exported directly from the mine to either the Federal Republic of Germany or the United States. Canadian consumption of cesium is not recorded.

Cesium exports from Canada are restricted under the provisions of the Export and Import Permits Act. Cesium ores, metal, chemical compounds and alloys containing cesium were placed on the Export Control List in 1976 and export to communist countries is prohibited. From the opening of the Bernic Lake mine in 1969 to the end of 1975, almost 86 per cent of the cesium exports went to the U.S.S.R. Since the control of cesium exports was initiated, major pollucite shipments have gone to either the United States or the Federal Republic of Germany.

WORLD DEVELOPMENTS

The data about production and consumption of cesium are limited. There are only three significant known deposits in the western world: Bernic Lake, Manitoba; Bikita Minerals (Pvt) Ltd. in Zimbabwe; and the Karibib area in Namibia. Smaller deposits and occurrences are at Veratrask, Sweden and on the island of Elba. Some resources in the United States may exist at sites of former cesium producers in Oxford County, Main and near Custer, South Dakota.

Production of cesium from deposits in Namibia and in the U.S.S.R. is not reported.

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Bikita Minerals is owned 50 per cent by The British Petroleum Company p.l.c., 25 per cent by AMAX Inc., and 25 per cent by Kerr-McGee Chemical Corporation. Its principal products are high-grade petalite and lepidolite ores, supplied to glass makers. Lenses of spodumene and pollucite are present within the high-grade lepidolite ore zone. The typical ore grade is 24 per cent Cs_2O and product is crushed to minus 12 mm. Pollucite reserves are thought to be about 10 per cent of those at Bernic Lake in Canada. Production of pollucite for export by Bikita is estimated to have averaged about 250 tpy in the last two years.

The United States is estimated to be the largest cesium consumer, accounting for an estimated 11.7 t of cesium in 1983 or 55 per cent of estimated world demand, according to the U.S. Bureau of Mines. Research applications constitute one of the largest markets for cesium (and rubidium, which can substitute for cesium). Estimated U.S. demand of cesium has increased rapidly from 11.7 t in 1983 to 21.8 t in 1984 to 31.8 t in 1985.

The Federal Republic of Germany, the United States and the U.S.S.R. are the three main producers of cesium metal and compounds. In the Federal Republic of Germany, Metallgesellschaft AG is the principal cesium producer. The Cabot Corporation is the only significant cesium producer remaining in operation in the United States. Callery Chemical Co. still has the capacity to produce cesium compounds and metal but its facilities are currently idle. Until exports of Canadian pollucite were restricted to the U.S.S.R., that country accounted for the majority of Canadian ore shipments. After the control of Canadian exports was begun the U.S.S.R. may have imported material originating from Zimbabwe to meet domestic requirements.

In 1984, the United States imported cesium compounds from the Federal Republic of Germany, Canada, Israel, Japan, Netherlands, Sweden and the United Kingdom. The Federal Republic of Germany was by far the major supplier of cesium compounds to the United States in 1983 and 1984. U.S. import data for part of 1985 seem to indicate that while imports of cesium chloride (likely primarily used for biomedical purposes) were about the same as the 1984 levels, there has been a significant increase in the imports of other cesium compounds. It is possible that increased catalytic use of cesium accounts for much of this increase.

PRICES

There are three grades of cesium metal sold: technical grade, 99 per cent; 99.5 per cent; high-purity grade, 99.9 per cent. Cesium compounds are available in technical grade purity, 99 per cent, or high purity, 99.9 per cent. Prices vary according to the quantity sold, as illustrated in the table which shows cesium prices (and prices for rubidium which can be substituted for cesium in some applications).

USES

Of the alkali metals, cesium has the lowest boiling point (670°C), the lowest first ionization potential (3.87 electron volts), the highest specific gravity (1.83) and the highest vapour pressure. Cesium's melting point is 28.5°C and thus can be handled as a liquid at normal temperatures.

Information about the demand for cesium is not well documented. The three major uses of cesium (as reported by Gamvrelis in 1984) were: density gradient solutions for separation of macromolecules, photoemissive uses, and scintillation uses. The high density and high solubility of cesium compounds (usually cesium chloride) is the major reason for its selection as a density gradient media. Cesium's low ionization potential, or relative ease with which cesium will shed its outer electron when exposed to light, accounts for its use to either produce electricity from light or light from electricity. A current can be generated when a cesium compound is exposed to infrared, visible or ultraviolet light (photoemissive uses); in reverse, the electrical energy resulting from ionizing radiation can be converted into light (scintillation uses).

An estimated 10 t of cesium chloride is used annually in North America as a density gradient media for DNA research. When centrifuged, a cesium chloride solution's linear density gradient results in DNA and other macromolecules being concentrated at specific locations depending upon their buoyant densities, allowing for easier identification.

Photoemissive and scintillation applications for cesium compounds are well documented. Often devices such as certain radiation detection units will employ both types of compounds. Other uses for such cesium compounds include: photomultiplier tubes, infrared lamps, spectrophotometers, photocells for military anti-aircraft "homing" projectiles and night vision devices.

Other minor uses noted for cesium and cesium compounds include: alkaline storage-battery electrolytes, scavengers for oxygen, ion propulsion of spacecraft, magnetohydrodynamic (MHD) power generation, a gamma source for sewage sludge sterilization (Cesium 137), and catalytic applications.

Cesium has not been the preferred fuel source for electropropulsion of spacecraft (ion propulsion) for over a decade. Even if cesium were to be used, present western world flight plans only would require usage of a minor amount of cesium in the next 10 to 20 years (estimated at less than 10 t in total).

MHD power generators are based upon the principle that a conductor moving through a field will generate an electrical current. The conductor does not have to be a metal such as copper but may be an electrically conductive fluid such as mercury, sodium or an ionized combustion gas. The active MHD systems use ionized combustion gas to generate current. Cesium or another alkali metal added to the gas will enable sufficient ionization to occur at temperatures "low" enough to be handled with present technology. Cesium ionizes at such "lower" temperatures and systems can operate at 2800 to 3000°C.

The ionized gas can be released after current generation (open cycle) or can be recycled and reheated for reuse (closed cycle). The open cycle technology employs potassium due to cost and availability. Unless the cesium were recovered and reprocessed from the exhaust gas of open system MHD plants, operation of a number of open cycle MHD power plants would rapidly deplete known cesium reserves. In closed cycle technology, operating losses are expected to be small and current reserves would support more closed than open cycle plants. Cesium's lower ionization potential permits the same performance at a lower temperature or superior performance at the same temperature as could be expected using potassium.

There are no full-scale commercial plants known to be in operation supplying continuous power to electrical grids. A 50 MW open cycle development plant is currently operating in Butte, Montana. Small scale research is continuing in the Netherlands and Japan on closed cycle technology, and the U.S.S.R. is expected to complete a 500 MW natural gas-fired open cycle plant by 1988.

A U.S. Department of Energy study estimated that commercial proving of MHD systems would not occur before 2010 and that if proven viable, it would not come on line until well after 2010.

There are smaller MHD systems in use which operate in a "blow-down-mode", whereby a high energy pulse (15-60 MW) can be generated for brief periods (10 seconds). Such smaller trailer mounted units are reported to be used in the U.S.S.R. for deep crustal geophysical investigations.

The use of cesium compounds for catalytic applications is believed to be increasing and is presently estimated to account for about 30 to 35 per cent of total cesium consumption. In the past, such catalysts have been used in hydrogenation and polymerization processes.

OUTLOOK

As research into chemical, medical and electrical power generation technologies are the major end-uses for cesium, there is great potential for rapid increase in demand following successful development of a significant new end-use. However, given the small and limited reserve base, rapidly increasing use should result in large price increases encouraging substitution away from cesium. Thus, cesium demand and prices have potential to exhibit large variations over a cycle of a few years.

Canada is well situated to benefit from increased consumption, given the substantial reserve base at Bernic Lake.

TARIFFS

Item No.		British Preferential	General Preferential	Most Favoured Nation	General
			(%)		
CANADA					
92805-1	Cesuim	10	7	10.7	25
93819-1	Compounds of cesium	10	8.5	13.1	25

MFN Reductions under GATT (effective January 1 year given)	1984	1985	1986	1987
		(%)		
92801-1	11.4	10.7	9.9	9.2
93819-1	13.4	13.1	12.8	12.5
UNITED STATES: (MFN)				
601.66 Pollucite	Remains free			
415.10 Cesium	6.5	6.1	5.7	5.3
418.50 Cesium chloride	4.8	4.5	4.3	4.0
418.52 Other compounds	4.4	4.3	4.1	4.0

EUROPEAN ECONOMIC COMMUNITY (MFN)

		1985	Base Rate	Concession Rate
			(%)	
28.05	Cesium & rubidium	3.4	4	3.2
28.30	Chlorides, other	6.9	9.6	6

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States, Annotated 1985, USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, Vol. 27, No. L320, 1985.

TABLE 1. CANADIAN CESIUM PRODUCTION[1], 1978-85

Year	Pollucite Shipped	Cesium Oxide Grade	Contained Cesium Oxide	Contained Cesium
	(t)	(%)	(t)	(t)
1978	254	27.2	69	65
1979	53	25	13	12
1980	-	-	-	-
1981	300	24	72	68
1982	-	-	-	-
1983	200	24	48	45
1984	300	24	72	68
1985[e]	525	24	126	119

Sources: Tantalum Mining Corporation of Canada Limited, and A. Gamvrelis in his work for Master of Natural Resource Management degree at the University of Manitoba.
[1] In addition, there have been small orders from time to time.
[e] Estimated; - Nil.

TABLE 2. WORLD CESIUM PRODUCTION (CESIUM CONTENT IN THE ORE), 1983-85

Year	Canada	Zimbabwe[1]	Namibia	U.S.S.R.
1983	45 t	48 t	nr	nr
1984	68 t	60 t	nr	nr
1985[e]	119 t	60 t	nr	nr
Average 1983-85	77 tpy	56 tpy	nr	nr

Sources: Tantalum Mining Corporation of Canada Limited and A. Gamvrelis, EMR.
[1] Pollucite grade assumed at 24 per cent Cs_2O.
nr Not reported; [e] Estimated.

TABLE 3. CESIUM AND RUBIDIUM PRICES (U.S. CURRENCY) IN NOVEMBER 1985

Material	Technical Grade		High Purity	
	Small lots	Large lots	Small lots	Large lots
Cesium				
Cesium metal	$10/g	$225/lb	$10.25/g	$275/lb
Cesium chloride	$39.20/lb	$34/lb	$78/lb	$58/lb
Rubidium				
Rubidium metal	$11.15/g	$250/lb	$11.40/g	$325/lb
Rubidium chloride	$100/lb	$92.50/lb	$149.10/lb	$141.60/lb

Source: Cabot Corporation, November 1985.

TABLE 4. CANADIAN EXPORTS OF POLLUCITE BY DESTINATION, 1978-85

Year	F.R.G.[1]	U.S.A.	Total
		(tonnes)	
1978	-	254	254
1979	53	-	53
1980	-	-	-
1981	300	-	300
1982	-	-	-
1983	200	-	200
1984	300	-	300
1985[e]	500	25	525

Sources: Tantalum Mining Corporation of Canada Limited, and A. Gamvrelis.
[1] Federal Republic of Germany.
[e] Estimated; - Nil.

Chromium

D.R. PHILLIPS

Canada imports all of its chromium requirements, largely in the form of chromite ore and ferrochromium. During 1985, ore imports fell 19 per cent from 12 800 t in 1984 to 10 316 t. At the same time, imports of ferrochromium decreased 25 per cent from 33 092 t in 1984 to 24 827 t in 1985. The severe reduction in imports of chromite ore reflected the depressed state of the Canadian refractory brick industry and the ferrous foundry industry. The reduction in ferrochromium imports in 1985 was attributed to a decline in the demand for specialty steels.

CANADIAN DEVELOPMENTS

Dominion Engineering Works, a subsidiary of Canadian General Electric Company Limited and one of North America's largest ferrous foundries was permanently closed in July 1985. The closure was due to the declining market for large ferrous castings. Dominion was one of the major Canadian consumers of chromite.

Canadian Steel Foundries, division of Hawker Siddeley Canada Inc. is also one of the largest steel foundries in North America. Reduced demand for large steel castings required in particular by the railway industry has also contributed to its reduced consumption of chromite.

Canada consumes about 12 000 t of chromite ore annually. The major consumers other than the foundries are Canadian Refractories, Division of Dresser Canada Inc., Didier Refractories Corporation, General Refractories Co. of Canada Ltd., and Kaiser Refractories Company Division of Kaiser Aluminium and Chemical of Canada Investment Limited.

Canada's annual consumption of ferrochromium is about 27 000 t. The major consumers are the steel companies. Atlas Steels division of Rio Algom Limited of Welland, Ontario, is the largest steel consumer of ferrochromium which is mainly in the form of charge chrome and high-carbon ferrochrome.

While there is no chromite ore presently mined in Canada, large resources of chromite exist in the Bird River area of Manitoba and the Eastern Townships of Quebec.

The Bird River deposits are a continuous band of low-grade chromite mineralization, believed to be similar in type to the important chromite deposits in Zimbabwe and the Republic of South Africa. These deposits have been considered uneconomic in the past although mounting concern about the supply of strategic materials such as chromite has led to increased exploration activity on them and the surrounding areas.

The federal and Manitoba governments have initiated studies as part of a Federal/Provincial Mineral Development Agreement to further assess the economics of developing the Bird River deposit.

Chromite mineralization in the Eastern Townships, which was exploited early in the century and during the Second World War, occurs as discontinuous and podiform deposits. Although these small deposits are generally satisfactory in grade and composition, they are not well defined and require further exploration to delineate and quantify the resource potential. The region has not been systematically explored, largely because the mineral rights were held in the past by many independent land owners. This situation changed in 1983 with the enactment of legislation by the provincial government to separate land ownership from mineral rights. Land owners, in order to retain their mineral rights after 1983, had to stake claims on their properties and carry out a specified amount of exploration and development work each year.

WORLD DEVELOPMENTS

The consumption of chromite is directly linked to the demand for specialty steels and for applications in the iron, chemicals and metallurgical industries. There has been a trend toward reduced chromium consumption in metallurgical applications due to the

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introduction of argon oxygen decarburization and continuous casting for making specialty steels. However, this is expected to have a diminishing impact on the overall consumption of the metal in the next decade.

The demand for chromite and ferrochromium remained relatively constant from 1982 to mid-1985. In May 1985 major producers increased production of ferrochromium in response to an increased demand for this commodity. This increase in demand coincided with political events in South Africa and was attributed to major traders and consumers increasing their inventories. Consequently, an oversupply of ferrochromium developed by late 1985, which caused a slight reduction in prices of 3 and 7 per cent respectively for high-carbon ferrochrome and charge chrome.

Middleburg Steel and Alloy of South Africa installed a thermal plasma unit for the production of ferrochromium at its Krugersdorp works. The plasma unit could represent substantial savings as its costs were predicted to be only a fraction of those for a conventional submerged electric arc furnace. Middleburg was also studying the possibility of forward integrating into the production of stainless steel directly from its plasma plant.

Union Carbide Corporation and Joslyn Stainless Steels division of Joslyn Mfg. & Supply Co. together developed the argon oxygen decarburization (AOD) process, now widely used in the production of stainless and heat-resistant steels. The process is essentially a refining step after the ferrochromium charge has been melted. Argon, an inert gas, and oxygen are added to the melt in order that carbon instead of chromium is preferentially oxidized. This allows the less expensive high-carbon ferrochrome to be used in place of high-priced, low-carbon ferrochrome. The overall advantages obtained are a lower cost for chromium additions as well as energy savings in the initial production of the ferroalloy. In Europe, a similar technology, known as the Creusot-Loire-Uddleholm (CLU) process, was being commercially developed by steelmakers.

The United States Bureau of Mines has developed a recycling technology to recover chromium from spent etching solution. In current practice, chromic acid is added to solutions used in finishing brass, etching printed circuit boards and preparing plastics for plating. After continued use the solution loses its etching ability because the initial trivalent chromium transforms to hexavalent chromium, a toxic substance that is subsequently treated and discarded. The Bureau of Mines new electrolytic process allows 88 to 96 per cent of chromium in the spent solutions to be regenerated. The process is currently being tested on different electroplating solutions.

The major chromite mine producers in 1984 were the U.S.S.R. with estimated production of 2.7 million t, Republic of South Africa with 2.5 million t, Albania with 1.0 million t, Zimbabwe with 0.5 million t, and Finland and India, each with 0.45 million t.

General Mining Union Corporation Limited (Gencor), a South African company, after acquiring a controlling interest of SA Manganese Amcor Ltd. (Samancor), reorganized its chromite ore facilities into a new company called Chromeore Pty. Ltd. The merging of their facilities made Chromeore the western world's largest producer of chromite ore.

South Africa's Transvaal Consolidated Land and Exploration Co. Ltd. closed its Milsell mine in 1983, but continued to operate its other two mines in Transvaal.

It was reported that effective January 1986, Union Carbide Corporation would sell all of its chromium, tungsten and vanadium metals business for $83 million. The sale is to include its 49 per cent interest in Tubatse Ferrochrome (Pty) Ltd. to General Mining Union Corporation Limited (Gencor) of South Africa, and all of its interests in Jagdlust Chrome Co. Pty Ltd., Chrometco Minerals (Proprietary) Limited, and Chrome Corp. (South Africa) Pty Ltd.

The world's major ferrochromium producers, considered as a group, operated at about 55 per cent of capacity in 1985. Present world ferrochromium capacity is considered adequate to meet requirements until the year 2000.

USES

While many minerals contain chromium, chromite is the only commercial ore mineral. The theoretical formula for chromite is $FeCr_2O_4$, although it usually contains several other elements and is represented by the general formula $(FeMn)O\ (CrAlFe)_2O_3$.

Traditionally, chromite ores have been classified as metallurgical, chemical and refractory grades, according to the expected industrial end-uses. However, recent technological advances have allowed some degree of interchange in the usage of these three product categories with the result that the classification has become less meaningful. Current nomenclature is based upon chromite composition in addition to end-use. High-chromium ores, defined by high Cr/Fe ratios, are used for making ferrochromium for metallurgical applications. High-iron chromites, previously limited almost entirely to the production of chromium-based chemicals, are now finding growing usage in the production of low quality ferrochromium, refractories and foundry sands. High-aluminum chromites with relatively low iron and silica have application mainly for refractory purposes, primarily in the manufacture of magnesite-chromite and chromite-mangnesite brick.

The principal use of chromium ferroalloys is in the production of stainless and heat-resistant steels. Most applications of stainless and heat-resistant steels are in corrosive environments such as petrochemical processing, high-temperature environments such as turbines and furnace parts, and consumer goods such as cutlery and decorative trim. Chromium is added to alloy and tool steels to increase their hardening ability and to improve 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 process equipment. Chromium-containing castings are usually used in high-temperature applications.

The refractory industry uses chromite in the manufacture of refractory bricks, castables, mortars and ramming gun mixes. Chromite castables, mortars and gunning mixes are used for repairs and in the bonding and coating of basic bricks, and in areas where the separation of various types of bricks by a chemically neutral substance is desirable.

Refractories containing both chromite and magnesite are used in furnaces wherever basic slags and dust are encountered, such as in the ferrous and nonferrous metal industries. In the ferrous industry, chromite-magnesite brick is used in basic open hearth and electric furnaces. The phasing-out of open hearth furnaces has led to a decline in the amount of chromite used as a refractory in the steel industry. However, this trend has been offset to a certain extent by an increase in electric furnace production and, overall, chromite refractory consumption in the steel industry is expected to remain stable during the next few years. In the nonferrous metals industry, chromite-magnesite brick is used mainly in converters. The increasing use of oxygen in oxygen-blowing converters, resulting in higher operating temperatures, has changed refractory requirements to a higher magnesite-content brick, thereby decreasing the consumption of chromite in this application. The glass industry uses chromite-magnesite brick in the reheating chambers of glass furnaces, while the kraft paper industry requires a dense chromite brick in recovery furnaces to resist chemical attack by spent liquors.

Chromium chemicals have a wide variety of applications in a number of industries. Most chromium chemicals are produced from sodium dichromate, which is manufactured directly from chemical-grade chromite. Chromium compounds are used as pigments, mordants and dyes in the textile industry; tanning agents for all types of leathers; and for chrome electroplating, anodizing, etching and dipping. Chromium compounds are also used as oxidants and catalysts in the manufacture of various products such as saccharin; in the bleaching and purification of oils, fats and chemicals; and as agents to promote water insolubility of various products such as glues, inks and gels.

OUTLOOK

The U.S.S.R., South Africa and the Philippines account for about 61 per cent of the world mine capacity.

World chromite mine capacity, which presently stands at 4.2 million tpy of contained chromium, is forecasted to remain unchanged to the year 1990. The world capacity for ferrochromium production is forecasted to increase by 9 per cent from 2.44 million tpy to 2.68 million tpy of contained chromium by the year 2000. In relation to mine and ferrochromium capacities, apparent world consumption of chromium is forecasted to increase from its present estimated level of 3.25 million tpy to 4.15 million tpy during the next decade. These projections indicate the extent of the excess production capability that will exist until the end of the century.

Chromite ore production in the U.S.S.R. is thought to be fairly stable. Production in 1984 and 1985 was estimated at 2.7 million t of which 70 per cent was estimated to be consumed domestically and stockpiled. Approximately 600 000 t were exported to market economy countries in 1983.

The sale of chromite to market economy countries is reported to be a major source of hard currency for the U.S.S.R. This trend is forecasted to continue but the quantity might increase if South Africa was to reduce or stop its exports.

Considering the recent political events in South Africa and the Philippines, and the implications of relying on the U.S.S.R., there might be cause for concern regarding the supply of chromium. However, no major change is expected in the availability of chromium from these countries in the short term. This conclusion was supported by South Africa's readiness to increase production in 1985 to meet the increased demand for chromite and its reported commitment not to reduce its supply of chromium to the western world. It has also been reported that the U.S.S.R. has plans to continue its supply to market economy countries (0.6 million t of chromite) as a means of acquiring hard currency. The Philippines also requires hard currency as an aid to stabilizing its economy.

The medium- and long-term outlook is affected by uncertainty in regards to supply continuity of South African chromium, largely because of the fragile political stability of this country. A sudden interruption in supply from South Africa could have serious economic consequences for Canada and the rest of the western world. Other producing countries could not readily increase chromium production to fill the gap created by such a disruption of supply.

Should this uncertainty of supply continue it is forecasted that primary and secondary production of chromium in the developing countries could accelerate and occur within the first quarter of the next decade rather than gradually replacing capacity as it becomes obsolete in the market economy countries, as previously cited.

The U.S.S.R. and South Africa account for 38 per cent of the world ferrochromium capacity. The world ferrochromium capacity is expected to be accompanied by a shift in the geographic locations of producers. New capacity in the future is likely to be located in countries where abundant ore reserves and low-cost electric energy are available, such as Brazil, Finland, India and Greece. It is anticipated that such new capacity would replace existing capacity in Japan and Europe as facilities in the latter countries become uncompetitive due to obsolescence and high energy costs.

The forecasted increase in comsumption represents an average annual growth rate of approximately 2.5 per cent. This projected growth rate takes into account a reduction in chromium consumption due to the progressive conversion to AOD's for the manufacture of steel, specifically in Europe where the adoption of this technology has only started.

The forecasted growth in consumption of chromium is expected to come mainly from Japan and the United States. Projected increases in Japan are likely to come from the expanding use of specialty steels for housing and industrial applications. In the United States estimated increases are likely to come from greater demand for specialty steel for the automotive sector.

PRICES

Chromium prices published by **Metals Week**

	December 30, 1983	December 28, 1984	December 20 1985
		($US)	
Chrome ore, dry basis, fob shipping point			
Transvaal 44% Cr_2O_3, no ratio (per tonne)	48.00-52.00	48.00-52.00	40.00-42.00
Turkish 48% Cr_2O_3, 3:1 ratio (per tonne)	110.00	110.00	125.00
Chromium metal			
Electrolytic 99.1% Cr, fob shipping point (per kg)	8.27	8.27	8.27
		(¢US)	
Ferrochromium, fob shipping point (per kg Cr content)			
High carbon 66-70% Cr, 5.0-6.5% C	119.05	119.05	119.05
Imported 60-65% charge chrome	99.23-101.41	99.21-101.41	101.41-103.62
Low carbon 67-73% Cr, 0.025% C	220.46	220.46	220.46

fob - Free on board

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
32900-1	Chrome ore	free	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	free
37506-1	Ferrochrome	free	4.3	5	free
92821-1	Chromium oxides and hydroxides	10	13.1	25	8.5
	With the following exceptions:				
	For use in the manufacture of artificial resins and plastics (expires June 30, 1987)	free	free	25	free
	For use in the manufacture of additives for heating, lubricating and fuel oils (expires June 30, 1987)		5		
92821-2	Chromium trioxide for use in the manufacture of galvanized and tin plated steel (expires June 30, 1986)	free	free	25	free
92838-8	Chromium potassium sulphate	free	free	10	free
92838-9	Chromium sulphate, basic	free	free	10	free

TARIFFS (cont'd)

Item No.		1985	1986 (%)	1987
CANADA (cont'd)				
MFN Reductions under GATT (effective January 1 of year given)				
37506-1		4.3	4.2	4.0
92821-1		13.1	12.8	12.5
UNITED STATES				
473.10-20	Chrome colours		4.0	
601.15	Chrome ore		free	
606.24	Ferrochromium, containing over 3% by weight of carbon		1.9	
632.86	Chromium alloys, unwrought, 96-99% silicon		9.0	
		1985	1986 (%)	1987
420.98	Chromate and dichromate	2.5	2.5	2.4
531.21	Chrome refractory and heat insulating bricks	8.1	7.3	6.6
606.22	Ferrochromium, not containing over 3% by weight of carbon	3.4	3.3	3.1
632.18	Chromium metal, unwrought and waste and scrap	4.0	3.9	3.7
632.88	Chromium alloys, unwrought, not otherwise specified	6.4	5.9	5.5
EUROPEAN ECONOMIC COMMUNITY			1985	
28.21	Chromium oxides and hydroxides		15	
28.38	Sulphates (excluding alums) of chromium		15	
	Alums: chromium potassium bis(sulphate)		13	
28.47	Salts of metallic acids:			
	Chromates		15	
	Dichromates and perchromates		14	
28.56	Carbides of chromium		12	
69.02	Refractory bricks, blocks, tiles and similar refractory construction goods with a basis of chromite		10[1]	
69.03	Other refractory goods with a basis of chromite		12	
73.02	Ferro-alloys:			
	Ferro-chromium		8	
	Ferro-silico-chromium		7	
81.04	Chromium:			
	Unwrought, waste and scrap			
	Chromium alloys containing more than 10% by weight of nickel		Free	
	Other		6	
	Other		8	

Sources: The Customs Tariff and Commodities Index, January 1985, Revenue Canada; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, L320, Vol. 27.
[1] Subject to a min. of 1.10 ECU per 100 kg gross.

TABLE 1. CANADA, CHROMIUM IMPORTS, 1983-85

	1983		1984P		1985e	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Imports						
Chromium in ores and concentrates						
Turkey		-	-	-	2 124	597
Philippines	-	-	236	76	1 281	593
United States	3 690	1,391	5 607	2,375	3 835	1,108
Cuba	3 444	517	1 254	581	368	117
South Africa	2 625	464	5 183	1,139	2 708	973
French Oceania	-	-	608	418	-	-
Total	9 759	2,372	12 888	4,589	10 316	3,388
Ferrochromium (gross weight)						
South Africa	5 501	4,567	7 980	7,633	6 405	7,255
United States	20 608	10,647	22 561	14,233	14 205	9,716
Yugoslavia	2 052	1,203	-	-	-	-
Sweden	2 522	1,368	2 000	1,424	3 733	3,445
Zimbabwe	336	470	551	938	484	842
Other countries[1]	1 540	1,041	-	-	-	-
Total	32 559	19,296	33 092	24,227	24 827	21,258
Chromium sulphates, including basic (gross weight)						
United Kingdom	713	642	617	545	683	527
West Germany	159	175	25	29	93	112
United States	-	-	54	43	-	-
Italy	120	122	75	63	144	123
Other countries[2]	89	71	-	-	-	-
Total	1 081	1,010	771	680	920	762
Chromium oxides and hydroxides (gross weight)						
United States	999	2,672	1 424	3,727	1 987	-
West Germany	472	1,317	353	1,045	361	891
United Kingdom	159	479	233	794	433	1,205
Italy	54	161	54	144	71	139
Other countries[3]	34	71	34	64	48	101
Total	1 718	4,700	2 098	5,774	2 900	2,336
Chromium dyestuffs (gross weight)						
United States	28	114	42	134	120	667
West Germany	14	103	39	116	20	112
Netherlands	10	46	35	83	11	112
Other countries[4]	9	113	12	97	29	71
Total	61	376	128	430	180	962

Source: Statistics Canada.
[1] Includes Belgium, Luxembourg and Spain. [2] Includes Yugoslavia and Japan. [3] Includes Poland, Japan and U.S.S.R.
[4] Includes Italy, People's Republic of China, Poland, Australia, Switzerland, United Kingdom, France and Japan.
Note: Components may not add due to rounding.
P Preliminary; e Estimated; - Nil.

TABLE 2. CANADA, CHROMIUM TRADE AND CONSUMPTION, 1970, 1975, 1978-85

	Imports		Consumption[2]	
	Chromite[1]	Ferro-Chromium[2]	Chromite	Ferro-Chromium[3]
	(tonnes)			
1970	27 619	20 814	56 212	28 356
1975	29 663	41 109	36 790	18 417
1978	28 497	30 432	27 472	36 572
1979	27 373	34 720	27 205	23 916
1980	28 373	41 369	27 900	30 175
1981	47 626	31 573	24 771	29 547
1982	8 053	21 783	15 330	18 393
1983	9 759	32 559	15 682	23 741
1984p	11 927	33 092	21 059	28 524
1985e	7 592	24 827	-	-

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Chromium content. [2] Gross weight.
[3] Includes charge chrome.
p Preliminary; e Estimated; - Nil.

TABLE 3. WORLD CHROMITE MINE PRODUCTION AND RESERVES, 1982-84

Country	Mine Production 1982	1983	1984e	Reservese
	(000 tonnes, gross weight)			
U.S.S.R.	3 402	2 700	2 700	142 000
Republic of South Africa	2 164	2 460	2 500	6 300 000
Albania	1 197	990	1 000	22 000
Zimbabwe	426	475	500	830 000
Turkey	372	440	450	80 000
India	340	400	450	64 000
Finland	399	375	400	32 000
Philippines	354	365	400	32 000
Brazil	953	310	350	10 000
Other market economy countries	245	351	400	25 000
Other central economy countries	43	55	60	4 000
World total	9 895	8 921	9 210	7 540 000

Source: U.S. Bureau of Mines, Mineral Commodity Summaries, 1985.
e Estimated.

Clays and Clay Products

M. PRUD'HOMME

Clays are a complex group of industrial minerals, each generally characterized by different mineralogy, occurrence and uses. All are natural, earthy, fine-grained minerals of secondary origin, composed mainly of a group of hydrous aluminum phyllosilicates and may contain iron, alkalis and alkaline earths. The clay minerals, formed by the chemical weathering or alteration of aluminous minerals are generally classified into four major groups based on detailed chemistry and crystalline structure - the kaolinite group, the smectite group (montmorillonite group of some usages), the clay-mica group and the chlorite group. Clay deposits suitable for the manufacture of ceramic products may include non-clay minerals such as quartz, calcite, dolomite, feldspar, gypsum, iron-bearing minerals and organic matter. The non-clay 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 proximity to growth centres in which clay products will be consumed.

Brick manufacturing included in the heavy clay products category accounts for over 80 per cent of the total value of output by clay products manufacturers using material from domestic sources, while drain tile and flue lining account for 2.5 per cent and 4.5 per cent respectively.

USES, TYPE AND LOCATION OF CANADIAN DEPOSITS

Common Clays and Shale. Common clays and shales are the principal raw materials available from Canadian deposits for the manufacture of structural clay products. They 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 material is sufficiently plastic to permit molding and vitrification at low temperature. 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. There are no specific recognized grades of common clay and shale. Specifications are usually based upon the physical and chemical tests of manufactured 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 fired strength and density will be adversely affected.

Most of the surface deposits of common 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.

In eastern Canada, shales are consumed in large quantities for manufacturing cement near Corner Brook in western Newfoundland, and at Havelock in Kings County, New Brunswick. Common clay from glacial drift is used in Ontario as a source of silica and alumina in the local manufacture of grey portland cement at Woodstock and St. Mary's. In Manitoba, shales and clays from glacial Lake Agassiz are extracted to produce lightweight aggregates. In Alberta, local glacial clays from Regina are used for manufacturing cement, lightweight aggregates

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and mineral wool insulation. In British Columbia, altered volcanic ash is extracted at Barnhard Vale for cement, and in Quesnel mainly for use in manufacture of refractory materials. Common clay is also extracted from Sumas Mountain near Abbotsford to produce flue lining, drain pipe, bricks and blocks.

The 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.

China Clay (Kaolin). China clay is a white clay composed mainly of kaolinitic minerals formed from weathered igneous rocks. Some deposits occur in sedimentary rocks as tabular lenses and discontinuous beds or in rocks that have been hydrothermally altered. Commercial china clays are beneficiated to improve their whiteness when used as fillers and their whitefiring characteristics when used in ceramics.

China clay is used primarily as a filler and coating material in the paper industry, a raw material in ceramic products, and a filler in rubber and in other products. 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.

Several occurrences of kaolin in Canada have attracted attention. In British Columbia, a deposit of clay similar to a secondary kaolin occurs along the Fraser River near Prince George. In Saskatchewan, known deposits of sandy kaolinized clay with off-white colored fines occur near Fir Mountain, Flintoft, Knollys, and Wood Mountain. In 1985, Ekaton Energy Limited of Calgary did some exploration work in the Wood Mountain - Eastend area; a feasibility study was carried out for a 90 000 tpy operation to produce china clay that will be used in the manufacture of paper, paint, ceramics and plastics. Reserves of kaolinized sand were estimated in excess of 332 million t. Plant construction could begin in 1986 and production in 1987. In Manitoba, various kaolinitic-rock deposits have been reported at Arborg, on Deer Island (Punk Island) and Black Island in Lake Winnipeg, and in the northwest at Cross Lake and Pine River; the Swan River Formation also has been studied as a potential source of kaolin. In Ontario, extensive deposits of kaolin-silica sand mixtures occur along the Missinaibi and the Mattagami rivers. In late-1985, Carlson Mines Ltd. of Toronto studied the feasibility of processing a silica-kaolin mixture from its property near Smooth Rock Falls. Reserves are estimated at 45 million t. About 500 t of undisturbed kaolin were taken from a test pit for further testing. In Quebec, kaolin deposits have been actively mined in the past as a coproduct of a silica operation, near St-Remi-d'Amherst, in Papineau County. Occurrences near Chateau-Richer in Montmorency County and Pointe Comfort in Gatineau County have been studied as a potential source of kaolin for alumina, suitable for aluminous cement and refractories. In 1985, kaolin from Chateau-Richer was extracted by Montréal Terra-Cotta Inc. for producing heavy clay products by mixing with local common clay at Deschaillons, Quebec.

Ball Clay. Ball clay is defined as a fine-grained, highly plastic and mainly kaolinitic sedimentary clay. Natural colours range from white to brown, blue, grey and black, usually related to carbonaceous material. Fired colours may be white to offwhite. They are extremely refractory materials and have less alumina and more silica than kaolin. Ball clays occur in beds or lenticular units characterized by complex variation, both vertically and laterally.

Ball clays occurring in Canada are mineralogically similar to high-grade, plastic fire clay and are composed principally of fine-particle kaolinite, quartz and mica. These clays are known to occur in the Whitemud and the Ravenscrag Formations - Willowbunch Member - of southern Saskatchewan. Clay production takes place near Claybank, Eastend, Estevan, Flintoft, Readlyn, Rockglen, Willowbunch and Wood Mountain.

Fire Clay (Refractory Clay). Fire clay is a detrital clay mainly composed of kaolinite with a high content of alumina and silica. It usually occurs in sedimentary rocks as lenticular bodies. These clays may range in plasticity from essentially that of ball clay to nonplastic varieties such as flint clay. They are formed by alteration of aluminous sediments deposited in a swampy environment or following transportation and concentration of clayey material.

Fire clay is used in the manufacture of products requiring high resistance to heat such as fire brick, insulating brick and refractory mortar. The refractory suitability is determined by the pyrometric cone equivalent (PCE) test. Canadian fire clays are used principally for the manufacture of medium- and high-duty fire brick and refractory specialties.

Various grades of good-quality fire clay occur in the Whitemud Formation in southern Saskatchewan and on Sumas Mountain in British Columbia. Fire clay, associated with lignite as well as with kaolin-silica sand mixtures, occurs in the James Bay watershed of northern Ontario along the Missinaibi, Abitibi, Moose and Mattagami rivers. At Shubenacadie, Nova Scotia, some seams of clay are sufficiently refractory for medium-duty fire clay. Clay from Musquodoboit, Nova Scotia, has been used by some foundries in the Atlantic provinces, and the properties and extent of this clay were investigated by the Nova Scotia Department of Mines.

Stoneware Clay. Stoneware clays are intermediary between low-grade common clays and the high-grade kaolinitic clays. They are typically a mixture of kaolinitic clay minerals and micaceous clay minerals. Stoneware clays must be capable of being fully vitrified at a relatively low temperature.

Stoneware clays are used extensively in the manufacture of sewer pipe, flue liners, and facing brick. They are widely used by amateur and studio potters.

The principal source of stoneware clay in Canada is the Whitemud Formation in southern Saskatchewan and southeastern Alberta. Stoneware clays also occur near Abbotsford on Sumas Mountain, at Chimney Creek Bridge, Quesnel and Williams Lake, British Columbia; near Swan River in Manitoba; and in Nova Scotia, at Musquodoboit and at Shubenacadie where it is used principally for manufacture of buff-facing bricks.

Bentonite and Fuller's Earth. Bentonite consists primarily of montmorillonite clay, and is formed from volcanic ash, tuff or glass, other igneous rocks, or from rocks of sedimentary origin. Sodium bentonite has strong swelling properties and possesses a high dry-bonding strength. Calcium bentonite of the non-swelling type, exhibits adsorptive characteristics. Fuller's earth contains mainly smectite-group clay minerals and is very similar to non-swelling bentonite. It is formed by alteration of volcanic ash or by direct chemical precipitation of montmorillonite in shallow marine basins. Fuller's earth is characterized by absorptive properties, catalytic action, bonding power and cation-exchange capacities.

Drilling Mud and Activated Clays. Drilling mud contains about 10 per cent swelling bentonite. Synthetic bentonites may also be used for special muds. The swelling properties of a bentonite used as a drilling mud may be improved by adding soda ash in a drying process to substitute calcium cations with sodium cations. Activated clays are non-swelling bentonites that are acid-leached to remove impurities and to increase the reactive surface and bleaching power. They are used for decolouring mineral oils and as catalysts.

Bentonite, fuller's earth and activated clays are covered in sections of a separate mineral review.

CANADIAN INDUSTRY

Clays. Production of clays is captive to their use in lightweight aggregates, cement and mineral wool insulation, which consumed mainly common clay, stoneware clay and ball clay. In Canada, there is no commercial production of china clay, and all requirements are supplied by imports which rose by 3.5 per cent to 202 209 t on a nine month basis in 1985. Imports, mainly from Georgia and South Carolina, which account for 98.8 per cent of total kaolin imports, are for markets in Ontario (60 per cent), Quebec (32 per cent), British Columbia (3.4 per cent) and Manitoba (3.4 per cent). Average prices for imported kaolin increased by 7.2 per cent to $134 a t in 1985, in current dollars. Excess kaolin production capacity in the United States led to continuous competition for sales and prices during 1985. Demand for china clay depends principally on the paper industry which accounts for more than 77 per cent of its use. The traditional method of shipping kaolin is dry, but transportation as a 70 per cent solid-slurry is increasing.

During 1985, the United States and China were the principal sources of supply for imported fire clay in Canada, with 94.6 per cent and 5.2 per cent respectively. Imports are mainly into Ontario (68 per cent) and Quebec (25 per cent). All requirements for clays in western Canada are supplied by the United States. Unit value for imported fire clay decreased by 4 per cent to $70.90 a t by the end of 1985, in current dollars.

Clay products. Clay products include structural materials - such as bricks and tiles - sewer pipes, flue linings, drain tiles, earthenwares, tablewares, sanitaryware and pottery. In 1985, nearly 40 companies produced more than 96 per cent of total output. The value of production of clay products rose 5.6 per cent to $144.5 million in 1985. Increased shipments were noted in eastern Canada, especially in Ontario (9.9 per cent), while Alberta and British Columbia experienced lower demand for clay products. Housing starts were strongly increased compared to 1984 levels, reflected in brisk sales during the summer and indicating an over-all economic improvement. Home buyers reacted to stable mortgage rates, and to improved business climate and sales especially for single family units have been strong in southern Ontario, and in Nova Scotia for multi-unit dwellings and condominium apartments.

Imported bricks and blocks, accounting for 3 per cent of total clay products imports, are shipped into Ontario (64 per cent) and British Columbia (28 per cent). The average import price in 1985 was about $127 per thousand bricks, a sharp decrease of 28 per cent from $176 per thousand bricks in 1984.

Imports of ceramic tiles account for 25 per cent of the value of imported manufactured clay products. Italy was the principal supplier of ceramic tiles with a value of shipments of $22.5 million for the first nine months of 1985; imports were into Ontario (53 per cent), Quebec (33 per cent) and British Columbia (10 per cent).

Brampton Brick Limited announced the acquisition of the Don Valley plant of Toronto Brick Company Limited which manufactured clay bricks. Jannock Limited of Toronto purchased the Canadian brickmaking operation of Domtar Inc. The acquisition included brick plants at Ottawa and Mississauga in Ontario, and at La Prairie in Quebec. The company also plans a $51 million project to expand its annual brickmaking capacity in Canada by 222 million units, partly by replacing obsolete kilns.

Refractories. Refractories are produced in Canada by 16 major manufacturers of basic and alumina-silica products. Special refractories such as refractory mineral wool and carbon-compound mortars are also produced. On a nine month basis in 1985, imports of refractories rose by 9 per cent in term of value in current dollars to $116 million compared to the same period last year. Refractories are imported principally from the United States (84.5 per cent), West Germany (7 per cent) and Japan (3 per cent), and include alumina bricks into Ontario (75 per cent) and Quebec (20 per cent). Exports of refractory bricks and shapes increased by 18 per cent. Refractories account for 78 per cent of total exports of all clay products, mainly to American markets (68 per cent).

WORLD REVIEW

Estimated world production of kaolin in 1984 increased by 12.2 per cent to 22 million t. Major world producers are the United States (33 per cent), the United Kingdom (19 per cent) and the U.S.S.R. (13 per cent). Ball clay production is dominated by the United States, the United Kingdom and Czechoslovakia. While plastic refractory clay is produced widely, fire flint clay is restricted to Australia, Austria, China, France, Hungary, South Africa, United States and U.S.S.R.

In Australia, Comalco Limited is constructing a kaolin plant at its Weipa bauxite mine in Northern Queensland. Completion of a 100 000 tpy plant to produce kaolin for use in the paper coating markets of Asia-Pacific areas is due in 1986. In the United Kingdom, English China Clays plc has produced a new line of coated calcined kaolin for use as a filler in manufacturing wire cable insulation.

In the United States, the production of kaolin in 1984 increased by 10 per cent to 7.25 million t, while the average unit value decreased by 2 per cent to $US 79.8 a t reflecting strong price competition in kaolin markets. Kaolin production has followed the continued growth of the U.S. economy and its rising consumption in the paper industry. Production of paper grade kaolin, calcined, water-washed and delaminated increased by 15 per cent, 7 per cent and 6 per cent respectively. China clay accounts for 18 per cent of the clay production and 61 per cent of output in terms of value. Exports of kaolin increased by 6 per cent to 1.27 million t and were mainly to Japan (33 per cent), Canada (19 per cent) and the Netherlands (13 per cent). During 1985, J.M. Huber Corp. announced the opening of a new calcined clay-processing facility in

Huber, Georgia, with a capacity of 36 000 tpy of filler and extender grade material. United Catalysts Inc. purchased the Albion Kaolin Co., located at Hephzibah in Georgia, from McDermott, Incorporated's Babcock & Wilcox Co. Unit; an expansion is planned to increase production of kaolin slurry for the filler and extender markets.

Since 1982 the brick and structural clay tile industry in the United States has shown a trend to increased production. The value of shipments rose about 13.5 per cent in 1984. Most clay bricks continued to be used in new residential construction. Imports of bricks are mainly from Canada and Mexico to supply border areas. The 1984 import volume was up by 14 per cent, to 209 millions bricks. Imports account for only 3 per cent of apparent U.S. consumption.

The U.S. refractories industry showed slow growth and a low production rate, reflecting lower demand in the metallurgy sector. During the period of economic recession the industry consolidated but since 1982 it has been restructured. Kaiser Refractories Company was sold to National Refractories and Minerals Corp. at a price of $US 86 million; North American Refractories division of Allied Canada Inc. was purchased by Kirkland Capital Corp.; and General Refractories Company is now controlled by Belmont Industries, Inc. A.P. Green Refractories Co. in Montana announced an expansion project to produce alumina-silica refractories at its Sulphur Spring plant in Texas.

OUTLOOK

Clays and clay products are materials characterized mainly by high bulk, low unit value and a sensitivity to transportation costs. Therefore, they are very sensitive to fluctuations in the general economic climate. Expenditures in the non-residential building sectors are expected to be well above the average growth in the economy, while only modest growth is anticipated in the residential sector. A steady economic recovery would permit the construction materials sector to expand production where necessary and establish long-term plans to meet demand more efficiently.

Since 1983, the increase in value of production of clay products has been due to increasing activity in the construction industry, especially in the residential building sector where housing starts have increased in all provinces except British Columbia and Alberta. In Canada, housing starts are estimated to be in the range of 150,000 units in 1985. The non-residential construction activity is expected to increase by nearly 4.5 per cent for both 1986 and 1987. Residential, commercial and institutional building construction sectors have been more active due to low interest rates, higher consumer confidence and a stable unemployment rate. On a regional basis, the construction outlook is fairly good in eastern Canada but less encouraging in the western région. From 1985 to 1990, total construction expenditures are forecast to grow at an annual rate varying between 2.5 per cent to 4.5 per cent. Structural clay products should benefit from promotion of factory-built panels and the trend to larger homes. However, competition from alternative construction materials such as concrete, building stone, aluminum, plastics and glass may slightly offset the expected increase.

The current restructuring of the North American refractories industry reflects the rationalization occurring in the U.S. refractory industry. Such changes are necessary because of technological improvements in the industry and because of reduced consumption in the metallurgy sector. The U.S. Bureau of Mines expects demand for refractory clays to increase at an average annual rate of 4.9 per cent for the period 1983-2000.

For its supplies of china clay, Canada is currently dependent on imports, mainly from the United States. However, developments are being carried out in anticipation of increasing demand from the paper industry. In the fine and coated paper sector, with capacity located mainly in eastern Canada, demand for fine paper was strong in 1985. The overall operating rate in the fine paper industry was estimated at about 92 per cent of capacity in 1985 and shipments are expected to rise another 3 to 4 per cent in 1986. The demand for clays in paper products is expected to grow and to replace some of the more expensive titanium dioxide pigment. However, the use of calcium carbonate in the alkaline paper making process could affect the long-term use of filler clay. Conversion to alkaline plants is unlikely feasible in the short-term, but new facilities might consider a shift from acid-process methods.

Demand for kaolin in the production of aluminum or alumina could occur if technological breakthrough and economical factors favour the substitution of imported bauxite.

PRICE QUOTATIONS FOR BALL CLAY AND KAOLIN

Chemical Marketing Reporter, December 30, 1985.

	$US per short ton
Ball clay, fob Tennessee	
Airfloated, bags, carload	49.00
Crushed, moisture repellent, bulk carload	24.00
Kaolin, fob Georgia	
Dry-ground, airfloated, soft	60.00
NF powdered, colloidal, 50 lb bags, 5,000 lb lots	.24/lb
Waterwashed, fully calcined, bags, carload	255.00
Waterwashed, uncalcined, delaminated paint grade, 1 micron average	182.00
Uncalcined, bulk, carload	
No. 1 coating	94.00
No. 2 coating	75.00
No. 3 coating	73.00
No. 4 coating	70.00
filler, general purpose	58.00

Industrial Minerals, December 1985 quotation (£1.00=$US 1.30-1.50)

	£ per tonne
Ball clay, fob works	
Air dried, shredded, bulk	15-40
Refined, noodled, bulk	35-40
Pulverized, air floated, bagged	50-80
Kaolin, refined, bulk, fob works	
Coating clays	70-120
Filler clays	40-60
Pottery clays	25-65

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
29500-1	Clays, including china clay, fire clay and pipe clay not further manufactured than ground	free	free	free	free
29525-1	China clay	free	free	25	free

UNITED STATES (MFN)		(¢ per long ton)		
521.41	China clay or kaolin	33.0		
521.81	Other clays, not beneficiated	free		
521.84	Other clays, wholly or partly beneficiated	50.0		
		1985	1986	1987
		(¢ per long ton)		
521.71	Common blue clay and other ball clays, not beneficiated	39.0	38.5	38.0
521.74	Common blue clay and other ball clays wholly or partly beneficiated	79.0	78.0	77.0

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610, U.S. Federal Register, Vol. 44, No. 241.
Note: In addition to the above tariffs various duties are in existence on manufactured clay products, viz., brick pottery, artware, etc.

TABLE 1. CANADA, VALUE OF PRODUCTION OF CLAYS AND CLAY PRODUCTS FROM DOMESTIC SOURCES, 1983-85

	1983	1984p	1985e
		($000)	
Production from domestic sources, by provinces			
Newfoundland	1,381	1,546	1,150
Nova Scotia	5,900	6,430	7,750
New Brunswick	3,200	3,313	4,325
Quebec	20,667	20,945	21,987
Ontario	74,673	83,461	91,725
Manitoba	3,395	2,156	2,150
Saskatchewan	3,572	3,561	4,050
Alberta	12,207	8,153	7,550
British Columbia	7,335	7,230	3,800
Total Canada	132,329	136,795	144,487
Production[1] from domestic sources, by products			
Brick - soft and stiff mud process and dry press	98,982	113,539	119,924
Drain tile	4,764	3,283	3,468
Flue linings	3,308	6,292	6,646
Other products[2]	17,600	9,851	10,404
Small establishments not reporting detail	7,675	3,830	4,045
Total	132,329	136,795	144,487

Source: Statistics Canada.
[1] Producers' shipments. Distribution estimated by Energy, Mines and Resources Canada.
[2] Including also sewer pipe and all potteries.
p Preliminary; e Estimated.

TABLE 2. CANADA, IMPORTS AND EXPORTS OF CLAYS, CLAY PRODUCTS AND REFRACTORIES, 1983-85

	1983		1984		(Jan.-Sept.) 1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Imports						
Clays						
China clay, ground or unground	249 835	28,534	253 080	32,181	202 209	27,099
Fire clay, ground or unground	30 065	2,315	43 744	3,236	33 802	2,399
Clays, ground or unground nes	89 099	6,891	106 661	8,151	109 975	8,620
Bentonite	187 228	9,545	337 054	15,307	224 082	11,987
Fuller's Earth	536	75	4 152	525	3 865	460
Drilling mud	44 866	7,674	4 326	2,697	4 090	3,426
Clays and earth, activated	12 203	10,304	12 669	10,307	9 599	9,984
Subtotal, clays	613 832	65,338	761 686	72,404	587 622	63,975
Clay Products	(M)		(M)		(M)	
Brick-building, glazed	1 991	351	2 307	385	3 985	392
Brick-building, nes	25 208	4,223	31 228	5,492	50 818	6,450
Building blocks and hollow tiles	..	775	..	952	..	1,283
Brick acid-proof	..	89	..	67	..	26
Clay bricks, blocks and tiles, nes	..	4,099	..	4,673	..	3,177
Ceramic tiles	(m^2)		(m^2)		(m^2)	
under 2 1/2" x 2 1/2"	544 925	3,984	610 775	4,872	296 703	2,467
over 2 1/2" x 2 1/2"	7 168 782	46,171	9 202 855	60,724	6 288 077	41,779
Subtotal, bricks, blocks, tiles	..	59,692	..	77,165	..	55,574
Ceramics						
Tableware, ceramics	..	93,068	..	104,426	..	77,712
Sanitaryware	..	148	..	118	..	99
Artware	..	25,449	..	30,598	..	23,394
Porcelain, electric insulators	..	21,002	..	28,786	..	22,568
Chemical stoneware, exc. laboratory	..	1,154	..	1,103		1,571
Pottery settings and firing supplies	..	710	..	507	..	523
Pottery basic products, nes	..	1,933	..	2,852	..	4,681
Clay end-products, nes	..	1,451	..	1,687		1,037
Subtotal, ceramics	..	144,915	..	170,077	..	131,585
Refractories						
Fire brick and shapes						
Alumina	20 664	16,679	24 750	20,682	21 511	18,083
Chrome	533	492	1 539	1,848	171	213
Magnesite	19 105	19,353	21 592	25,841	18 341	20,935
Silica	3 027	2,671	3 918	3,292	1 592	2,668
Nes	111 444	37,802	124 968	50,927	85 403	40,207
Refractory cements and mortars	..	14,456	..	17,011	..	14,044
Plastic fire brick and ramming mixture	..	1,933	..	1,272	..	1,625
Crude refractory materials, nes	7 148	1,213	9 115	1,969	9 291	2,084
Grog (refractory scrap)	4 655	476	5 089	585	3 256	428
Foundry facings	..	1,865	..	2,266	..	1,759
Refractories, nes	..	7,313	..	15,240	..	13,950
Subtotal, refractories	..	104,253	..	140,933	..	115,996
Total clays, clay products and refractories	..	374,198	..	460,579	..	367,130
Imports by main countries						
United States	..	186,059	..	234,650	..	190,282
Japan	..	38,644	..	56,575	..	48,098
United Kingdom	..	53,126	..	51,965	..	39,585
Italy	..	26,490	..	35,128	..	25,827
West Germany	..	17,807	..	17,808	..	16,811
France	..	5,713	..	5,115	..	6,898
Taiwan	..	6,919	..	8,785	..	6,897
Spain	..	7,856	..	11,561	..	6,455
South Korea	..	3,780	..	5,387	..	3,763
People's Republic of China	..	3,831	..	4,491	..	3,344
Brazil	..	3,744	..	3,945	..	3,341
Greece	..	4,339	..	5,282	..	2,417
Hong Kong	..	2,116	..	2,865	..	1,382
Other	..	13,774	..	17,023	..	12,030
Total	..	374,198	..	460,579	..	367,130
Exports						
Clays, ground and unground	272	66	646	150	4 988	2,447
Clay products	(M)		(M)		(M)	
Building brick, clay	2 352	641	2 330	619	1 221	448
Clay bricks, blocks, tiles, nes	..	1,496	..	1,890	..	1,168
Subtotal, bricks, blocks, tiles	..	2,203	..	2,659	..	4,063
High-tension insulators and fittings	..	3,447	..	4,208	..	3,112
Tableware, nes	..	8,770	..	7,942	..	5,492
Subtotal, porcelain, tableware	..	12,217	..	12,150	..	8,604
Refractories						
Fire brick and shapes	32 182	20,280	38 005	22,019	30 359	19,222
Crude refractory materials	241 131	955	579 488	2,428	283 282	2,293
Refractory nes	..	20,159	..	31,587	..	22,356
Subtotal refractories	..	41,594	..	56,034	..	43,871
Total clays, clay products and refractories	..	56,014	..	70,843	..	56,538
Exports by main countries						
United States	..	41,426	..	54,153	..	38,181
Cuba	..	743	..	2,165	..	3,059
Dominican Republic	..	2,129	..	1,443	..	1,622
South Africa	..	734	..	1,408	..	348
Other countries	..	10,982	..	11,674	..	13,328
Total	..	56,014	..	70,843	..	56,538

Source: Statistics Canada.
P Preliminary; .. Not available; nes Not elsewhere specified; M = Thousands; m^2 = Square metres.

TABLE 3. CANADA, SHIPMENTS OF REFRACTORIES, 1980-83

	1980		1981		1982		1983	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Monolithics	42 852	19,555	25 103	14,026	28 948	18,404	26 624	17,726
Fire brick and shapes	134 671	73,664	122 413	66,034	87 066	52,781	80 831	46,960
Cement and mortars	39 402	13,842	56 558	18,026	46 004	15,198	57 382	23,953
All other products[1]	...	28,596	...	34,002	...	26,753	...	30,918
Total	...	135,657	...	132,088	...	113,136	...	119,557

Source: Statistics Canada.
[1] Includes also castables.
... Figures not appropriate or not applicable.

TABLE 4. CANADA, CLAYS, CLAY PRODUCTS AND REFRACTORIES, PRODUCTION AND TRADE, 1970, 1975, 1980-84

	Production					
Year	Domestic Clays	Imported Clays[2]	Total	Refractory Shipments[1]	Imports	Exports
			($ million)			
1970	51.8	33.6	85.4	42.3	81.2	15.6
1975	78.4	59.1	137.5	65.0	177.4	25.1
1980	108.5	83.4	191.9	135.7	386.2	63.8
1981	119.1	85.1	204.2	132.1	432.0	65.7
1982	96.0	63.4	159.4	113.1	349.8	50.5
1983	129.1	57.8	186.9	119.6	374.2	56.0
1984P	136.8	..	..	..	460.6	70.8

Source: Statistics Canada.
[1] Includes fire brick and shapes, refractory cements, mortars, and monolithics, plus all other products shipped. [2] Includes electrical porcelains, glazed floor and wall tile, sanitaryware, pottery, art and decorative ware plus all other products.
P Preliminary; .. Not available.

TABLE 5. CANADA, CONSUMPTION (AVAILABLE DATA) OF CLAYS, BY INDUSTRIES, 1981-84

	1981	1982	1983P	1984P[1]
		(tonnes)		
China Clay				
Pulp and paper products[2]	85 555	92 997r	97 235	146 689
Ceramic products	9 764	6 680	10 267	9 378
Paint and varnish	5 955	5 510	6 082	5 705
Rubber and linoleum	4 033	5 951	6 568	7 225
Other products[3]	21 917	74 513	21 176	21 660
Total	127 224	185 651r	141 328	190 657
Ball Clay				
Ceramic products misc.	18 694	11 084	19 749	16 506
Refractories	2 743	11 969	2 578	2 280
Other[4]	127 979	78 951	45 049	51 084
Total	149 416	102 004	67 376	69 870
Fire Clay				
Foundries	11 731	8 936	8 829	9 857
Refractories	14 929	14 546	5 840	6 803
Other[5]	2 467	4 183	9 458	11 383
Total	29 127	27 665	24 127	28 043

[1] Increase in number of paper and paper products and paper pulp companies surveyed. [2] Includes paper and paper products and paper pulp. [3] Includes refractory brick mixes, cements, glass fibre and wools, adhesives, foundry, wire and cable and other miscellaneous products. [4] Includes structural clay products, adhesives, miscellaneous chemicals, petroleum refining, paint and varnish and other miscellaneous products. [5] Includes abrasives, ceramic products, concrete products, paint and varnish, petroleum refining, and rubber products.
P Preliminary; r Revised.

TABLE 6. KAOLIN: WORLD PRODUCTION, 1981-84, MAJOR COUNTRIES

	1981	1982	1983e	1984P
		(000 tonnes)		
United States	6 950	5 770	6 530	7 210
United Kingdom	3 800	3 560	2 720	4 080
U.S.S.R.e	2 540	2 630	2 630	2 810
Colombia[1]	810	810	760	800
Spain[3]	790	700	680	700
India[1]	390	530	550	620
Czechoslovakia	510	530	660	600
West Germany	470	450	410	450
Brazil[2]	470	490	420	450
Romania	410	410	410	410
France	330	350	340	350
Others	3 040	2 380	3 530	3 560
Total	20 510	19 140	19 640	22 040

Source: U.S. Bureau of Mines, 1984, clays, Preprints of Minerals Yearbook, S. Ampian.
[1] Crude, saleable kaolin. [2] Processed.
[3] Included crude and washed kaolin.
e Estimated; P Preliminary.

TABLE 7. MAJOR CANADIAN MANUFACTURERS OF STRUCTURAL CLAY PRODUCTS AND REFRACTORIES, 1985, BY PROVINCE

Company	Plant Location	Products	Raw Material	Size[1] and Remarks
NEWFOUNDLAND				
Trinity Brick Products Limited	St. John's	building bricks	shale	(B)
NEW BRUNSWICK				
L.E. Shaw Limited	Chipman	facing brick, tiles, drainage and partition	shale	(E)
NOVA SCOTIA				
L.E. Shaw Limited	Lantz	brick, block and tile	common clay, ball clay	(E)
QUEBEC				
Bricade Estrielle Inc.	Westbury	facing brick	common clay	(A)
Citadel Brick Ltd.	Beauport	building brick, drain tile and flue lining	shale	(C)
Didier Refractories Corporation	Bécancour	brick and shape, monolithics and mortar	alumina-silica, silica	(E)
Domtar Inc. Construction materials div.	Laprairie	building brick and facing	shale	(G)
Dresser Canada Inc. Canadian refractories div.	Grenville	brick and shape, monolithics	alumina-silica and basic	(F)
Duquesne Refractories Limited	Montreal	monolithics and mortar	alumina-silica and carbon	(A)
St. Lawrence Brick Co., Limited	Laprairie	building brick	shale	(C)
Montreal Terra-Cotta Inc.	Deschaillons	building brick, tile and flue lining	shale, common clay	(B)
Quigley Canada Inc.	Lachine	brick and shape, cements	fire clay, basic	(A)
ONTARIO				
Amos C. Martin Limited	Park Hill Wallenstein	drain tile	shale	(A)
A.P. Green Refractories Co.				
Acton div.	Acton	brick and shape	alumina-silica	(A)
Weston div.	Weston	monolithics	alumina-silica	(C)

TABLE 7. (cont'd)

Company	Plant Location	Products	Raw Material	Size[1] and Remarks
ONTARIO (cont'd)				
Babcock & Wilcox Industries Ltd.	Burlington	brick and shape monolithics, mineral wool	alumina-silica kaolin	(C)
Bimac Canada Metallurgical Limited	Burlington	brick and shape	-	(B)
BMI Refractories Inc.	Smithville	monolithics and mortar	-	(A)
Brampton Brick Limited	Brampton	building brick	shale	(C)
Canada Brick Co.				
Burlington div.	Burlington	building brick	shale	(E)
F.B. McFarren div.	Streetsville	building brick	shale	
Streetsville div.	Streetsville	building brick	shale	
Dochart Clay Products Co. Ltd.	Arnprior	tile	common clay	(B)
Domtar Inc.				(G)
Construction materials div.				
Mississauga div.	Mississauga	building brick	shale	
Ottawa div.	Ottawa	building brick	shale	
Dresden Tile Yard (1981) Limited	Dresden	building brick, tile and flue lining	shale	(A)
General Refractories Co. of Canada Ltd.	Smithville	brick and shape, mortar	alumina-silica and basic	(D)
George Coultis and Son Limited	Thedford	tile, drain tile	shale	(B)
Halton Ceramics Limited	Burlington	block and tile	common clay and shale	(A)
Hamilton Brick Limited	Hamilton	building brick	shale	(B)
Kaiser Refractories Company	Oakville	monolithics and mortar	alumina-silica and basic	(C)
National Sewer Pipe Limited	Oakville	flue lining and sewer pipe	shale and fire clay	(B)
North American Refractories	Haldimand	monolithics and mortar	alumina-silica	(B)
Plibrico (Canada) Limited	Burlington	monolithics and mortar	alumina-silica	(E)

TABLE 7. (cont'd)

Company	Plant Location	Products	Raw Material	Size[1] and Remarks
ONTARIO (cont'd)				
R&I Ramtite Canada Limited C-E Refractories	Welland	monolithics and mortar; brick	alumina-silica and basic	(C)
United Ceramics Limited Toronto Brick div.	Toronto	building brick	shale	(D), closed
MANITOBA				
I.XL Industries Ltd. Red River Brick and Tile div.	Lockport	brick and tile	common clay	(E)
SASKATCHEWAN				
A.P. Green Refractories Co.	Claybank	brick and shape	alumina-silica	(A)
I.XL Industries Ltd. Western Clay Products div.	Regina	facing brick, flue lining and sewer-pipe	stoneware clay	(A)
Thunderbrick Limited Estevan Brick div.	Estevan	building brick	ball clay	(C)
ALBERTA				
I.XL Industries Ltd.				
Medicine Hat Brick and Tile div.	Medicine Hat	brick, block, tile	common clay	(D)
Medicine Hat Sewer Pipe div.	Medicine Hat	sewer pipe and flue lining	common clay	-
Northwest Brick and Tile div.	Edmonton	building brick	common clay	(B)
Redcliff Pressed Brick div.	Redcliff	facing brick and fire brick	common clay	(B)
BRITISH COLUMBIA				
Clayburn Refractories Ltd.	Abbotsford	brick, mortar and monolithics	alumina-silica	(D)
Fairey & Company Limited	Surrey	brick and shape, monolithics, mortar	alumina-silica	(A)
Sumas Clay Products Ltd.	Sumas	brick, drain tile and flue linking	common clay	(C)

Sources: Statistics Canada; Mineral Policy Sector; Energy, Mines and Resources Canada.
[1] Size keys: (A) up to 25 employees; (B) 25-49; (C) 50-99; (D) 100-199; (E) 200-499; (F) 500-999; (G) over 1000 employees.
- Information not available.

Coal and Coke

J.A. AYLSWORTH

The Canadian coal industry again set records for production and export of coal in 1985 in spite of difficult domestic and international market conditions. Preliminary year-end statistics indicate that production of saleable coal should total 60.5 million t, up 5 per cent over 1984. Exports are also forecast to have grown during 1985 to 27.2 million t, up 8 per cent over 1984.

In contrast to these increases, it appears likely that for the first time in many years overall domestic coal consumption will decrease relative to the previous year due to a major decline in coal use by Ontario Hydro. Thermal coal demand for use for the generation of electricity grew, however, in Nova Scotia, Manitoba, Saskatchewan and Alberta. Overall coal consumption in Canada is forecast to total 48 million t, down by 1 per cent over 1984. Coal imports will also register a decrease this year, down 18 per cent to 15 million t, due to the reduced import requirements of Ontario Hydro. Other developments also suggest that 1985 was a year of transition for the Canadian coal industry in which producers continued to adjust to the changing market realities of the 1980s.

PRODUCTION AND DEVELOPMENTS

Coal production in Nova Scotia in 1985 is forecast to total 2.8 million t, down about 8 per cent from 1984. This decrease reflects reductions in output from both Cape Breton Development Corporation (CBDC) mines, which normally account for about 90 per cent of provincial production, and from several small privately owned mines. During 1985 some of the CBDC production came from the new Phalen development project and from reclamation of waste dumps as well as from the traditional Lingan and Prince collieries. Exports of coal from Nova Scotia, all of which come from CBDC operations, are forecast to total about 500 000 t in 1985, unchanged from 1984. The majority of these exports were destined for European and Latin American markets.

Provincial coal production will remain at its current level until CBDC's new Phalen mine begins full production in late 1987. The majority of the more than one million t annual output of this mine will be marketed within the province for the generation of electricity. Two other mines are under study in Nova Scotia. One is near Springhill and the other in Pictou County. The latter project is in the feasibility stage and if developed could produce up to 600 000 t of coal annually for utility and other markets. The mine, owned by Suncor Inc., would employ up to 250 people and cost $95 million to develop.

New Brunswick coal production in 1985 is forecast to almost equal 1984 output at just over one half million t. All of this coal is sold to the provincial utility for the generation of electricity.

Coal production from Saskatchewan's five mines is forecast to total 9.745 million t in 1985 down about 2 per cent from 1984. This first decrease in output in several years primarily reflects decreased sales to markets in Ontario. Sales to provincial power stations in 1985 were up over 1984.

Coal production in Alberta continued to lead that of other provinces in 1985. Total provincial output grew by nearly 6 per cent to 24.3 million t. This total includes 16.6 million t of sub-bituminous coal and 7.7 million t of bituminous coal. The sub-bituminous coal is primarily used in mine mouth electricity generating plants while the bituminous coal is sold domestically to utilities in Alberta and Ontario and internationally to steel companies and utilities in Asian, European and Latin American markets.

Work was under way on two new coal projects in Alberta during 1985. The Genesee mine is being developed by Fording Coal Limited and Edmonton Power to supply the new Genesee Generating Station scheduled to begin service in 1989. Manalta

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Coal Ltd.'s Montgomery mine was expanded to supply coal for the first unit of the new Sheerness Generating Station scheduled for commissioning in early 1986.

Coal production in British Columbia grew by 11 per cent in 1985 to 23 million t. This represented the largest provincial production increase recorded in 1985 and moved British Columbia almost equal with Alberta in terms of volume of coal produced. In terms of the values of output, British Columbia has long been the Canadian leader, and in 1985 accounted for $1.1 of $1.9 billion. Virtually all of the production from British Columbia is exported to overseas markets, although 848 000 t was marketed to domestic users outside of British Columbia in 1985.

Two mines are in the pre-development phase in British Columbia. The Mount Klappan anthracite project is in the feasibility study stage having shipped test samples of its coal to domestic and overseas markets. This Gulf Canada Resources Inc. mine would initially employ up to 750 people directly at a production level of 1.5 million tonnes and market its coal through the port of Stewart in northwestern British Columbia. A production decision is expected sometime in the latter half of 1986.

On Vancouver Island, the Quinsam Coal mine owned by Quinsam Coal Ltd., is well advanced in the planning and approvals process. At a production rate of 1 million tpy this mine would employ about 230 people. Marketing studies are currently under way looking at both domestic and export markets for the mine's high volatile bituminous thermal coal.

CANADIAN COAL UTILIZATION

Domestic coal utilization is forecast to total about 48 million t in 1985, down 1 per cent from 1984 levels. The utility sector is the major domestic market, accounting for 39.3 million t or 82 per cent of total Canadian demand. Other domestic markets include the steel industry which consumed 6.7 million t of coal, and general industry and other users which consumed about 2 million t of coal in 1985.

Thermal coal consumption grew by 17 per cent in Nova Scotia in 1985 to a record level of 2.3 million t. Coal now supplies about 70 per cent of all electricity generated by the provincial utility, Nova Scotia Power Corporation (NSPC), with all of coal coming from provincial sources. The major event of the year was the start of conversion of the 150 megawatt oil fired power station at Point Tupper to coal, scheduled to be completed by December 1987. It will initially require 250 000 t of coal but eventually would use up to 400 000 t annually when operating at full capacity. Additional new coal fired power generating capacity will be required in Nova Scotia in the late 1980s or in the early 1990s. All of the required coal will be supplied from Nova Scotian mines.

Coal consumption in New Brunswick will be down by about 18 per cent in 1985 to about 500 000 t reflecting the greater use of provincial nuclear generating capacity and a new electricity tie-in with Quebec. A decision on the possible conversion of the 1000 megawatt, three-unit Coleson Cove generating station from oil to coal will likely be made by the New Brunswick Electric Power Commission (NBEPC) sometime in 1986. Unless some or all of these units are converted to coal, provincial coal demand will remain at current levels for some years to come.

For the first time in many years, consumption of thermal coal for the generation of electricity by Ontario Hydro declined in 1985. Consumption is estimated at 10.9 million t, down 19 per cent from 13.4 million t in 1984. This decline reflected the new nuclear capacity available at the Pickering and Bruce stations and is the beginning of a trend forecast to continue until early in the 1990s. This 2.5 million t decline in coal use by Ontario Hydro was the major factor behind the decline in overall Canadian coal consumption in 1985 and the decline in coal imports from the United States.

In spite of Ontario Hydro's overall reduction in coal consumption, its use of Canadian coal is forecast to have grown by about 5 per cent in 1985 to 3.3 million t representing about 30 per cent of total consumption, compared with 23 per cent in 1984. The Atikokan coal fired station, using Saskatchewan lignite coal, officially entered service in November 1985 in northwestern Ontario.

Demand for coal by steel plants and general industry and other users in Ontario is forecast to total 7.7 million t in 1985. Total demand in Ontario therefore fell by 12 per cent in 1985 to about 18.6 million t, down from 21 million t in 1984. Coal consumption in Saskatchewan for the generation of electricity is forecast to total 8.5 million t in 1985, up 7 per cent over 1984. Most of this increase was due to the low water levels and lower electricity production from hydro sources. Coal consumption will grow slowly in Saskatchewan until the early 1990s when new coal fired units are forecast to come on-stream.

Thermal coal consumption in Alberta grew by 5 per cent in 1985 to 16.9 million t. This will increase by over one million t next year due to the January 1986 commissioning of the first 400 megawatt unit of the Sheerness Generating Station. A second similar sized unit is scheduled for completion in 1990. Two other 400 megawatt units, at the Genesee Generating Station, are scheduled for commissioning in 1989 and 1991. With the completion of these stations thermal coal demand in Alberta will exceed 23 million t.

EXPORTS AND IMPORTS

Canada is a major world coal trader exporting and importing more than 42 million t of coal valued at over $3 billion. In spite of continuing difficulties in world markets, Canada's coal exports expanded by an impressive 9 per cent in 1985, to 27.2 million t. Imports on the other hand fell by about 18 per cent to 15 million t. Final statistics for 1985 should place Canada as the world's fifth largest exporter and fourth largest importer of coal. Total world coal trade in 1984 exceeded 300 million t fairly equally divided between coking and thermal coal.

Much of the expansion in Canada's trade was accounted for by increased exports to our major market, Japan, although increases were also recorded in shipments to other markets in Europe, Latin America and the Pacific Rim. Exports from Canada's west coast were divided between the port of Vancouver which exported in excess of 19 million t, and the new coal terminal at Ridley Island near Prince Rupert which shipped over 7 million t, up substantially from just over 5 million t in 1984. This later increase reflected the significant progress made by Quintette Coal Limited in improving its output relative to 1984 when it was experiencing start-up problems.

In spite of the increased level of overseas shipments, the export segment of Canada's coal industry continues to experience difficult times. Profit margins are down due to several years of price and volume cutbacks caused by slower than forecast growth in demand for coking and thermal coal and an increase in worldwide supply capacity. The slowdown in the growth of demand was the result of the global recession of the early 1980s.

Canadian companies have undertaken significant cost reduction programs, reduced the size of their work force and improved their levels of efficiency in response to the price and volume cutbacks. While this puts the industry in a much more competitive position for developing new contracts, it is recognized that the remaining years of this decade will be an era of slow growth for additional exports. The emergence of Colombia as a new thermal coal exporter to European and Asian markets, and the U.S.S.R. and People's Republic of China as exporters to the Pacific Rim markets suggests that the competition will be more intense in the years ahead.

Nevertheless, Canadian exporters continue to make progress in winning a growing share of the world's largest coal import market - Japan. In 1984, Canada replaced the United States as the second largest supplier of coking coal to the Japanese steel industry and preliminary figures suggest that Canada will remain the second largest supplier in 1985. Future significant increases in exports from Canada may, however, depend on the growing world thermal coal market. The importance of this market is demonstrated by the fact that all the major new export coal mines under active investigation in Canada, or in the pre-development phase, are mines that will produce thermal coal.

The decline in the level of Canadian imports in 1985, as noted elsewhere reflects the development of new nuclear capacity in Ontario. This decline will continue into the 1990s but may be reversed once all the nuclear capacity currently under construction is on-stream.

Domestic coal requirements for electricity, for steelmaking, and for general industry usage will increase throughout the remaining years of this decade and into the 1990s. All of the additional coal used for the generation of electricity, which is the largest of these markets, is likely to be supplied from Canadian mines and the level of this demand could be accelerated if some of the R, D & D into new coal burning technologies now under way in Canada and elsewhere, proves commercially viable.

TABLE 1. SUMMARY OF COAL SUPPLY BY TYPE AND VALUES, 1981-85

	1981		1982		1983		1984		1985[3]	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
DOMESTIC[1]										
Bituminous										
Nova Scotia	2 539	133,226	3 052	174,474	2 986	144,000	3 094	161,951	2 830	169,000
New Brunswick	524	23,308	499	24,450	558	29,000	564	29,742	555	29,800
Alberta	6 895	272,238	6 978	337,742	7 315	371,000	7 630	358,478	7 730	307,100
British Columbia	11 781	590,935	11 768	654,130	11 697	588,000	20 775	1,035,785	23 000	1,101,700
Total	21 739	1,019,707	22 396	1,190,796	22 556	1,132,000	32 062	1,585,956	34 115	1,607,600
Sub-bituminous										
Alberta	11 551	42,559	13 021	88,022	14 464	112,000	15 422	126,302	16 620	151,400
Lignite										
Saskatchewan	6 798	55,305	7 494	73,520	7 760	95,000	9 918	130,706	9 745	125,100
Total	40 088	1,117,571	42 811	1,352,398	44 780	1,339,000	57 402	1,842,964	60 480	1,884,100
IMPORTED[2]										
Bituminous & anthracite briquettes	14 836	991,994	15 773	1,132,000	14 667	1,031,000	18 352	1,366,000	15 000	..
Total	54 924	2,109,565	58 584	2,484,338	59 447	2,370,000	75 754	3,208,964	75 480	..

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] fob mines. [2] Value at United States ports of exit. [3] Preliminary figures or estimates.
.. Not available.

TABLE 2. PRODUCER'S DISPOSITION OF CANADIAN COAL[1], 1984

Destination	Nova Scotia	New Brunswick	Saskatchewan	Alberta	British Columbia	Canada
			(000 tonnes)			
Newfoundland	1	-	-	-	-	1
Prince Edward Island	8	-	-	-	-	8
Nova Scotia	2 248	-	-	-	-	2 248
New Brunswick	17	558	-	-	-	575
Quebec	-	-	-	-	-	-
Ontario	-	-	1 319	1 880	766	3 968
Manitoba	-	-	346	1	23	370
Saskatchewan	-	-	8 253	1	57	8 311
Alberta	-	-	-	16 194	2	16 196
British Columbia	-	-	-	2	124	126
Total Canada	2 274	558	9 918	18 078	972	31 800
Japan	76	-	-	3 784	12 682	16 542
Others	423	-	-	1 050	7 123	8 596
Total shipments	2 773	558	9 918	22 912	20 777	56 938

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Saleable coal (raw coal, clean coal and middling sales).
- Nil.

TABLE 3. SUMMARY OF COAL SUPPLY-DEMAND, 1974-85

Year	Canada Production				Imports				
	Bituminous	Sub-Bituminous	Lignite	Total	Anthracite	Bituminous	Total Available	Domestic Consumption	Exports
				(million tonnes)					
1974	12.5	5.1	3.5	21.1	0.4	12.0	33.5	24.9	10.5
1975	15.8	6.0	3.5	25.3	0.4	15.4	41.1	25.5	11.4
1976	14.4	6.4	4.7	25.5	0.3	14.3	40.1	28.2	11.9
1977	15.3	7.9	5.5	28.7	0.4	15.0	44.1	30.8	12.4
1978	17.1	8.3	5.1	30.5	0.3	13.8	44.6	31.7	14.0
1979	18.4	9.6	5.0	33.0	0.2	17.3	50.5	34.8	13.7
1980	20.2	10.5	6.0	36.7	0.3	15.5	52.5	37.3	15.3
1981	21.7	11.6	6.8	40.1	0.4	14.4	54.9	38.4	15.7
1982	22.3	13.0	9.5	42.8	0.3	15.5	58.6	41.5	16.0
1983	22.5	14.5	7.8	44.8	0.3	14.4	59.5	43.6	17.0
1984	32.1	15.4	9.9	57.4	0.2	18.1	18.3	48.6	25.1
1985[1]	34.1	16.6	9.7	60.5	..	..	16.0	48.0	27.1

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Preliminary figures or estimates.
.. Not available.

TABLE 4. COAL USED BY THERMAL POWER STATIONS IN CANADA, BY PROVINCES, 1966-85

	Nova Scotia	New Brunswick	Ontario	Manitoba	Saskatchewan	Alberta	Total Canada
				(000 tonnes)			
1966	799	294	3 500	79	1 116	1 360	7 148
1967	758	275	4 435	38	1 334	1 427	8 267
1968	646	240	5 523	179	1 354	2 128	10 070
1969	676	150	6 424	51	1 123	2 378	10 802
1970	548	113	7 696	503	1 969	2 951	13 780
1971	689	271	8 560	446	1 996	3 653	15 615
1972	663	281	7 599	410	2 145	4 113	15 211
1973	585	193	6 615	386	2 806	4 474	15 059
1974	606	292	6 721	132	2 902	4 771	15 424
1975	571	248	6 834	323	3 251	5 345	16 572
1976	730	207	7 612	979	3 521	5 996	19 045
1977	572	198	8 795	1 113	4 304	7 461	22 443
1978	771	151	9 097	341	4 585	8 029	22 914
1979	644	198	9 901	73	4 956	9 181	24 956
1980	1 052	315	10 779	240	4 972	10 424	27 782
1981	1 126	515	11 460	332	4 935	11 445	29 813
1982	1 300	548	12 484	184	5 897	13 242	33 656
1983	1 400	564	13 025	109	6 625	14 492	36 216
1984	1 974	610	13 413	163	7 925	16 123	40 208
1985[1]	2 300	500	10 900	225	8 500	16 875	39 300

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Preliminary figures or estimates.

TABLE 5. EXPORT DEMAND FOR CANADIAN COAL, 1984-85

Country	1984[1]		Jan.-Nov. 1985[2]	
	(000 t)	($000)	(000 t)	($000)
United Kingdom	192	14,041	342	23,100
Belgium-Luxembourg	321	19,799	49	3,285
Denmark	325	17,505	329	17,470
West Germany	418	23,015	331	20,993
France	417	21,013	630	30,906
Netherlands	116	6,291	30	2,101
Sweden	244	18,161	312	20,841
Hong Kong	192	9,293	432	18,437
Pakistan	159	10,921	144	9,941
Japan	16 543	1,281,791	16 771	1,307,707
South Korea	3 583	219,738	3 806	242,628
Taiwan	746	45,334	611	40,077
Brazil	1 055	73,018	887	59,047
Chile	142	8,835	157	10,831
Mexico	163	11,092	195	13,035
United States	191	8,653	313	14,900
Yugoslavia	119	7,282	-	-
Others	212[3]	9,495	309[4]	16,677
Total	25 138	1,805,277[5]	25 648	1,851,976[5]

[1] Statistics Canada and Energy, Mines and Resources, Canada. [2] Statistics Canada, Domestic Exports by Commodities and Countries, Catalogue 65-004. Preliminary figures. [3] Includes Italy, Philippines, Egypt, Spain. [4] Includes Finland, Italy, Iran, Spain, India, People's Republic of China, Philippines. [5] Fob port of export.

TABLE 6. SUMMARY OF COAL DEMAND, 1980-84

	1980	1981	1982	1983	1984
			(000 tonnes)		
DEMAND					
Thermal Electric					
Canadian	19 314	20 998	24 033	26 748	9 935
Imported	8 468	8 815	9 623	9 468	10 273
Total	27 782	29 813	33 656	36 216	40 208
Metallurgical					
Canadian	961	784	229	102	-
Imported	6 279	5 593	5 347	5 481	6 542
Total	7 240	6 377	5 576	5 583	6 542
General Industry					
Canadian	1 190	962	1 075	667	628
Imported	955	1 044	986	1 003	1 136
Total	2 145	2 006	2 061	1 670	1 764
Space Heating					
Canadian	166	171	185	180	185
Imported	-	-	-	-	-
Total	166	171	185	180	185
Exports					
Canadian	15 269	15 705	16 004	17 011	25 138
Total					
Canadian	36 900	38 620	41 526	44 708	55 886
Imported	15 702	15 452	15 956	15 952	17 951
Grand Total	52 602	54 072	57 482	60 660	73 837

Sources: Statistics Canada; Energy, Mines and Resources Canada.
- Nil.

TABLE 7. CANADA, COKE PRODUCTION AND TRADE, 1974-84

	Production		Imports		Exports	
	Coal	Petroleum	Coal	Petroleum	Coal	Petroleum
			(tonnes)			
1974	5 443 427	274 412	509 058	746 033	260 892	24 940
1975	5 277 837	270 685	546 456	572 557	96 081	161 576
1976	5 289 185	678 432	287 249	591 859	169 895	136 970
1977	4 845 066	921 363	382 827	986 678	198 727	157 191
1978	4 967 664	1 014 076	553 349	973 985	217 595	134 762
1979	5 775 141	1 105 433	520 534	980 657	228 601	125 416
1980	5 249 744	1 156 444	626 923	908 322	319 554	150 200
1981	4 659 007	1 098 397	653 645	935 929	190 879	200 149
1982	3 999 117	1 083 129	453 915	650 810	129 793	104 897
1983	4 120 002	986 730	576 649	759 954	45 606	65 323
1984	4 900 478	1 072 983	660 257	886 734	116 226	55 300

TABLE 8. CANADIAN COAL PRODUCTION, 1985[1]

	000 tonnes	$000
Bituminous		
Nova Scotia	2,830	169,000
New Brunswick	555	29,800
Alberta	7,730	307,100
British Columbia	23,000	1,101,700
Sub-bituminous		
Alberta	16,620	151,400
Lignite		
Saskatchewan	9,745	125,100
Total	60,480	1,884,100

[1] Preliminary estimates, Statistics Canada.

TABLE 9. CANADA, COAL PRODUCTION, IMPORTS, EXPORTS AND CONSUMPTION, 1980-85

	Production	Imports	Exports	Domestic Consumption
	(000 tonnes)			
1980	36 664	15 829	15 269	37 333
1981	40 088	14 836	15 705	38 367
1982	42 811	15 773	16 004	41 478
1983	44 780	14 667	17 011	43 649
1984	57 402	18 352	25 138	48 699
1985[1]	60 480	15 000	27 200	48 000

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Preliminary figures or estimates.

Cobalt

R.G. TELEWIAK

Consumption of primary cobalt in the western world is estimated to be 18 000 t in 1985, the same as 1984. An additional 2 000 t of cobalt contained in secondary material, was also utilized by consumers.

Demand from the superalloy sector, which accounts for about one-third of the total, was again particularly strong. This was led by the manufacture of new commercial and military jet engines, as well as normal replacement of jet engine parts, primarily turbine blades.

CANADIAN DEVELOPMENTS

The two mine producers of cobalt, Inco Limited and Falconbridge Limited, recover cobalt as a byproduct of nickel-copper production. Inco operates mines at Sudbury, Ontario and Thompson, Manitoba. Falconbridge's mines are also at Sudbury.

At Port Colborne, Ontario, Inco operated its cobalt refinery at its capacity of 900 tpy of electrolytic cobalt rounds. The refinery was opened in 1983 and high quality cobalt metal is produced for use, primarily in the superalloy sectors.

At Sudbury, Inco proceeded with development of the high-grade deep zone of the Creighton mine, which is expected to provide some of the company's lowest cost ore. Cost reduction programs continued to be pursued aggressively, particularly in mining. Increased use of bulk mining methods was a major factor in decreasing the company's operating costs.

At Thompson, Inco commenced preliminary production at its Thompson open-pit in October. The deposit is high-grade, averaging 2.7 per cent nickel along with values in copper, cobalt and platinum group metals. The open-pit will replace the Pipe open-pit which was mined out in 1984 but from which stockpiled ore was taken in 1985. As a result of less complex metallurgy, the metal recoveries are expected to be higher than Pipe ore. The ore grade is also three times higher than at Pipe.

Falconbridge, at Sudbury, commenced a three year, $216 million program of preproduction, development and capital expenditures. A major part of the program is to deepen the Strathcona No. 1 shaft, and to develop the Craig and Onaping deposits. Falconbridge had fallen behind in mine development a few years ago, due to other priorities.

Cobalt feedstock supply for Sherritt Gordon Mines Limited's refinery at Fort Saskatchewan, Alberta, remained about the same as in 1984. Sherritt Gordon toll refines cobalt for several producers and in 1985 material from AMAX Inc. continued to be obtained. However, with the late-November closure of AMAX's refinery in Louisiana, United States this material will be unavailable in 1986.

An airstrip was completed on the copper-cobalt Windy Craggy property of Geddes Resources Limited in northwestern British Columbia. The deposit is reported to contain 318 million t of mineralization grading 1.5 per cent copper, 0.08 per cent cobalt plus gold values. A 850 m adit is planned for 1986. The adit will be driven through the zone rich in cobalt and into the part of the deposit with higher gold values.

WORLD DEVELOPMENTS

Zaire, which possesses over one-half of the cobalt production capacity in the western world, continued its market stabilization strategy adopted in 1984. Exports were closely monitored to ensure that international supply and demand were in approximate balance. La Générale des Carrieres et des Mines du Zaire (Gecamines), the Zairean state-owned mining company and marketing agency, has announced that it will increase or decrease sales and production as necessary in order to maintain market equilibrium.

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Falconbridge started an expansion of its refinery at Kristiansand, Norway to 54 400 t of nickel annually from 38 600 t, with adjustments for the refining of copper, cobalt and precious metals. A long-term agreement was signed with BCL Ltd., which operates mines and a smelter at Selebi Pikwe, Botswana. BCL agreed to deliver 6 500 t of matte to the refinery in 1985, 21 000 t in 1986 and 41 000 tpy from 1987 to 1999.

AMAX Inc. in the United States, which had been treating the BCL matte, closed its Port Nickel, Louisiana, refinery on November 30. The Botswana matte had been the major source of mátte with the remainder coming from Agnew Mining Co. Pty. Ltd. in Australia. AMAX has a contract until 1989 with Agnew for the matte and AMAX agreed to terms with Sherritt Gordon and Outokumpu Oy for sale of most of it. The AMAX refinery had been the only primary nickel and cobalt processing facility in the United States.

PRICES

The producer price of cobalt was kept at $US 11.70 per pound throughout the year. This price had been initially cut in April 1983 and the major factor in keeping the price at that level, has been the market stabilization strategy adopted by Zaire.

Merchant prices, however, were weaker and differentials of up to $1.00/lb between the producer and market prices, were obtained. In the latter part of the year, merchant prices were under downward pressure, due partially to some concerns that the producer price may fall, and also that some unauthorized cobalt material may soon be released from Zaire.

USES

One of the major uses for cobalt is in superalloys where it improves the strength, wear and corrosion resistance characteristics of the alloys at elevated temperatures. The major use of cobalt-base superalloys is in turbine blades for aircraft jet engines and gas turbines for gas pipelines. Cobalt-based superalloys normally contain 45 per cent or more cobalt, while nickel- and iron-based superalloys contain 8 to 20 per cent cobalt.

Although the demand for cobalt in the production of magnets has been declining in recent years, this is still an important use for cobalt. Consumption of cobalt in this sector is almost one-half of what it was in 1970.

Cobalt-base alloys are used in applications where difficult cutting is involved and high abrasion resistance qualities are required. The most important group of cobalt-base alloys is the stellite group, containing cobalt, tungsten, chromium, and molybdenum as principal constituents. Hard-facing or coating of tools with cobalt alloys provides greater resistance to abrasion, heat, impact and corrosion.

Cobalt metal powder is used as a binder in making cemented tungsten carbides for heavy-duty and high-speed cutting tools.

As a chemical product, cobalt oxide is an important additive in paint, glass, and ceramics. Cobalt is also used to promote the adherence of enamel to steel for applications such as appliances, and steel to rubber for the construction of steel-belted tires. A cobalt-molybdenum-alumina compound is used as a catalyst in hydrogenation and in petroleum desulphurization.

OUTLOOK

Over the long-term, cobalt consumption is expected to increase at an annual rate of 1 to 2 per cent. The price volatility in the late-1970s and early-1980s, along with some concern over potential security of supply, has resulted in considerable substitution away from cobalt in certain uses and is a major factor in the forecast of a relatively modest increase.

Major consuming countries have expended considerable resources to find substitutes for cobalt in key applications. These programs have reduced the amount of cobalt used or eliminated it completely in certain applications. As an example, Pratt & Whitney Group of the United States has developed a jet engine combustor which consists of a nickel alloy, to replace a cobalt alloy. A heat resistant ceramic coating reportedly makes the nickel alloy at least as durable as the cobalt one.

Due primarily to the threat of substitution, the price of cobalt is not considered likely to advance significantly in real-terms from its average level for 1984 of just over $US 11.50/lb. A substantially higher price would encourage more substitution and it would be in the long-term interest of producers to not precipitate that type of action.

Zaire and Zambia are the two largest producers in the world, accounting for about two-thirds of cobalt capacity. The strategies which these two producers pursue, along with possible other events in these countries, will have a major impact upon supply and resultantly on prices and consumption.

TABLE 1. CANADA, PRODUCTION TRADE 1983-85 AND CONSUMPTION 1982-84

	1983		1984		1985P	
	(kilograms)	($)	(kilograms)	($)	(kilograms)	($)
Production[1] (all forms)						
Ontario	1 088 364	17,758,765	1 687 632	48,583,550	2 321 894	79,599,170
Manitoba	321 262	5,804,674	435 701	12,542,960	353 754	12,127,395
Total	1 409 626	23,563,439	2 123 333	61,126,510	2 675 648	91,726,565
Exports					**(Jan.-Sept.)**	
Cobalt metal						
United States	654 191	11,585,000	1 149 524	25,326,000	963 022	22,457,000
United Kingdom	107 974	3,805,000	179 481	2,549,000	71 000	396,000
South Africa	21 559	539,000	-	-	431	18,000
Belgium-Luxembourg	67 995	379,000	136 996	764,000	82 000	457,000
Australia	14 856	208,000	3 929	118,000	4 315	153,000
Other countries	18 707	330,000	17 135	574,000	6 643	569,000
Total	885 282	16,846,000	1 487 065	29,330,000	1 127 411	24,052,000
Cobalt oxides and hydroxides[2]						
United Kingdom	184 000	6,061,000	320 000	5,951,000	197 000	5,464,000
United States	8 000	112,000	17 000	72,000	-	-
Belgium-Luxembourg	-	-	36 000	573,000	-	-
Total	192 000	6,173,000	192 000	6,173,000	197 000	5,464,000
Consumption[3]	1982r		1983		1984P	
Cobalt contained in:						
Cobalt metal	63 863		82 615		85	736
Cobalt oxide	4 634		10 563		19	923
Cobalt salts	12 456		7 818		7 313	
Total	80 953	..	100 996	..	112 972	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Production (cobalt content) from domestic ores. [2] Gross weight. [3] Available data reported by consumers.
P Preliminary; r Revised; - Nil; .. Not available.

TABLE 2. CANADA, COBALT PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975 AND 1980-84

		Exports		Imports		
	Production[1]	Cobalt metal	Cobalt oxides and hydroxides	Cobalt ores[2]	Cobalt oxides and hydroxides[3]	Consumption[4]
	(tonnes)					
1970	2 069	381	837	..	..	148
1975	1 354	431	561	..	..	123
1980	2 118	325	1 091	2	26	105
1981	2 080	677	601	24	20	101
1982	1 274	585	230[r]	2	30	81[r]
1983	1 410	885	192	45	30	101
1984	2 123	1 487	373			113P

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Production from domestic ores, cobalt content including cobalt content of Inco Limited and of Falconbridge Limited shipments to overseas refineries. [2] Cobalt content. [3] Gross weight.
[4] Consumption of cobalt in metal, oxides and salts.
P Preliminary; r Revised; . Not available.

TABLE 3. WORLD PRODUCTION OF COBALT

	1981	1982	1983P	1984e
	(tonnes)			
Zaire	15 420	11 300	11 300	16 960
Zambia	3 420	3 250	3 200	4 620
Canada	2 080	1 274	1 410	2 123
Australia	1 470	1 480	1 360	1 270
Finland	1 035	930	910	910
Cuba	1 715	1 500	1 650	1 530
U.S.S.R.	2 180	2 270	2 360	2 630
Other	3 430	2 267	1 800	1 027
Total	30 750	24 271	23 990	31 070

Source: United States Bureau of Mines.
P Preliminary; e Estimate.

Columbium (Niobium)

D.G. FONG

Western world columbium production in 1985, estimated at 20 000 t of columbium pentoxide (Cb_2O_5) improved slightly over 1984. Mine production of columbium in Canada was at capacity during 1985 while the demand for Canadian pyrochlore concentrates remained strong.

World columbium consumption in 1985 made only a modest gain compared with 1984 when consumption improved by over 15 per cent because of the economic recovery. Although the demand for carbon steels and high-strength-low-alloy steels showed a marginal decline, the market for superalloys and stainless steels remained strong throughout most of 1985, especially for superalloys.

The continuing strength in the aerospace industry, and near record orders for new commercial aircrafts in 1985, will most likely result in a firm demand for columbium-containing superalloys over the next half decade.

Prices for most columbium products during 1985 were unchanged, except for Canadian pyrochlore concentrates which were lowered by about 20 per cent at year-end in the Metals Week price quotation.

CANADIAN DEVELOPMENTS

Niobec Inc., with its mine located at St. Honoré, Quebec, is Canada's sole columbium producer. Niobec is jointly-owned by Société québécoise d'exploration minière (SOQUEM) and Teck Corporation. Production in 1985 was estimated at 3 180 t of columbium pentoxide (Cb_2O_5) contained in pyrochlore concentrate, a slight increase from 1984. The output is expected to increase in 1986 because mining will encounter higher ore grades.

Niobec became the only major world supplier of pyrochlore concentrate following a decision taken by Brazilian producers to convert all their output into intermediate products. Shipments of Canadian pyrochlore concentrates, containing about 60 per cent Cb_2O_5 are destined primarily for the United States (27 per cent), western Europe (35 per cent) and Japanese (36 per cent) markets.

Highwood Resources Ltd. continued development work at its Thor Lake deposit in the Northwest Territories. Thor Lake is located 110 km southeast of Yellowknife on the north shore of Great Slave Lake. The property contains several multi-metal deposits, each with slightly different mineralization. Exploration work between 1977 and 1981 outlined 70 million t of mineralization with an average grade of 0.03 per cent tantalum oxide (Ta_2O_5), 0.40 per cent columbium oxide (Cb_2O_5), 3.5 per cent zirconium oxide (ZrO_2) and 1.7 per cent combined rare earth oxide (REO). Additional drilling in the 1983-84 seasons identified a beryllium zone containing 1.8 million t of 0.85 per cent beryllium oxide (BeO).

In 1985, an underground ramp was driven into one of the mineralized zones to obtain bulk samples of beryllium and yttrium ore for pilot plant testing. At year-end, metallurgical testing of the bulk samples was being carried out at an Ontario laboratory. If this property is brought into production, tantalum, columbium, rare earths and other associated elements could be produced as byproducts or coproducts.

Iron Ore Company of Canada (IOC) discontinued work in 1985 at its Strange Lake property because of studies that indicated a limited market for metals contained in this deposit. The IOC property, located near Lac Brisson and straddling the boundary between Quebec and Labrador, was reported to contain a large tonnage of yttrium, zirconium, rare earths, columbium and tantalum. The deposit was discovered in 1979 in a follow-up of a geochemical survey of the region under a joint federal-provincial program.

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WORLD DEVELOPMENTS

Companhia Brasileira de Metalurgia e Mineracao S.A. (CBMM), the world's largest columbium source, produces about 85 per cent of Brazil's annual output; the balance is produced by Mineracao Catalao de Goias S.A. Together they have an installed capacity of 46 200 t columbium concentrates and 27 700 t of ferrocolumbium.

Brazil's columbium production in 1985 was estimated to be about the same as in 1984, reported at 16 783 t Cb_2O_5 equivalent. Exports by CBMM were about 11 839 t of ferrocolumbium and 771 t of high purity columbium oxide, compared with 11 261 t and 673 t respectively in 1984. Catalao's exports were estimated to be the same as in 1984, which were 2 074 t of ferrocolumbium.

CBMM is owned 55 per cent by Metropolitana de Comércio e Participacoes, a private Brazilian interest, and 45 per cent by Molycorp, Inc. of the United States. The ownership of the Mineracao Catalao operation changed hands in late-1984 when Anglo American Corporation of South Africa Ltd. acquired a controlling interest.

In recent years, CBMM has placed a high priority on the further processing of its columbium ores. In addition to nickel-columbium alloy and high purity oxides operations, the company announced in 1985 its decision to invest $US 4.6 million in a plant to start commercial production of pure columbium metal for global markets. The new project, to be located at Araxa in the state of Minas Gerais, is near its mine and plant site and will have a production capacity of 100 tpy. Startup of the new operation is scheduled for 1987.

USES

The steel industry is the largest consumer of columbium, which is used in the form of ferrocolumbium as an additive agent in high-strength-low-alloy (HSLA) steels, carbon steels, and stainless steels. Although the quantity of contained columbium may be as low as 0.02 per cent, the yield strength and mechanical properties of the resulting steel are significantly improved. These characteristics are particularly important in applications such as large-diameter pipeline, automotive components, structural applications and drilling platforms.

High-purity columbium pentoxide is used mainly in superalloys for turbine and jet engines, which have traditionally been the second largest use after steels. A columbium addition to the cobalt- and nickel-based superalloys improves the high-temperature characteristics of these alloys. In addition, a columbium-based alloy containing tantalum, tungsten and zirconium is being used for the orbital maneuvering engine in the U.S. space shuttles.

In the manufacture of high-alloy and stainless steels, columbium is used to impart resistance to corrosion at elevated temperatures, a property of particular importance in petroleum processing plants, heat exchangers for severe chemical environments and acid pressure vessels.

One of the important properties of pure columbium is its superior conductivity compared with other metals. Super conductivity is the loss of all resistance to direct electrical current at temperatures near absolute zero. This special property of columbium allows the construction of powerful electrical generators, which are much more efficient than conventional generators with copper wire windings. Also, because of the powerful magnetic field created by the superconductors, it is used extensively in the construction of nuclear magnetic resonance (NMR) spectrometers. In addition, many potential applications in electrical devices are being developed, including new types of motors, ship engines, electric generators and switch elements for computers.

Special high-purity columbium pentoxide is produced for optical applications. Additions of columbium pentoxide to optical glass give a high refractive index and thereby allow production of thin lenses for eyeglasses. This characteristic, along with others such as lightweight and durability, enable such lenses to be competitive with plastic lenses.

PRICES

The price for Canadian pyrochlore concentrates remained unchanged throughout most of 1985 but dropped from $US 7.17 to $US 5.73 per kg of contained Cb_2O_5 at year-end in the Metals Week price quotations. Prices for other columbium products remained stable during the year. Regular grade ferrocolumbium remained at $US 12.48 and high-purity vacuum grade at $US 39.03 per kg of contained columbium.

OUTLOOK

Improved steelmaking technology and lower steel requirements will continue to have a negative impact on the consumption of a number of ferroalloy products. The demand for ferrocolumbium, however, is expected to fare better than most other ferroalloys because of the advantages held by columbium steels, which result in substantial material savings for many steel applications. In the long run, the demand for columbium in the western world is expected to grow between 3 and 4 per cent a year.

Increased uses of HSLA steels in auto-making for component and structural parts is expected to be a continued trend and an important factor in the demand growth for columbium. Growth in automobile applications for HSLA steels came mainly from the unitized frame for maintaining strength and wheel rims for weight reduction. Further growth is likely to be in forged products such as connecting rods and crankshafts which will result in cost savings from the elimination of heat treatment.

The outlook for the Canadian steel pipe and tube industry is less certain. The market for large and small diameter pipe is expected to remain at current levels through 1986. Steel casing and tubing demand, which was strong in 1985 because of increased drilling activities in Canada, will likely decline in 1986 with the end of the petroleum incentive (PIP) grants. Also, the industry is forecasting a modest decline in demand for specialty steels in 1986.

Stainless steel products, another major use of columbium, experienced a slight downturn in late-1985 from a strong market in 1984. The decline was due mainly to a softening in sales of consumer durable goods and weaker orders for some capital goods. This trend is expected to continue in 1986.

The use of columbium in superconductors is expected to have a bright future. Current plans for the production of large superconductors, which would find application in particle accelerators, atomic smashers and levitating systems for trains could result in a large increase in the demand for columbium.

The expanding use of magnetic resonance imagers (MRI) is projected to have a noticeable impact on the columbium market in the near future. MRI is used for medical scanning in hospitals; it is a more powerful technology than X-ray scanners but does not emit radiation. The potential growth in this area is substantial.

On the supply side, there will be adequate resources and production capacity to meet the forecasted demand increase. Brazil has an abundance of columbium reserves, both proven and as yet to be developed; CBMM is in a position to double its 25 000 tpy pyrochlore plant whenever markets warrant.

Canada also has large resources which occur in a number of undeveloped deposits across the country. In view of the strong growth potential for columbium, some of these deposits are likely to be mined in the next decade. The development of these deposits will enhance Canada's position as an important world columbium supplier.

Adequate supplies to satisfy growing demand and the relative stability of columbium prices have been key factors in expanding the markets for this metal. These factors are expected to prevail in the foreseeable future, with the result that columbium should remain cost effective as a steel additive, particularly in relation to its closest substitute, vanadium.

PRICES

Prices as quoted in Metals Week in December 1984 and 1985, U.S. currency.

	1984	1985
	($)	
Columbium ore		
Columbite, per kg of pentoxide, cif U.S. ports[1]	7.72-11.02	7.70-11.02
Canadian pyrochlore, per kg, fob mine	7.17	5.73
Ferrocolumbium, per kg Cb, fob shipping point		
Low alloy	12.48	12.48
High purity alloy	39.02	39.02
Columbium metal, per kg 99.5-99.8%, fas shipping point		
Reactor ingot	72.75-88.18	72.75-88.18
Reactor powder	79.37-105.82	79.37-105.82

[1] The range reflects variations in the ratio of columbium pentoxide (Cb_2O_5) to tantalum pentoxide (Ta_2O_5).
cif - Cost, insurance and freight; fob - Free on board; fas - Free alongside ship.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
32900-1	Columbium and tantalum ores and concentrates	free	free	free	free
35120-1	Columbium (niobium) and tantalum metal and alloys in powder, pellets, scrap, ingots, sheets, plates, strips, bars, rods, tubing or wire for use in Canadian manufactures (expires June 30, 1986)	free	free	25	free
37506-1	Ferrocolumbium, ferrotantalum, ferro-tantalum-columbium	free	4.3	5	free

MFN Reductions under GATT (effective January 1 of year given)		1985	1986	1987
			(%)	
37506-1		4.3	4.2	4.0
UNITED STATES				
601.21	Columbium ore	free		
		1985	1986	1987
			(%)	
628.15	Columbium metal, unwrought, and waste and scrap (duty on waste and scrap suspended to June 30, 1982)	4.0	3.9	3.7
628.17	Columbium, unwrought alloys	5.6	5.2	4.9
628.20	Columbium metal, wrought	6.4	5.9	5.5

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated 1985, USITC Publication 1610; U.S. Federal Register, Vol. 44, No. 241.

TABLE 1. CANADA, COLUMBIUM (NIOBIUM) PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975 AND 1979-85

	Production[1]	Imports: Primary forms and fabricated metals		Exports[2]	Consumption
	Cb_2O_5 Content	Columbium	Columbium Alloys	Columbium Ores and Concentrates to United States	Ferrocolumbium and Ferro-tantalum-columbium, (Cb and Ta-Cb Content)
	(kilograms)				
1970	2 129 271	..	..	576 227	132 449
1975	1 661 567	..	..	9 682	215 910
1979	2 512 667	855	W	509 953	360 152
1980	2 462 798	877	156	655 721	486 251
1981	2 740 736	913	303	419 865	455 500
1982	3 086 000	805	59	291 193	356 000
1983	1 744 722	967	396	543 599	359 000r
1984	2 766 805	1 045	236	1 132 892	482 000
1985P	3 300 000	..	..	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada; U.S. Department of Commerce.
[1] Producers' shipments of columbium ores and concentrates and primary products, Cb_2O_5 content. [2] From U.S. Department of Commerce, Imports of Merchandise for Consumption, Report FT 135. Quantities in gross weight of material.
P Preliminary; .. Not available; W Withheld to avoid disclosing confidential company data; r Revised.

Copper

W.J. McCUTCHEON

Canadian copper producers continued to experience financial difficulties due to low metals prices. In Canada, and abroad, a number of copper companies and properties were offered for sale as low prices reduced corporate profits; but these low prices also made some sales difficult.

Canadian copper shipments and copper production increased in 1985 compared with 1984. Estimated shipments and production of copper in copper concentrates are 730 000 t and 770 000 t, respectively, in 1985 compared with 722 000 t and 722 000 t in 1984. Production of copper in copper concentrates is forecast at 775 000 t for 1986.

CANADIAN DEVELOPMENTS

The only copper production in the Maritimes throughout the year occurred as a byproduct of the zinc-lead operations at the Brunswick Mining and Smelting Corporation Limited in Bathurst, **New Brunswick.** In **Nova Scotia,** Rio Algom Limited's East Kemptville tin mine started trial production. About 1 500 tpy of byproduct copper in concentrates should be produced when the mine reaches full production.

In **Quebec,** Noranda Inc.'s Division Mines Gaspé continued development work to prepare the new E-32 orebody for production in 1988, as a replacement for the Needle Mountain underground mine which will be depleted by that time. Needle Mountain operated a full year but the Copper Mountain open-pit mine remained shut. The Gaspé smelter operated through the year, smelting concentrates produced at the mine and those imported from South America. The Quebec government announced regulations in February to control the emission of sulphur dioxide from sources within the province. The Gaspé and Horne smelters will be required by the end of 1990 to contain 65 per cent and 50 per cent, respectively, of the sulphur entering the plants. As well, the Horne smelter will be required to contain 35 per cent of the sulphur entering the plant by the end of 1989.

At B.P. Minerals Limited's Selbaie operations, development continued on the zinc-copper open pit. The 4 500 tpd pit is expected to start producing by November 1987. In December, Esso Minerals Canada agreed to purchase a 35 per cent interest in the Selbaie property. In the Chibougamau camp, the three gold-copper producers expressed interest in a chloride-based leach process for copper. Shaft sinking continued on schedule towards Corporation Falconbridge Copper's 2.1 million t Ansil orebody grading 7.18 per cent copper.

The **Ontario** operations of Inco Limited and Falconbridge Limited in the Sudbury basin, which together produced 150 000 t of copper in 1984, are reviewed in the nickel chapter of this Yearbook. Falconbridge Limited announced an agreement to buy Kidd Creek Mines Ltd. from the Canada Development Corporation (CDC) for $Cdn 615 million of shares and cash. Falconbridge shareholders will vote on the deal in early-1986.

Expansion of the copper smelter and copper refinery capacity to 90 000 tpy of cathode continued at Kidd Creek's operations in Timmins. In September, an equipment fault in a holding furnace resulted in a spill of 400 t of molten copper over the anode casting facilities. The casting machine was back in operation 17 days after the incident.

The Ontario government introduced measures to control the province's SO_2 emissions including those from the Sudbury nickel-copper operations of Falconbridge and Inco Limited.

In **Manitoba,** Sherritt Gordon Mines Limited ceased production at the Fox mine in late-November, after exhausting economic reserves. Sherritt's Ruttan mine was deepened and the increased output resulted in significant cost reductions. The Trout mine, operated by Hudson Bay Mining and Smelting Co., Limited, (HBM&S) will increase production by about 15 per cent in 1986 compared with 1985. Hudson Bay's parent, Inspiration Resources Corporation of the

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United States, engaged a Toronto investment firm to determine if Hudson Bay could be sold as a part of a program to raise capital for corporate debt reduction and to reduce Inspiration's dependence upon base-metals. Interested companies were reported to include, Inco, Sherritt and Gränges Exploration Ltd., but no agreement was concluded.

In **British Columbia,** an in-pit crusher and conveyor was completed in January at Utah International Inc.'s Island Copper mine and this reduced operating costs. In December, the company announced plans to increase mill throughput by 3 000 tpd. This will permit lower grade ore to be processed and will take advantage of a two year discount on the additional electrical power rates which has been offered. In September, Westmin Resources Limited officially opened its new HW mine and the new 3 000 tpd mill adjacent to its existing facilities. Noranda Inc. announced that it would sell assets to reduce its debt by $Cdn 1 billion: the first major sale was its 31 per cent interest in Placer Development Limited. Brenda Mines Ltd. and Noranda's Bell mine recommenced operations in September. The reopening followed an agreement with the British Columbia government to reduce hydroelectric rates and certain taxes and also an agreement with the unions to extend existing contracts. Both mines are expected to cease operations by the end of 1988, after exhausting economic reserves. Gibraltar Mines Limited announced a $Cdn 12 million program to leach waste and low-grade ore to produce 5 000 tpy of cathode through solvent extraction and electrowinning. Operations are expected to commence in the fall of 1986 and will be assisted by a discount on electric power rates.

Producers' domestic shipments are estimated to be about 205 000 t in 1985, the same as the revised 1984 estimate. The estimate for consumption in the table entitled "Canada, Copper Production, Trade and Consumption" is the sum of shipments by Canadian producers to domestic destinations plus the refined metal imports.

Competitiveness

Unlike the majority of copper producers in other nations the profitability of Canadian copper producers is greatly influenced by the prices of other metals. There is no Canadian producer mining only copper. The largest copper producer in 1984 was a nickel company, Inco, and the second largest, Kidd Creek, derived more revenue from the sale of zinc than from the sale of copper. Thus, the changes in competitiveness of a significant portion of Canadian copper production depends more on the changes in prices of other metals than changes in the price of copper. At the end of 1985, the fall of nickel and zinc prices relative to copper had a negative impact on the economics of a significant proportion of Canadian copper production.

Canadian currency has appreciated in the past few years relative to the currencies of most other major copper producers, with the exception of those in the United States. While the decline of the value in Canadian currency relative to that of the United States has helped a number of Canadian copper producers, the Canadian industry's competitiveness has been severely affected by the significant devaluations that have benefited almost all other major copper producing nations.

WORLD DEVELOPMENTS

Copper producers in the western world continued to reduce operating costs by: producing at higher rates, increasing ore grade, reducing dilution, and increasing productivity. Copper prices remained low despite the drawdown in stocks at the beginning of the year and concerns then voiced about the availability of adequate supplies of high quality material. Demand in 1986 is forecast to be about the same as in 1984, about 7.5 million t.

In the western world, mine production of copper is estimated at 6.20 million t in 1985, down from the 6.33 million t in 1984. Refined production is estimated at 7.2 million t, the same as 1984. Western world refined consumption is estimated at 7.3 million t, down from 7.55 million t in 1984. Chile was again the world's largest producer, and western Europe remained the largest consumer of refined copper.

In the **United States,** mine and refined copper production is estimated at 1.05 million t and 1.44 million t respectively, compared with 1.09 million t and 1.51 million t in 1984. Refined consumption is estimated at 1.96 million t in 1985 compared with 2.04 million t in 1984. In early-1985, the unions and major producers had attempted to renegotiate labour contracts to obtain concessions in early-1985, but no agreement was reached. These contracts expire in 1986 and there is potential for supply disruptions, depending upon the outcome of these negotiations.

ASARCO Incorporated closed its Tacoma smelter due to the cost of pollution control measures that would have been required to keep the facility in operation. ASARCO's losses for the first 9 months of 1985 totaled $US 52 million compared to $US 70 million for the first 9 months of 1984.

Atlantic Richfield Company's subsidiary, Anaconda Minerals Company, sold the Butte mine in September to Washington Corporations, a highway construction and mine development company. The smelter, the refinery and the tailings were not included in the deal. Kennecott Corporation closed its Utah Copper Division at the end of April. The 180 000 tpy operation had been running at one-third of capacity since July 1984. A $US 400 million modernization project was announced which is expected to result in a resumption of the operations by 1988.

Exxon Minerals Company announced that it would apply for permits to mine the Crandon property in Wisconsin. Newmont Mining Corporation's subsidiary Magma Copper Company lost $US 30 million in the first 9 months of 1985. Magma's San Manuel smelter will require an estimated $US 130 million retrofitting work to comply with future pollution control standards. The decision on whether to proceed with the retrofitting will depend upon upcoming labour negotiations.

Phelps Dodge Corporation's primary metal operations reduced costs considerably, showing a $US 42 million profit for the first 9 months of 1985 compared to a loss of $US 76 million for the same period in 1984. Phelps Dodge expected to produce about 360 000 t of copper from its Morenci and Tyrone mining operations in 1985. The Ajo smelter was closed in April, due to the costs of complying with air pollution standards. The sale of a 15 per cent interest in its Morenci mine to Sumitomo Metal Mining Co. Ltd. and Sumitomo Corporation for $US 75 million was completed in November. Sumitomo will receive 15 per cent of the concentrates produced. In December, Phelps Dodge announced that Morenci would be expanded to a capacity of 258 000 tpy in mid-1987 by a $US 90 million program to be financed by Phelps Dodge and Sumitomo. Part of the expansion program will include construction of a solvent extraction/electrowinning plant. A further expansion by 9 000 tpy is planned before 1990.

In **Chile**, copper production was affected by an earthquake in March which damaged ports, resulting in the closure of the Las Ventanas smelter and briefly closed the El Teniente mine. Production for the year is estimated at 1.3 million t, with Corporacion Nacional del Cobre de Chile, (Codelco-Chile) accounting for 1.03 million t. Codelco-Chile's profits in 1984 were $US 144 million after payments of $US 556 million to the state.

Codelco-Chile is planning to invest an estimated $US 1.2 billion in its Chuquicamata operations, over a five year period. Milling capacity will be increased by 50 per cent to 150 000 tpd. A flash smelter/acid plant and additional leach facilities will also be installed.

Empresa Nacional de Minera's (ENAMI) smelter at Las Ventanas was damaged by the March earthquake and forced to close until mid-April. Codelco decided against building a 100 000 tpy refinery near Santiago to handle El Teniente blister now processed at Las Ventanas.

Texaco, Inc. sold its half interest in the Escondida property in northern Chile for less than $US 100 million. Utah International Inc. (owned by The Broken Hill Proprietary Company Limited (B.H.P.) of Australia) increased its holding in the property to 60 per cent while Rio Tinto Zinc Corporation Limited (RTZ) took 30 per cent of the property and the Japan-Escondida Corporation took the remaining 10 per cent. The feasibility of mining the 675 million t orebody grading 2.1 per cent Cu will be re-examined in 1986. Present plans envisage a capital cost of $US 1.1 billion to place the mine in operation, producing 300 000 to 350 000 tpy of copper in concentrates at the start of the next decade. The start up of such a large concentrate producer could result in increased treatment and refining charges in the Pacific basin for existing producers.

No final decision was made by year-end whether to bring Rio Algom Limited's Cerro Colorado deposit into production. A production rate of about 60 000 t of copper in concentrates for a capital cost of $US 200 million from the 65 million t, 1.38 per cent Cu deposit has been considered. Exxon will spend $US 80 million to expand the output at its El Soldado mine of its subsidiary Cia Minera Disputada de las Condes S.A. from 30 000 t of copper in concentrates to 60 000 tpy by mid-1987. Exxon's expansion plans for its Los Bronces mine are expected to be reviewed by mid-1986: the 40 000 tpy operation could produce 120 000 tpy of copper in concentrates after an investment of $US 400 million.

In **Zaire,** production for 1985 is estimated at 510 000 t, compared to 500 000 t for 1984. The majority of the production came from the state-owned producer, Générale des Carrieres et des Mines (Gecamines) which produced about 474 000 tpy. Zaire secured a World Bank loan for $US 100 million as part of a $US 750 million plan to rehabilitate the Gecamines facilities. At the end of the year, European donors were expected to contribute about $US 100 million towards the plan to maintain production. Transportation problems due to low water levels and congestion of rail facilities hindered Gecamines throughout the year.

In **Zambia,** Zambia Consolidated Copper Mines Limited operations were affected by a shortage of foreign exchange. As a result of shortages of spare parts and diesel fuel, coupled with a strike in June by 8,000 workers, production for 1985 decreased to about 495 000 t of copper from 522 000 t in 1984. In addition to this, some material was imported from Zaire and smelted and refined in Zambia. The European Commission agreed to provide $US 23 million, repayable after a 10 year grace period at an interest rate of 1 per cent.

In **Portugal,** the 49 per cent interest in Sociedad Minera de Neves-Corvo, previously held by French interests, was sold to RTZ in mid-1985. The $US 200 million project is expected to produce about 65 000 t of copper in concentrates by the end of 1988 from a 25 million t orebody grading more than 8 per cent copper. In addition to the main orebody, there is an additional 40 million t of copper-zinc-lead-silver reserves. In November, a state-owned company invited tenders for the design and construction of a 100 000 tpy smelter, refinery, acid plant and infrastructure estimated to cost $US 300 million.

Peruvian copper production is estimated at 390 000 t compared to 364 000 t the year earlier. Blister and refined production is estimated to have increased by 11 per cent and 2 per cent, respectively, compared with 1984 production. The Tintaya mine owned by the Empresa Minera Especial Tintaya S.A. (Ematinsa) was officially inaugurated in early-1985. The $US 237 million project is expected to produce about 55 000 tpy of copper in concentrates.

In **Brazil,** the start-up of a pilot plant for the Salobo deposit in Carajas is planned for early-1986. There are reports that the 1.2 billion t Salobo deposit, grading 0.85 per cent copper, will start-up in 1988 at a rate of about 150 000 t of copper in concentrates.

In **Australia,** Western Mining Corporation Limited and BP Australia Ltd. decided to proceed with the initial phase of the $A 550 million Olympic Dam Project in South Australia by 1988. The 450 million t orebody grading 2.5 per cent copper, 0.8 kg/t of U_3O_8 with gold and silver should produce 55 000 tpy copper, 2 000 tpy of U_3O_8 and about 90 000 ounces of gold annually. Further expansion could take the production up to a rate of 150 000 tpy of copper. Mount Isa Mines Ltd. improved its competitive position by increasing the ore grade mined from 3.3 per cent copper to 3.9 per cent, and by eliminating over 1,000 jobs.

Philippine copper production declined slightly in 1985 compared to 1984. Production was 175 689 t in the first nine months of 1985 compared to 172 479 t in the same period of 1984. Atlas Consolidated Mining and Development Corporation closed two mines and a concentrator to reduce financial losses. Japanese interests agreed to provide $US 12 million to assist with the reopening of the Sipilay mine, in return for 90 per cent of the concentrates. The mine is expected to be operating at full capacity in early-1986.

Japanese smelters continued to operate at reduced output in 1985, due to the world shortage of concentrates. Low rates of smelter capacity utilization are expected to continue through 1986. Domestic copper and zinc mines will be able to apply for $US 58 million in low interest loans. The loans are available when the domestic price of copper and zinc drop below $US 0.916/lb and $US 0.481/lb, respectively (at an exchange rate of 215 yen to the U.S. dollar). Forecasts for fiscal 1985/86 (and actual data for fiscal 1984/85) are: demand 1.4 million t (1.47 million t), domestic refined production 0.935 million t (0.935 million t), and refined imports 0.36 million t (0.44 million t).

Imports of copper by the **People's Republic of China** totalled 214 000 t for the first half of 1985 compared to 103 000 t for the same period in 1984.

U.S.S.R. copper production is not officially reported. There are widely differing copper estimates for both production and consumption. As an example, production estimates for 1982 vary from about 560 000 t to 1 115 000 t. Priority is reportedly being given to the development of the Udokan copper region in the east of Siberia. Four deposits totalling 2 billion t grading 2 per cent copper would be operated to obtain a target of 400 000 tpy of refined output.

INTERNATIONAL ORGANIZATION ON COPPER

There were a number of calls for the establishment of an international organization consisting of producing and consuming nations, to discuss the problems of the copper industry. The Intergovernmental Council of Copper Exporting Countries (CIPEC) and a number of other producers or international associations indicated support, to varying degrees, for the establishment of an international study group for copper, modelled after the International Lead Zinc Study Group (ILZSG). The Canadian industry, based upon the success of the ILZSG, supports the concept as a means to address the long standing problems in the world industry. Bills were introduced in the United States to support the establishment of an International Copper Action Commission to serve as a forum for discussions, develop forecasts and promote increased consumption and market development of copper.

PRICES

The London Metal Exchange (LME) settlement price for higher grade copper averaged $US 0.649/lb, up from $US 0.626/lb in 1984. The price of higher grade copper on the LME peaked at $US 0.75/lb on May 9, up from $US 0.59/lb at the start of the year. The price ended the year at $US 0.63/lb. The monthly average prices for the period 1983-1985 are shown in the table "Average Copper Prices."

The LME decided to change the copper contracts to reflect the increased importance of higher grade copper. A new grade A contract will start cash trading on July 1, 1986. Higher grade cathodes and only a limited number of wirebars will be deliverable against the contract. A second standard contract will be started at the same time against which all registered brands of copper will be deliverable. Futures trading for the two contracts will commence April 1, 1986.

The suspension of tin trading and the possible threat to certain merchants prompted some producers to be concerned that copper might be sold at distress prices by merchants desperate to raise cash. Codelco-Chile suggested that consideration be given to establishing metal exchange warehouses in Asia, either by a new LME contract or through a new exchange. The possibility of a United States denominated contract for copper on the LME was also raised.

STOCKS

The total LME plus Comex copper stocks at the end of 1984 were 377 700 t: these declined to 297 000 t by the end of 1985 although a low of 275 000 t was reached in May, when the U.S. price peaked. Total non-socialist world stocks were estimated by Commodities Research Unit Ltd. to have declined from 1.57 million t at the end of 1984 to 1.42 million t at the end of November 1985.

USES

Copper is the preferred material when superior electrical or thermal conductivity and corrosion resistance is desired. Copper's electrical conductivity is over 60 per cent greater than that of aluminum, and copper's thermal conductivity exceeds aluminum's by over 75 per cent. Hence copper's main uses are for the transmission of electrical energy and electrical signals, for water transmission and for heat transfer. In 1984, 70 per cent of the 2.04 million t of United States copper consumption was for the production of copper wire: comparable figures were 74 per cent of 1.37 million t for Japan, 59 per cent of 0.79 million t for the Federal Republic of Germany, 82 per cent of 0.40 million t for France. In total, the four largest consumers of refined copper (accounting for about 60 per cent of the copper consumption in the western world in 1984) used 70 per cent of their copper in the making of wire.

OUTLOOK

The consumption of refined copper is expected to be about 7.5 million t in 1986. Subsequent copper consumption will be determined by the state of the major nations' economies. From a 1981 base, an average growth rate trending at 1.2 per cent a year is forecast to 1990. Thereafter, assuming that certain national debt and other economic problems are manageable, a 1.6 per cent a year growth rate is forecast through the 1990s.

There are few new uses for copper being developed. One of the factors retarding research and development into new uses is the relatively minor amount of money being spent compared to other materials such as aluminum and plastics. A number of producers either withdrew or gave notice of their intent to withdraw from organizations promoting copper and investigating new uses. Thus the spending to defend copper consumption will decrease in 1986. In contrast to the decreased funding, the Copper Development Associations in Europe announced their proposal for a media campaign to promote copper and to enhance its image.

The telecommunications uses of copper account for between 10 and 12 per cent of U.S. domestic shipments. Of this total, about 10 per cent of communications copper usage is threatened by fiber optics due to their greater capacity per unit cross sectional area to carry data, to their resistance to unauthorized interception and to the longer distances possible between repeater stations. However, only about 1/2 to 1 per cent of United States copper shipments is threatened by fiber optics in the short-term. A far greater threat to copper usage in the telecommunications fields is the technological innovations which require less copper for the same performance. The use of smaller diameter telecommunications cables and multiplexing of signals have and are expected to continue to have, a greater impact on copper's use for communications than fiber optics.

Just as copper producers over-built in the past based upon optimistic projections for the future, so too the consumers of copper over built. As a result industries, such as telecommunications, have considerable excess capacity and have been able to temporarily reduce their copper consumption.

An average LME settlement price of $US 0.69/lb is expected in 1986. If a prolonged labour dispute in the United States results, then the prices will be higher.

Growth in consumption is expected to slow in 1987 and 1988. Since over one-half of the non-socialist world's production is not sensitive to price change in the short-term, reduced consumption will not likely be matched by reduced production, and as a result stocks will accumulate and prices will decline. Prices of $US 0.65 and $US 0.62/lb are forecast (in 1985 U.S. dollars).

At such low prices, many producers will not be able to generate enough cash to permit the major capital investments that they have deferred since 1982. This will have the effect of reducing either the life of these operations or their production rate. As capital expenditures for new tailings areas, deepened shafts, mill expansions, or major equipment purchases become absolutely necessary, such operations will be forced either to close down and wait for higher prices or to obtain funding from non-commercial lenders.

A scenario of low prices (resulting from an economic slow-down and failure to adjust production to reduced copper consumption) could result in copper being in short supply at a later date. Presently, there is an inventory of shut-down mine capacity which could be brought back into production if the operators were to perceive that a price rise would be sustained. But year-by-year, mines shut in the early-1980s become less amenable to reopening. Prices over $US 0.75/lb are unlikely to be sustained in 1986 (or in 1987 if a slow down occurs). As more of the shut capacity becomes permanently shut there will be less reserve capacity able to be quickly reactivated to meet increased consumption at current prices, except through construction of new facilities which require higher copper prices.

Under the scenario of a slow-down, if consumption rebounds by the end of the decade to reach the trend growth rate of 1.2 per cent a year for the 1980s, then prices will rise due to the pressure on existing production facilities. As greenfield facilities cannot be quickly developed, the period of high prices could last for a couple of years before supply increased sufficiently. Prices could rise over $US 0.90/lb in this scenario (1985 U.S. dollars), then fall back considerably as new capacity starts up.

Alternatively, if a slowdown in copper consumption does not occur, then higher prices in the remainder of the 1980s would allow mines to make more capital expenditures to meet the future increased consumption in a more balanced and timely manner. This would see prices rising to about $US 0.80-0.85/lb (1985 U.S. dollars) in the early-1990s, remain on average at this level for about half of the 1990s and decline thereafter due to increased technological efficiency of producers.

About 80 to 85 per cent of non-socialist copper consumption takes place in western Europe, the United States and Japan. This share of non-socialist world production is not forecast to change before 1990 due to debt problems in the developing countries. After 1990, the developing world could attract an increasing share of copper consumption.

Canadian Competitive Position

The competitive position of the Canadian copper producers depends upon a number of factors. The prices of byproduct metals and the value of Canadian currency compared to major competitors affect the revenues of Canadian copper producers. A prolonged low zinc price would likely result in decreased copper output below the projected 775 000 t of copper in copper concentrates for 1986. Nonprofit-related taxes and charges by the federal and provincial governments and the ability of Canadian producers to continue to match the cost reductions occurring in the rest of the world affect the relative cost of Canadian copper. Beyond those factors, the relative competitiveness of Canadian producers is affected by the degree to which producers in other countries receive concessionary financing (not available to Canadian producers) for rehabilitation of production facilities.

Canadian producers have increased their competitive position by decreasing their estimated average costs from 11 per cent over the western world average production cost in 1982, to 1 per cent above the average cost in 1985. However, many third world producers with much lower labour rates have a greater potential to continue to cut costs. Canadian concentrate exporters benefit from the low treatment and refining charges in the Pacific.

TARIFFS

Item No.		British Preferential	Most Favoured Nation (%)	General	General Preferential
CANADA					
32900-1	Copper in ores and conc.	free	free	free	free
33503-1	Copper oxides	free	13.1	25.0	free
34800-1	Copper scrap, matte and blister and copper in pigs, blocks or ingots; cathode plates of electrolytic copper for melting, per lb	free	free	1.5¢	free
34820-1	Copper in bars or rods, when imported by manufacturers of trolley, telegraph and telephone wires, and electric wires and electric cables, for use only in the manufacture of such articles in their own factories	free	4.3	10.0	free
34835-1	Electrolytic copper powder electrolytic iron powder, for use in Canadian manufactures (expires June 30, 1986)	free	free	10.0	free
34845-1	Electrolytic copper wire bars, for use in Canadian manufactures per lb (expires June 30, 1986)	free	free	1.5¢	free
35800-1	Anodes of copper	free	free	10.0	free

MFN Reductions under GATT (effective January 1 year given)	1985	1986 (%)	1987
33503-1	13.1	12.8	12.5
34820-1	4.3	4.1	4.0

UNITED STATES (MFN)

602.30	Copper, ores etc.	Remains free		
612.02	Unwrought copper, etc.	- no change -		1.7
612.08	Copper waste and scrap	3.3	2.9	2.4

EUROPEAN ECONOMIC COMMUNITY (MFN)		1985	Base Rate	Concession Rate
26.01	Copper, ores and conc.	free	free	free
74.01	Copper in matte, unwrought copper, waste and scrap	free	free	free

JAPAN (MFN)

26.01	Copper, ores and conc.	free	free	free
74.01	(1) Copper in matte etc.	free	free	free
	(2) Copper, unwrought			
	(a) containing not more than 99.8% by weight of copper etc.	7.6%	8.5%	7.3%
	(b) Other			
	(i) Containing by weight, not less than 25% of zinc and not less than 1% of lead	17.25yen/kg	24yen/kg	15yen/kg
	(ii) Containing more than 95% by weight of copper			
	- blister copper in bar	7.6%	8.5%	7.3%
	- other	21.75yen/kg	24yen/kg	21yen/kg
	(iii) Containing not more than 95% by weight of copper	21.75yen/kg	24yen/kg	21yen/kg
	(3) Waste and scrap			
	(a) Unalloyed	0.6%	2.5%	free
	(b) Other: containing more than 10% by weight of nickel	5.6%	22.5%	free
	(c) Other	0.6%	2.5%	free

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, Vol. 27, No. L320, 1985; Customs Tariff Schedules of Japan, 1985; GATT Documents, 1979.

TABLE 1. CANADA, COPPER PRODUCTION, TRADE AND CONSUMPTION, 1983-85

	1983[r]		1984[p]		1985[e]	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Shipments[1]						
British Columbia	282 754	597,710	280 638	530,968	302 479	598,607
Ontario	219 803	412,140	292 220	552,879	280 025	554,169
Quebec	63 740	132,352	67 618	127,933	68 855	136,265
Manitoba	67 163	132,008	67 537	127,781	67 704	133,986
New Brunswick	11 369	19,037	7 800	14,757	6 585	13,031
Saskatchewan	6 204	13,676	4 798	9,078	4 699	9,299
Newfoundland	-	384	1 147	2,169	-	-
Yukon	1 904	-	-	-	-	-
Northwest Territories	102	-	69	130	-	-
Total	653 040	1,307,307	721 826	1,365,695	730 347	1,445,357
Refinery output	464 333	..	504 252	..	488 000	..
Exports					(Jan.-Sept.)	
Copper in ores, concentrate and matte						
Japan	212 094	270,931	222 298	280,877	164 926	238,847
South Korea	38 716	39,898	37 473	45,071	4 378	6,420
Taiwan	23 761	35,151	21 094	28,248	20 710	28,499
Norway	18 216	27,818	26 100	38,424	22 537	36,053
United States	12 255	17,608	15 100	19,267	345	53
People's Republic of China	2 516	4,064	8 079	10,919	12 338	19,244
Mexico	1 713	2,572	507	584	-	-
United Kingdom	1 775	2,538	823	1,550	578	1,138
Belgium-Luxembourg	1 900	2,141	246	145	503	315
Other countries	850	882	7 333	8,826	2 355	3,268
Total	313 796	403,603	339 053	433,911	228 670	333,837
Copper in slag, skimmings and sludge						
United States	1 708	753	2 754	1,118	3 228	896
Other countries	-	-	-	-	286	136
Total	1 708	753	2 754	1,118	3 514	1,033
Copper scrap (gross weight)						
United States	31 939	42,123	28 242	42,298	18 977	28,204
Other countries	4 711	5,914	4 230	6,107	8 487	12,452
Total	36 104	48,037	32 472	48,405	27 464	40,656
Brass and bronze scrap (gross weight)						
United States	11 870	16,557	11 461	15,459	6 538	7,958
Italy	(3)	(3)	(3)	(3)	1 442	1,799
West Germany	(3)	(3)	(3)	(3)	1 147	1,404
Other countries	2 670	3,431	3 849	4,776	3 851	4,647
Total	14 540	19,988	15 310	20,235	11 536	14,009
Copper alloy scrap, nes (gross weight)						
United States	2 094	2,473	3 944	4,644	2 716	2,863
Belgium-Luxembourg	222	268	301	354	1 323	1,542
South Korea	149	188	412	554	(3)	(3)
Other countries	171	225	60	83	389	515
Total	2 637	3,154	4 717	5,635	4 428	4,920
Copper refinery shapes						
United States	93 138	190,264	185 622	343,768	97 497	183,907
People's Republic of China	67 137	135,242	38 528	56,642	24 063	40,921
United Kingdom	46 445	91,697	39 840	72,720	31 409	59,793
Netherlands	35 074	71,784	15 980	28,963	21 102	35,392
West Germany	24 496	49,494	24 540	43,764	13 970	26,280
France	13 203	25,842	13 043	23,540	7 888	14,822
Sweden	6 261	12,229	12 409	22,197	6 232	11,840
Belgium-Luxembourg	4 429	9,362	18	38	6 646	13,121
Italy	3 299	6,353	4 655	8,253	3 051	5,765
Japan	2 946	3,317	2 004	3,664	-	-
South Korea	-	-	3 996	7,282	-	-
Taiwan	-	-	3 007	5,177	-	-
Other countries	2 099	4,114	2 337	15,514	541	1,040
Total	298 527	599,698	345 979	631,522	212 399	392,881
Copper bars, rods and shapes, nes						
United States	5 532	14,396	9 422	23,706	8 782	21,237
Cuba	(3)	(3)	2 772	5,861	1 609	2,977
Venezuela	1 574	3,556	-	-	(3)	(3)
Saudi Arabia	-	-	3 108	5,922	(3)	(3)
Bangladesh	(3)	(3)	2 787	5,292	(3)	(3)
Other countries	2 330	5,192	4 109	8,056	6 008	12,503
Total	9 436	23,144	22 198	48,837	16 399	36,717
Copper plates, sheet and flat products						
United States	3 472	11,253	6 023	19,335	3 797	12,903
India	-	-	-	-	3 503	6,424
Other countries	354	1,199	218	716	1	9
Total	3 826	12,452	6 241	20,051	7 301	19,336
Copper pipe and tubing						
United States	3 685	10,832	4 964	14,617	3 746	11,167
Israel	1 073	2,905	1 016	2,695	553	1,509
Other countries	1 012	3,172	550	1,642	120	376
Total	5 770	16,909	6 530	18,954	4 419	13,052

TABLE 1. (cont'd.)

	1983r		1984P		(Jan.-Sept.) 1985e	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Copper wire and cable (not insulated)						
United States	540	1,129	486	1,048	166	454
Saudi Arabia	122	376	(3)	(3)	38	122
Puerto Rico	127	344	-	-	-	-
Panama	-	-	-	-	29	139
Other countries	102	294	168	519	36	190
Total	891	2,143	654	1,567	269	905
Copper alloy shapes and sections						
United States	12 376	35,858	19 120	53,480	9 842	28,092
Other countries	79	295	119	443	23	76
Total	12 455	36,153	19 239	53,923	9 865	28,168
Copper alloy pipe and tubing						
United States	4 630	12,564	5 086	14,821	2 755	9,247
Other countries	103	357	42	128	60	202
Total	4 733	12,921	5 128	14,949	2 815	9,429
Copper alloy wire and cable, not insulated						
United States	104	292	379	808	168	451
South Africa	43	222	(3)	(3)	-	-
Other countries	45	225	34	216	10	69
Total	192	739	413	1,024	178	520
Copper and alloy fabricated materials, nes						
United States	1 337	4,855	1 759	5,919	853	3,397
United Kingdom	132	319	745	1,314	(3)	(3)
Other countries	93	531	190	646	311	732
Total	1 562	5,705	2 694	7,879	1 164	4,129
Insulated wire and cable[2]						
United States	24 323	83,689	33 217	116,430	27 799	101,645
Saudi Arabia	3 196	10,397	(3)	(3)	(3)	(3)
Other countries	5 778	22,252	10 584	42,480	6 903	26,070
Total	33 297	116,338	43 801	158,910	34 702	127,715
Total exports of copper and products	..	1,301,737	..	1,466,920	..	1,027,307
Copper Imports						
Copper in ores and concentrates	24 231	40,140	36 173	34,619	66 221	53,764
Scrap	64 364	68,206	66 531	76,347	57 970	69,531
Refinery shapes	24 559	56,138	25 563	48,751	14 034	29,265
Bars, rods and shapes, nes	9 620	21,512	5 111	11,087	4 292	9,479
Plates, sheet & flat products	1 350	4,577	4 970	14,139	3 787	10,698
Pipe and tubing	3 472	11,922	3 008	10,751	2 539	9,133
Wire and cable, not insulated	1 822	7,021	3 405	12,600	3 058	11,504
Alloy scrap (gross weight)	7 178	7,547	9 807	7,547	5 535	6,382
Powder	827	1,846	1 103	2,805	630	1,562
Alloy refinery shapes, bars	9 837	23,684	12 367	31,244	8 477	21,293
Brass plates, sheet, strip, etc.	3 542	11,060	4 170	13,025	3 043	9,803
Alloy plates, sheet, etc. nes	1 693	7,771	1 768	8,226	1 131	5,504
Alloy pipe and tubing	2 858	12,905	4 106	19,317	2 863	13,689
Alloy wire & cable not insul.	1 178	3,934	1 278	4,297	1 060	3,680
Copper & alloy fab. mat., nes	1 849	10,277	2 128	11,707	1 892	9,799
Insulated wire and cable	..	64,849	..	79,521	..	69,713
Oxides and hydroxides	201	543	234	577	185	525
Sulphate	873	638	2 644	1,751	656	520
Alloy castings	503	3,416	693	4,483	359	2,467
Total imports of copper and products	..		-	392,794	..	338,311
					1985e	
Producers' domestic shipments						
Refined	170 443	..	205 476	..	205 000	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Blister copper plus recoverable copper in matte and concentrate exported; totals may not add due to independent rounding. [2] Includes small quantities of non-copper wire and cable, insulated. (3) Minor amounts, included in other countries total: for complete details, refer to Statistics Canada Monthly Catalogue 65-004 for Exports by Commodities and 65-007 for Imports by Commodities.
- Nil; .. Not available or not applicable; nes Not elsewhere specified; P Preliminary; r Revised; e Estimated.

TABLE 2. CANADA, COPPER PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975 AND 1980-85

	Production		Exports			Imports	Consumption[2]
	Shipments[1]	Refinery Output	Concentrates and Matte	Refined	Total	Refined	Refined
				(tonnes)			
1970	610 279	493 261	161 377	265 264	426 641	13 192	229 026
1975	733 826	529 197	314 518	320 705	635 223	10 908	196 106
1980	716 363	505 238	286 076	335 022	621 098	13 466	208 590
1981	691 328	476 655	276 810	262 642	539 452	24 778	241 537
1982	612 455	337 780	257 930	232 621	490 551	28 028	158 587
1983	653 040	464 333	313 796	298 528	612 324	24 559	195 002
1984p	721 826	504 252	339 053	345 979	685 032	25 563	231 039
1985e	730 000	488 000	228 670[3]	212 399[3]	441 069[3]	14 034[3]	167 625[3]

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Blister copper plus recoverable copper in matte and concentrate exported. [2] Producers' domestic shipments of refined copper plus imports of refined shapes. [3] Jan. to Sept. 1985 data.
p Preliminary; e Estimated.

TABLE 3. WESTERN WORLD MINE PRODUCTION OF COPPER, 1984 AND 1985

	1984	1985e
	(000 tonnes)	
Chile	1 290	1 300
United States	1 090	1 050
Canada[1]	722	730
Zambia	522	495
Zaire	500	510
Peru	364	390
Australia	236	275
Philippines	233	210
South Africa	212	180
Other[2]	1 165	1 060
Total western world	6 334	6 200

Sources: World Bureau of Metal Statistics, U.S. Bureau of Mines, and Energy, Mines and Resources Canada.
[1] Shipments. [2] Includes Yugoslavia.
e Estimated.
Based upon information available to January 3, 1986.

TABLE 4. WESTERN WORLD REFINED PRODUCTION[1] OF COPPER, 1984 AND 1985

	1984	1985e
	(000 tonnes)	
United States	1 510	1 435
Japan	935	935
Chile	879	860
Zambia	522	495
Canada	495	505
Belgium	396	430
Germany, Federal Republic	379	400
Zaire	225	225
Peru	219	225
Other[2]	1 647	1 690
Total western world	7 207	7 200

Sources: World Bureau of Metal Statistics, U.S. Bureau of Mines, and Energy, Mines and Resources Canada.
[1] Primary, secondary and electrowon copper.
[2] Includes Yugoslavia.
e Estimated.
Based upon information available to January 3, 1986.

TABLE 5. CANADIAN COPPER AND COPPER-NICKEL SMELTERS, 1984

Company and Location	Product	Rated Annual Capacity (tonnes of ores and concentrates)	Blister or Anode Copper Produced[1] (tonnes)	Remarks
Falconbridge Limited Falconbridge, Ont.	Copper nickel matte	570 000	32 100	A smelter modernization program begun in 1975 was completed in 1978 at a cost of $79 million. Fluid bed roasters and electric furnaces replaced older smelting equipment. A 1 800 tpd sulphuric acid plant treats roaster gases. Matte from the smelter is refined in Norway.
Inco Limited Sudbury, Ontario	Molten "blister" copper, nickel, sulphide and nickel sinter for the company's refineries; nickel oxide sinter for market, soluble nickel oxide for market	3 630 000[2]	117 500[3]*	Oxygen flash-smelting of copper concentrate; converters for production of blister copper. Roasters, reverberatory furnaces for smelting of nickel-copper concentrate, converters for production of nickel-copper Bessemer matte. Production of matte followed by matte treatment flotation sulphides, then by sintering to make sintered-nickel products for refining and marketing. Electric furnace melting of copper sulphide and conversion to blister copper.
Kidd Creek Mines Ltd. Timmins, Ontario	Molten "blister" copper	59 000 t of copper	68 000*	Mitsubishi-type smelting, separation and converting furnaces treat continuous copper concentrate feed stream to yield molten 99 per cent pure copper which is transported by ladles and overhead cranes to two 350 t anode furnaces. Furnaces rebricked in fall of 1983. Expansion plans to 90 000 tpy by 1988 announced in 1984.
Noranda Inc. Horne smelter, Noranda, Que.	Copper anodes	838 000	176 900	Three reverberatory furnaces, one of which is now considered to be permanently shut down: 5 converters; 1 continuous reactor; an 85 tpd oxygen plant to supply oxygen-enriched blast. Continuous reactor modified to produce matte instead of metal. A $35 million project to overhaul and modify the smelter with electricity to become the plant's major energy source was completed in 1982. The new 450 tpd oxygen plant will decrease unit fuel requirements and increase capacity of the continuous reactor, and reduce fuel requirements for a reverberatory furnace.
Noranda Inc. Gaspé smelter, Murdochville, Que.	Copper anodes	325 000	28 100	Equipped with one fluid bed roaster, one reverberatory furnace and two converters plus an acid plant. Treats Gaspé and custom concentrates.
Hudson Bay Mining and Smelting Co., Limited, Flin Flon, Man.	Copper anodes	400 000	64 400	Five roasting furnaces, one reverberatory furnace and three converters. Company treats its own copper concentrate from mines at Flin Flon and Snow Lake, as well as custom copper concentrates, zinc plant residues and stockpiled zinc-plant residues fed to reverberatory furnace.

[1] Smelter output as reported in corporate annual reports; if no smelter data available, then refinery output shown and indicated by * following number. [2] Includes copper and nickel-copper concentrates. This capacity cannot all be fully utilized owing to Ontario government sulphur dioxide emission regulations. [3] Includes a small portion of copper from Inco's Manitoba operations.

TABLE 6. COPPER REFINERIES IN CANADA, 1984

Company and Location	Rated Annual Capacity	Output in 1984[1]	Remarks
	(tonnes)		
Noranda Inc. Division CCR, Montreal East, Quebec	435 000	309 400	Refines anodes from Noranda's Horne and Gaspé smelters, from the Flin Flon smelter and also from purchased scrap. Copper sulphate and nickel sulphate recovered by vacuum evaporation. Precious metals, selenium and tellurium recovered from slimes. Produces C.C.R. brand electrolytic copper cathodes and cakes and billets.
Inco Limited Copper Cliff, Ont.	180 000	117 500	Casts and refines anodes from molten converter copper from the Copper Cliff smelter; also refines purchased scrap. Gold, silver, selenium and tellurium recovered from anode slimes, along with platinum metals concentrates. Recovers and electrowins copper from Copper Cliff nickel refinery residue. Produces ORC brand electrolytic copper cathodes, and wirebars.
Kidd Creek Mines Ltd. Timmins, Ontario	(See Note)	68 000	Molten copper from two 350 t anode furnaces is cast in a Hazelett continuous casting machine into continuous copper strip, then formed to 145 kg anodes in a blanking press. Spent and scrap anodes are remelted in a 40 t ASARCO shaft furnace. Cathodes formed in jumbo sized electrolytic tanks in a highly automated tankhouse. A decopperized precious metal slime is also marketed. Note: Expansion to 90 000 tpy by 1988 under way since 1984.

[1] As reported in corporate annual reports.

TABLE 7. AVERAGE COPPER PRICES (LME Settlement Prices for Higher Grade Copper)

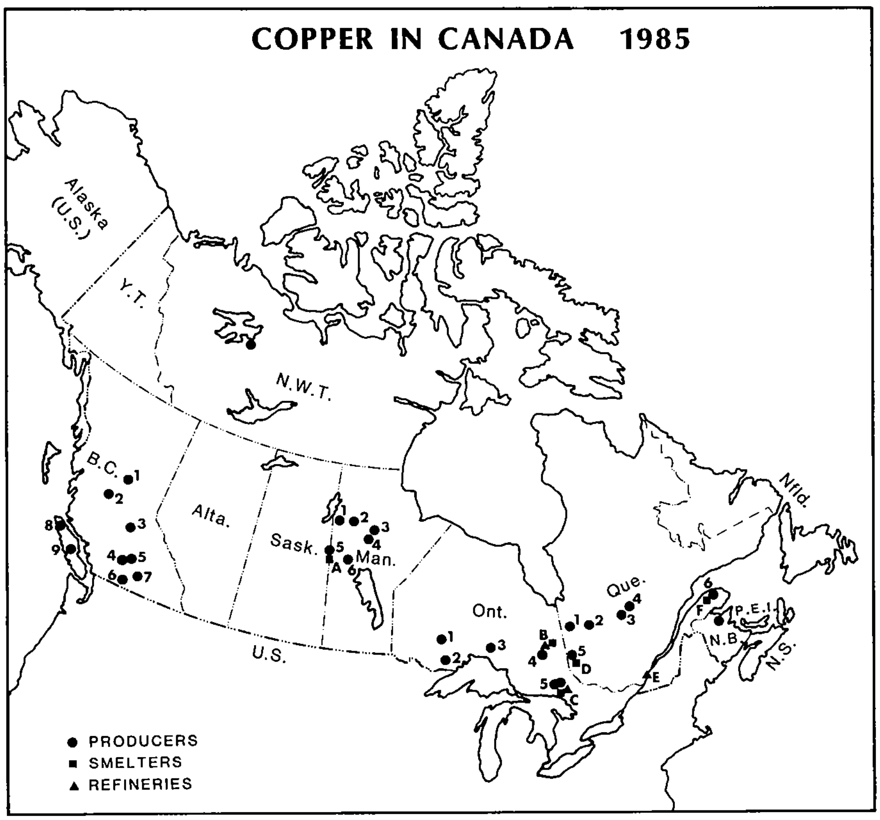
	1984	1985
	(current US ¢/lb)	
January	62.4	61.6
February	64.9	63.0
March	68.1	63.0
April	69.5	68.1
May	64.4	69.4
June	61.9	65.0
July	60.4	66.9
August	60.7	64.4
September	58.7	62.0
October	57.7	62.8
November	61.0	62.1
December	60.0	63.2
Annual	62.6	64.9

Source: Metals Week.

TABLE 8. CANADIAN COPPER STATISTICS AND FORECAST

		Production of Copper in	
	Shipments[1]	Cu Concentrates	All Concentrates
		(000 t)	
1980	716	690	750
1981	691	564	620
1982	612	595	630
1983	653	655	677
1984p	722	722	753
1985e	730	770	..
1986e	..	775	..

[1] Total of recoverable copper mined and smelted in Canada plus payable copper exported.
p Preliminary; e Estimated; .. Not available.


COPPER IN CANADA 1985
Alaska (U.S.)
Y.T.
N.W.T.
B.C.
Alta.
Sask.
Man.
Ont.
Que.
Nfld.
P.E.I.
N.B.
N.S.
U.S.
● PRODUCERS
■ SMELTERS
▲ REFINERIES

PRODUCERS IN 1983 or 1984

(numbers and letters correspond to those in map above)

British Columbia

1. Noranda Inc. (Bell mine)
2. Equity Silver Mines Limited
3. Gibraltar Mines Limited
4. Lornex Mining Corporation Ltd.
5. Cominco Ltd.
6. Newmont Mines Limited
7. Brenda Mines Ltd.
8. Utah Mines Ltd.
9. Westmin Resources Limited

Saskatchewan

Hudson Bay Mining and Smelting Co., Limited

Manitoba

1. Sherritt Gordon Mines Limited (Fox mine)
2. Sherritt Gordon Mines Limited (Ruttan mine)
3. Inco Limited (Thompson mine)
4. Inco Limited (Pipe mine)
5. Hudson Bay Mining and Smelting Co., Limited, Flin Flon area
6. Hudson Bay Mining and Smelting Co., Limited, Snow Lake area

Ontario

1. Mattabi Mines Limited
   Noranda Inc. (Lyon Lake)
2. Inco Limited (Shebandowan mine)
3. Noranda Inc. (Geco mine)
4. Kidd Creek Mines Limited
   Pamour Porcupine Mines, Limited
5. Falconbridge Limited, Sudbury area
   Inco Limited, Sudbury area

Quebec

1. B.P. Resources Canada Limited
2. Noranda Inc. (Matagami mine)
3. Corporation Falconbridge Copper, Opemiska division
4. Northgate Mines Ltd.
   Campbell Resources Inc.
5. Corporation Falconbridge Copper, Lac Dufault division
6. Noranda Inc., Division Mines Gaspé

New Brunswick

Brunswick Mining and Smelting Corporation Limited

SMELTERS

A. Hudson Bay Mining and Smelting Co., Limited
B. Kidd Creek Mines Ltd.
C. Inco Limited
   Falconbridge Limited
D. Noranda Inc.
F. Noranda Inc., Division Mines Gaspé

REFINERIES

B. Kidd Creek Mines Ltd.
C. Falconbridge Limited
   Inco Limited
E. Noranda Inc., Division CCR

An inventory of undeveloped Canadian copper deposits is available in the publication Canadian Mineral Deposits Not Being Mined in 1983, Energy, Mines and Resources Canada, Report MRI 198, ISBN 0-660-11580-8.

For detailed production and ore grade information, refer to the Table of Nonferrous Mines immediately following the Zinc chapter.

Crude Oil and Natural Gas

R. THOMAS

According to third quarter drilling statistics for 1985, the number of well completions for Canada could reach a record high of 10,600 wells, almost 9 per cent above the 9,763 completions achieved during 1984. The aggregated depth during this year's wells may be some 11.6 million metres compared to last year's total of 10.6 million m. Alberta continues to be the centre of activity for oil and gas in the country. It is very likely that the province will reach almost 6,500 completions, or about 60 per cent of the total for Canada. In the four western provinces, the pace for exploration drilling continues at 20 per cent ahead of the corresponding period in 1984. Development drilling is also about 25 per cent ahead of last year's figure, so that overall completions to date are close to 23 per cent above those for 1984. All upstream, or leading, indicators such as land sales, geophysical crew activity, well licence issuances, and drilling rig utilization have increased markedly during the year, reinforcing the view that 1985 will be another record year.

In all areas of Canada, the remaining established reserves of crude oil and equivalent at the commencement of 1985, stood at slightly over 1 000 million m^3. This represented a decline, over the previous year, of some 4 per cent where in 1984 the volume was 1 100 million m^3. In the conventional regions the decline in reserves was negligible due to production being offset by reserves additions. Production at Norman Wells increased whereas the discovered resources in the east coast were revised downwards, thus accounting for the overall decline of oil reserves. Canada's total production of conventional crude oil, synthetic and pentanes plus/condensate is expected to average 250 000 m^3/d, an increase of 3 per cent over 1984s average of 244 000 m^3/d. It is also anticipated that the average daily volumes for export will be 72 000 m^3, an increase over the previous year of 23 per cent, and accounting for 29 per cent of domestic production.

At January 1, 1985, Canada's remaining established reserves of marketable natural gas were 2.8 trillion m^3, an increase over the previous 12 months of 7.5 per cent. Production during the year is estimated to average some 200 million m^3/d, an increase of 6 per cent over last year's daily output of 188 million m^3. The sales of natural gas within the domestic market place are expected to average 134 million m^3/d compared to 130 million m^3/d in 1984. The volumes for export to the United States may be 66.4 million m^3/d, an increase of almost 14 per cent over last year's daily average of 58.5 million m^3.

The remaining established reserves of liquefied petroleum gases, from natural gas pools, have risen by 24 per cent, from 109 million m^3 to 135 million m^3. The daily production of LPGs is expected to increase by 9 per cent, from 55 000 m^3 to 60 000 m^3 comprised of pentanes plus, propane, butane, and ethane.

According to the Geological Survey of Canada, the recoverable oil and gas potential in western Canada is being revised upward as new regions are developed. The potential for oil ranges from 1 500 million m^3 to 9 000 million m^3 with 50 per cent expectation value of 4 700 million m^3. By deducting the current remaining established oil reserves from the high confidence level (90 per cent) of 1 500 million m^3, there would remain to be discovered roughly 420 million m^3. Concerning natural gas; its potential ranges from 4 300 billion m^3 to 18 000 billion m^3 with a 50 per cent expectation of 9 500 billion m^3. Similarly, the volume remaining to be discovered might be 1.5 trillion m^3.

The province of Alberta is believed to contain approximately 160 billion m^3 of bitumen - heavy oil in oil sands deposits, from which 55 billion m^3 may be recoverable. Currently, there are only two major commercial plants, Suncor Inc. and Syncrude Canada Ltd., that together

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produce some 27 000 m^3/d of synthetic crude oil from licenced reserves of 3 900 million m^3 in the Athabasca field.

In addition to the extraction of oil sands from open-pit mines, there are several in-situ projects in place in western Canada whose future production will have a definite impact on overall crude oil output. The two major projects are Esso Resources Canada Limited at Cold Lake and The British Petroleum Company p.l.c./Petro-Canada at Wolf Lake. These two facilities currently produce 4 600 m^3/d and will expand to 13 000 m^3/d upon completion. Also included in the Cold Lake deposits are several smaller projects that have recently begun production in their primary stages. The Dome Lindbergh facility currently produces 1 000 m^3/d of bitumen and is expected to reach 2 400 m^3/d by 1989, with a 20 year life. The Amoco Lindbergh project, having received government approval in March, 1985, will initially produce 630 m^3/d with output peaking by 1995 to 4 100 m^3/d and planned existence for 30 years. PanCanadian Petroleum Limited, also situated at Lindbergh, anticipates initial production to average 475 m^3/d in 1986 and in 1995, should reach 3 200 m^3/d. Another Lindbergh project is operated by Murphy Oil Company Ltd., which produces some 140 m^3/d. During 1985, the company will have completed 53 wells at a cost of $35 million in the first of four phases. Subsequent phases will be added every two years so that by 1992, the expected daily production should reach 1 600 m^3. The increase in activity in the Lindbergh area can be attributed to the relatively short project payout period (two-to-three years) which has been ensured by applicable fiscal terms and two-to-three years of high primary production. The next promising area within the Cold Lake deposits is the Primrose region where several pilot projects are being evaluated by companies such as: Dome Petroleum Limited, Suncor Inc., Petro-Canada, and Canadian Occidental Petroleum Ltd. Should all projects mentioned prove successful in the Cold Lake region, that area may produce 37 000 m^3/d by 1995.

Another source of available crude oil is that remaining in existing fields or pools after primary and secondary recovery. Through the use of "enhanced oil recovery", a technique involving chemical, steam stimulation or other type of thermal flooding, a sizeable volume of additional crude can be recovered. The technology and capital cost required is very price-sensitive. The GSC estimates its potential to be in the range of 160 to 950 million m^3. In an "EOR" program, an operator may extract an additional 20 per cent of the oil that remains after secondary recovery, assuming that a total of 60 per cent of the reserves would be made recoverable.

Although Canada's Western Sedimentary Basin is in a mature phase of exploration for conventional oil, new oil pools in existing regions continue to be discovered. Significant new discoveries include the Desan oil field of northeastern British Columbia by Gulf Canada Resources Inc. The oil produced from this field is being trucked to Zama in Alberta until a pipeline is installed. Several other new oil pools were discovered in central Alberta and in the Kerrobert region of Saskatchewan. Currently, the number of successful oil exploration wells is some 18 per cent above those of the same period for 1984, and development drilling is up by 16 per cent; a positive indication of the industry's exploratory increase. After 1980, Canada recorded a decline in drilling for gas due to softness in the export market. In 1979, the National Energy Board, after two gas hearings, allowed sizeable additional volumes for export. Not all volumes were taken because of market conditions in the United States. A renewed interest by Canadian gas companies to explore and develop natural gas reserves has occurred because of recent federal-provincial agreements. The number of gas well completions has risen by 38 per cent over the past year, and the NEB has begun gas export hearings in order to determine future export volumes.

OUTLOOK

The record level of activity achieved during 1985 is expected to continue through 1986, primarily because of recent successes and new federal-provincial fiscal policies that have been designed to return the oil and gas sector to market-sensitive pricing. In March, the Western Accord was signed between the Governments of Canada, Alberta, Saskatchewan, and British Columbia with the objectives of replacing existing price controls and moving towards the deregulation of oil prices. This agreement also phased out some federal taxes and encouraged reinvestment, job creation and increased energy security. Items included in the Western Accord to be phased out or immediately terminated are: the Natural Gas and Gas Liquids Tax, the Incremental Oil Revenue Tax, the Canadian Ownership Special Charge, the Crude Oil Export Charge and the Petroleum Compensation Charge.

The Petroleum Incentives Program will also be modified beginning in 1986 with provisions for grandfathering of existing exploration agreements for Canada's offshore and far northern regions. Commencing on January 1, 1986, the Petroleum and Gas Revenue Tax will be reduced each year, phasing-out at the end of 1988. In conjunction with the termination of such federal incentives, the producing provinces are allowing for the reduction, and in some cases the non-payment for specified periods, of royalties payable on oil and gas. These changes to regimes have been introduced in order to encourage the petroleum industry and new entrants to invest in new oil and gas exploration and development.

Preceding the Western Accord by a month and a half, was the Atlantic Accord signed between the Government of Canada and the Government of Newfoundland and Labrador. This agreement established a joint management regime and revenue sharing from hydrocarbon resources similar to that of the western provinces.

On October 30, 1985, the federal government announced a new frontier energy policy entitled "Canada's Energy Frontiers: A Framework for Investment and Jobs". This newly introduced policy is intended to encourage investment in frontier regions of Canada by allowing all companies, domestic and foreign, to explore and develop energy resources on a non-discriminatory and competitive bidding basis.

On November 1, 1985, the Governments of Canada, Alberta, British Columbia, and Saskatchewan agreed upon the pricing and marketing of natural gas. During the transition period of twelve months, governments will continue to regulate prices. After this, natural gas prices in interprovincial trade will be determined between the buyer and seller. Prices under existing contracts will remain at $2.79804 per gigajoule at the Alberta border until October 31, 1986. The policy is for the price of natural gas to be market-sensitive while ensuring that domestic consumers do not pay more than the equivalent export price.

SUMMARY

Canada has a large remaining oil and gas resource base including the oil sands of Alberta and the heavy oil resources in Alberta and Saskatchewan which hold the greatest potential for development. The current deliverability from established oil reserves allow for a 14 year supply and 36 years for natural gas. New technologies in drilling, production and enhanced recovery have improved project economics. There has been a move away from the mega-projects planned in the past to smaller facilities with "add-on" features. This is in consideration for the amount of capital required and uncertainties in prices and markets. Recent changes in Canada's energy policies are expected to encourage exploration, development and investment both in the western provinces and in the frontier regions.

Conversion factors (approximate):
1 cubic metre (m^3) = 6.3 barrels oil and liquids
1 cubic metre (m^3) = 35.3 cubic feet gas
1 metre (m) = 3.281 feet
1 million = 10^6
1 billion = 10^9
1 trillion = 10^{12}

Diatomite

DANIEL J. SHAW

Diatomite is a siliceous, sedimentary rock composed mainly of opaline silica formed from the fossilised skeletal remains of the diatom, a unicellular aquatic plant related to the algae. Diatoms, of either fresh or salt water origin, extracted silica from the surrounding water and secreted it as a micro-porous, intricate, complex fossil arrangement, often symmetrical in design, which accumulated to form deposits, some of which are hundreds of feet thick. Diatomite's usefulness stems from its physical characteristics and chemical inertness. The porous structure provides unusual filtering properties, low bulk-density, large surface area and low thermal conductivity. The main requirements for deposition of a commercial scale deposit are: large shallow basins, an abundant supply of soluble silica, often provided by vulcanism; sufficient nutrients for the diatoms; the absence of growth inhibiting constituents such as a high concentration of soluble salts; and little deposition of clastic sedimentary materials. While many known occurrences appear across the world, large-scale production occurs primarily on the western coast of the United States and in western Europe.

CANADIAN INDUSTRY AND DEVELOPMENTS

Diatomite has been produced every year in Canada since 1896; however, this production has fallen short of Canadian consumption every year and has been augmented by imports, primarily from the United States. Essentially all Canadian diatomite production was from lake deposits in Nova Scotia up until 1941; however, since 1955 all production has originated from the Quesnel area in central British Columbia.

In 1967, Dome Petroleum Limited acquired the mining rights of Crownite Diatoms Ltd. and through a name change formed the wholly-owned subsidiary - Crownite Industrial Minerals Ltd. - to mine and process diatomite and pozzolanic shales from deposits just west of Quesnel. Crownite Diatoms Ltd. had operated for about six years on a very limited basis, producing mainly burnt shale pozzolan which was used as a construction material. Under Crownite Industrial Minerals' ownership the plant had a rated capacity of 36 000 tpy and produced low-quality diatomite suitable for the manufacture of insulating brick for use in the refractories industry and as a carrier in the production of fertilizers.

In early-1982, the Crownite Industrial Minerals' plant changed ownership and was re-opened in mid-December under the name of Microsil Industrial Minerals Ltd. Partnership after upgrading to a more efficient unit. The new plant is concentrating on the production of granular 'aggregate' products such as floor absorbents, soil conditioners, granular chemical carriers, pet litters, plus a limited number of processed powder products.

MARKET AND TRADE

Diatomite is marketed in three grades - natural, calcined or pink, and flux-calcined or white. Although mining is by open-pit methods and normally uncomplicated, present processing techniques are not simple. For example, common size reduction methods such as ball milling or grinding would destroy the delicate structure of the mineral which would render it useless for such applications as filtration and as a flatting agent in paint. Current production techniques require costly plant equipment such as dryers, kilns, cyclones and air classifiers to produce a product of high purity and consistent uniformity.

The successful marketing of diatomite products by major producers has depended, to a large degree, on their ability to furnish high calibre technical sales service, backed by strong research and development facilities, to the specialized needs of customers. While these expensive facilities have been an effective barrier to entry into the field, the existence of small producers supplying local or lower grade markets attests to their

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ability to compete successfully against their large counterparts. The large diatomite producers are well-established and market their products under trade names, one or more of which the customer recognizes as best serving its requirements.

The principal use for diatomite is as an industrial filtration medium. The porous structure of the individual diatoms and of their arrangement within the bedded deposit results in a material with about 90 per cent voids, capable of removing solid particles as small as 0.1 micron in size, while not impeding the flow of liquid through the filter. Flux-calcined grades which are calcined at up to 2200°F with alkali salts, although more expensive, are favoured as filtration aids.

Diatomite is one of the principal extender minerals or fillers. It is used as a flatting agent in paint, a bulking agent in paper, a pozzolanic agent in concrete and a shrinkage-control agent in plastics. These applications usually require calcined material which would average over 90 per cent silica content and have a near-white appearance.

As a powder, an aggregate or in the form of bricks, blocks or slabs, diatomite is used as an insulation material, its cellular structure providing sound-proofing qualities and low thermal conductivity. In natural form (uncalcined) diatomite in the minus 325-mesh size range is used as a fertilizer coating and insecticide carrier.

United States: In 1984, a breakdown of U.S. diatomite production sold, including exports, reveals that the filtration use accounts for the largest share of demand, 62 per cent. Over the last decade filtration's market share of demand has been relatively stable, between 60-68 per cent of U.S. shipments. Filler and additive applications have been increasing over the last decade and in 1984 accounted for a 34 per cent market share.

Current world diatomite production is estimated at 1.7 million t. In 1984, United States was by far the largest producer, accounting for approximately 38 per cent of world production. U.S. production, 640 000 t in 1984, is confined to four western states - California, Nevada, Oregon and Washington. Of these, diatomite operations in California account for more than half of the U.S. production. Four companies - Eagle-Picher Industries Inc., Grefco Inc., Manville Products Corporation, and Witco Chemical Corporation account for a large proportion of diatomite extracted and processed in the United States.

Europe: The most important European producers are located in France and Denmark, where 1984 production is estimated at 270 000 t and 140 000 t respectively. Over 90 per cent of French production comes from the operations of Carbonisation et Charbons Actifs SA in Cantal and Ardèche. The other French producer is Diatomeé et Derivées SA operated by the Manville Corporation subsidiary, Manville International Corporation. Manville International Corporation is also involved in diatomite mining and processing in Spain, Iceland and Mexico and when combined with Manville Products Corporation's production in California represents 25 per cent of world production. The U.S.S.R. and Romania are also important producers, however, details from these countries are hard to obtain. Together, these two countries are estimated to produce 272 000 t of diatomite - representing about 16 per cent of world production.

OUTLOOK

The outlook for diatomite is one of continued steady growth both in the short- and long-term. As concern for the environment and health becomes more apparent, especially in developing countries, the need for more efficient filtration of water supplies and industrial and chemical wastes, for example, will become greater. From the 1984 base, demand for diatomite is expected to increase at an average annual rate of about 3 per cent through 1990. The main increases will be in filter applications where diatomite's performance is unmatched.

TABLE 1. CANADA, DIATOMITE IMPORTS 1980-85 AND CONSUMPTION 1982-84

	1980		1981		1982		1983		1984		1985[1]	
	tonnes	$000	tonnes	$000	tonnes	$000	tonnes	$000	tonnes	$000	tonnes	$000
Imports												
Diatomaceous earth												
United States	26 577	4,472	25 545	5,311	23 130	5,074	23 298	5,382	23 892	6,339	17 610	4,332
United Kingdom	-	-	163	58	-	-	-	-	-	-	-	-
Denmark	-	-	-	-	-	-	-	-	-	-	4	2
Total	26 577	4,472	25 545	5,369	23 130	5,074	23 298	5,382	23 892	6,339	17 614	4,334

	1982	1983	1984
		(tonnes)	
Consumption			
Fertilizers, stock and poultry feed	7 972	9 118	8 136
Refractrory brick, mixes	555	1 686	2 658
Sugar processing	1 487	1 179	1 151
Other	4 004	3 206	2 402
Total	14 018	15 189	14 347

Sources: Energy, Mines and Resources, Canada; Statistics Canada.
[1] First nine months of 1985 only.
- Nil.

TABLE 2. WORLD DIATOMITE PRODUCTION 1970, 1975, AND 1980-84

	1970	1975	1980	1981	1982	1983	1984
				(tonnes)			
United States	542	514	625	623	556	562	581
Brazil	-	-	17	17	16	16	18
Denmark	238	236	152	152	125	125	127
France	160	209	218	220	200	240	245
West Germany	92	45	53	52	42	43	45
Iceland	13	23	18	18	20	25	27
Spain	18	23	27	24	20	65	64
Other Western World Countries	156	177	155	153	132	171	163
Centrally Planned Countries	372	408	227	227	277	277	272
World total	1 591	1 635	1 492	1 486	1 388	1 524	1 542

Source: Mineral Commodity Summaries, U.S.B.M.
- Nil.

Ferrous Scrap

R. McINNIS

The Canadian ferrous scrap industry fared slightly better in 1985 than in the previous two years, although volumes sold and prices received were very close to those of 1984.

In the first half of 1985, sales were static and prices were about the same as in 1984. By the end of July, prices increased marginally and held relatively steady during the last quarter. The Canadian market for scrap was quite different from that in the United States where prices for No. 1 heavy melting scrap dropped from about $US 78 a short ton in January 1985 to approximately $US 63 in December.

The declining value of the Canadian dollar was partially responsible for the price increase in the last quarter of 1985 and also helped to produce a slight increase in exports of ferrous scrap, especially to the United States.

In recent years, scrap purchases have followed closely the volume of steel produced in a given month as many steel mills have kept inventories of scrap to a minimum. A just-in-time approach to materials sourcing has become a common operating procedure in the industry.

There was little change in the volume of scrap purchased by the Canadian steel industry in 1985. The steel mills purchased 2.55 million t in the first 9 months of 1985, compared with 2.62 million t in the same period of 1984. The total consumption of scrap by the steel industry including own-generated scrap was 4.8 million t in the first 8 months of 1985, down from the 5.0 million t used in the same period in 1984. Ferrous scrap consumed by the steel industry in 1984 totalled 7.5 million t.

A considerable increase in the amount of continuously cast steel will occur as new casting equipment comes on-stream. Stelco Inc., Dofasco Inc. and IPSCO Inc. are all installing new continuous-casting equipment, which will reduce the amount of own-generated scrap produced in these mills. Since the amount of scrap used in the production of a tonne of steel is unlikely to diminish, Canadian steel companies can be expected to use larger tonnages of purchased scrap.

The demand by scrap users for higher quality products, especially in terms of the chemical analysis, will continue as the world steel industry pursues its quest for better steels.

CANADIAN INDUSTRY STRUCTURE

The Canadian ferrous scrap industry comprises approximately 600 firms. These companies collect, store and process the ferrous scrap purchased by the user industries. Most of these firms are small and are involved only in the collection of scrap. Dealers who are also involved in the sorting and storage of scrap are fewer in number, while those which engage in capital intensive processing comprise the smallest group. Scrap processing requires heavy equipment such as mechanical shredders, shears, presses and bundlers. This segment of the scrap industry produces the products needed by the user industries, such as steel mills.

Scrap is such an important raw material that it is common practice for Canadian steel producers to hold equity in scrap processing companies in order to reduce the risk of supply problems.

Autobody shredding equipment represents a significant capital investment in the scrap industry. There are presently 15 shredders installed in Canada, which in aggregate have the capacity to process about 1.3 million cars per year.

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CANADIAN DEVELOPMENTS

The Canadian ferrous scrap industry was severely depressed in 1982 and early-1983. However, during the second half of 1983, demand increased and prices improved rapidly. Prices and shipments continued to increase during 1984, and then stabilized in 1985.

In an integrated steel mill the ratio of purchased to own-generated scrap, that is consumed by the mill, varies from year to year. This ratio for the Canadian steel industry was 1.0 in 1981, 0.89 in 1982 and 1983, 0.93 in 1984 and 0.98 in September 1985. The ratio is partly a function of the price of scrap and partly dependent on other factors. For example, steel mills may replace some of their consumption of purchased scrap with iron produced in their operating blast furnaces. This often enables a steel company to avoid banking its blast furnaces which is expensive and could incur additional costs because of contracted supplies of iron ore and coal. This practice may have been applied in 1982 when the amount of purchased scrap used per tonne of steel produced was unusually low, even though the price of scrap was especially depressed.

In the case of the electric furnace steel industry the price-demand relationship is much more direct because ferrous scrap is the principle raw material. Electric furnace mills can consequently produce steel at considerably less cost than integrated mills in periods of low steel demand and low scrap prices, allowing them to capture market share and remain profitable.

The increasing use of continuous casting and improvements in basic oxygen furnaces (BOF) such as the advent of Lance Bubbling Equilibrium (LBE) equipment, will tend to reduce the levels of own-generated scrap and increase the demand for purchased scrap. Also, the entrance of QIT Fer et Titane Inc. into the production of steel in 1986 will probably add to the demand for purchased scrap. QIT currently produces pig iron as a coproduct with titanium dioxide in its electric furnace smelting facilities at Tracy, Quebec.

The QIT steelmaking facility will be a potential scrap customer because, with its capacity to produce 440 000 tpy of steel billet, it could use up to 132 000 tpy of scrap, although the present intention is to make high quality billet from its own pig iron.

Canada is more than self-sufficient in scrap, but there are regional differences in supply and consumption that result in significant trade between Canada and the United States. A high percentage of scrap that is in excess of eastern Canadian needs is exported to markets in the northeastern United States while the western Canadian market, which is generally deficient in local scrap, imports it from the American northwest and central regions.

The ferrous recycling industries in Canada and the United States share what they consider to be a single market. There are few restraints to the movement of scrap across the border and, consequently, prices in the United States have a major impact on those in Canada. Most Canadian exports of scrap go to the United States, which has accounted for over 90 per cent of Canadian scrap exports during the last three years. Virtually all Canadian imports originate in the United States.

As the recycling industry in Canada has grown, and as it has become more mechanized and efficient, an increasing tonnage has been available for export. The international market for scrap is very competitive and tends to fluctuate widely from year to year. Countries which have a history of buying significant volumes of scrap include South Korea, Spain, Italy and Japan.

SCRAP CLASSIFICATION

The producers of ferrous scrap describe unprocessed scrap by its origin. Home or own-generated scrap is produced in the manufacture of steel mill products, whereas prompt industrial scrap is generated by the secondary manufacturing industry and obsolete scrap comes from discarded machinery, equipment and structures.

Prompt and obsolete scrap is generally processed by the recycling industry and is made into a number of products for which standards have been written by the Canadian Association of Recycling Industries.

Scrap classification is based on factors such as size, type of material, cleanliness, and residual alloys. The most common grades are as follows:

Scrap Products

Class No.	Grade and Type
100	No. 1 Heavy Melting Steel
101	No. 1 Hydraulic Bundles
102	No. 2 Bushelling - Prepared
103	No. 2 Heavy Melting Steel
104	Plate and Structural Steel
105	No. 2 Hydraulic Bundles
106	Hydraulic Silicon Bundles
107	No. 2 Bushelling - Prepared
108	No. 1 Bushelling (Clips)
109	Short Shovelling Steel Turnings (Crushed)
110	Machine Shop Turnings
111	Mixed Turnings and Borings
112	Cast Iron Borings
113	No. 1 Shredded Scrap
114	No. 2 Shredded Scrap
115	Briquetted Steel Turnings - Alloy Free
116	Briquetted Steel Turnings - Alloyed
117	Foundry Steel

USES

Most ferrous scrap is used in electric furnace steel mills and integrated mills for the production of steel. The foundry industry is the second largest market for scrap. Minor markets include the production of iron powders, sinter, ferroalloys and abrasives.

Scrap used in the electric furnace steel industry must be carefully selected in order to minimize the melting time and the consequent cost of energy per tonne, and to maximize the furnace productivity. Apart from causing variations in the time it takes to melt each heat, the tramp elements in the scrap may also affect the levels of residual elements in the steel because there is less opportunity in electric furnace operations to remove them by oxidation and slagging. Certain elements like tin are more difficult to remove than others. Also, it takes larger amounts of selected grades of scrap, than would be required in other furnaces, to produce a tonne of finished steel. Depending on the scrap grade it can take from 1 100 to 1 200 kg of scrap to produce 1 000 kg of steel.

Open-hearth and basic oxygen furnaces (BOF) provide more scope for steel refining. In these, scrap can be added at about 50 per cent and 30 per cent of the respective charges. In a BOF a small amount of scrap is necessary to absorb the energy released when the carbon in the molten iron is removed by oxidation. This same energy can be used to melt up to 30 per cent scrap. Apart from the saving in energy, ferrous scrap is usually much cheaper than iron produced in a blast furnace. Therefore, integrated mills try to optimize the scrap charged to their steel furnaces and focus some of their research effort on this aspect of the operation. These types of furnaces can tolerate relatively higher levels of impurities or tramp elements because of the diluting effect of the main charge of pig iron as well as the greater potential for the removal of unwanted elements.

On balance, integrated steel operations have more flexibility than electric furnaces with respect to the percentage of scrap in furnace feed and they are also less dependent on scrap availability and price. In periods of high demand when integrated mills operate near capacity, scrap usage is often maximized to increase steel production even if scrap prices are high. The reverse situation may apply when steel demand is low and scrap use is governed by a minimum blast furnace operating rate. In this case it would be necessary to restrict scrap use to avoid over-production even if scrap were available at a very low price.

OUTLOOK

Both integrated and electric furnace mills are experiencing rapid technological change which will have a long-term impact on the scrap market.

Recent research and development efforts have been focused on increasing the amount of scrap that can be used in the oxygen steel converter. New developments include systems in which fuel and oxygen are blown into the converter to preheat the scrap charge, and Lance Bubbling Equilibrium (LBE) equipment in which inert gases are blown through the bottom of a BOF-type vessel. The more efficient mixing created by the LBE system results in higher yields, increases the amount of scrap that can be charged, and improves the quality of the steel produced. LBE equipment is being installed in a number of Canadian BOF's.

The market for scrap and the amount of scrap purchased by integrated mills also varies with the amount of scrap produced within the steel plant. The introduction of continuous casting has considerably reduced the ratio of home to purchased scrap.

Yields from molten crude to finished steel can increase by almost 20 per cent when continuous casting is used instead of ingot casting. At least three new continuous casters will be installed in Canadian mills in the next few years.

In the case of electric furnace mills the main substitute for scrap is direct reduced iron, which when melted with scrap has the advantage of diluting the concentration of tramp elements, but it is considerably more costly than scrap. Technical developments in this industry have centred on the treatment of the steel in a holding vessel, a technique that frees the furnace for more production and allows a final treatment to improve the chemistry of the steel produced.

Scrap usage is expected to increase by approximately 2 per cent in 1986. In the medium-term to 1990, usage should increase 4 to 5 per cent per year as more continuous casting equipment is added and a greater percentage of the steel made in North America is produced in electric furnaces. The growth rate after 1990 is forecasted to slow to approximately 2 per cent per year.

The anticipated rising demand for higher quality scrap, especially in terms of low levels of tramp elements and more desirable product forms will likely require the installation of more sophisticated equipment. This could include x-ray spectrometers to analyze scrap, mechanical separators, high pressure bailers and briquetting machines for the production of high density product, and improved shredders that would increase the performance of separating ferrous metal from nonferrous and nonmetallic components.

PRICES

The composite price in U.S. dollars per long ton delivered for No. 1 heavy melting steel scrap, as quoted by the American Metal Market, increased from $59.20 in January 1983 to $86.99 in December 1983. Prices continued to increase in 1984 with the highest price of $96.25 in February 1984. Since reaching this recent high, the price began to weaken and fell to $71.56 by the end of 1985.

The price index for ferrous scrap (1971=100) published by Statistics Canada Catalogue 62-001 shows No. 1 heavy melting scrap at an annual average of 208.6 in 1983, 266.2 in 1984 and 254.1 in 1985. For No. 1 and 2 bundles the index was 222.1 in 1983, 246.1 in 1984 and 247.9 in 1985.

PURCHASE PRICE INDEX OF FERROUS SCRAP, ANNUAL AVERAGE

	1981	1982	1983	1984	1985
			(1971=100)		
No. 1 Heavy Melting	243.3	207.3	208.6	266.2	254.1
No. 2 Heavy Melting	242.3	230.4	198.4	256.7	266.7
No. 1 and 2 Bundles	245.1	216.5	222.1	246.1	247.9
Steel Turnings	418.6	310.1	319.7	446.4	446.4
Prepared and Unprepared Bushellings	246.4	196.0	189.3	235.7	216.3
Plate and Structural and Special Foundry	252.5	215.8	236.4	313.4	289.3

Source: Statistics Canada Catalogue 62-011.

TABLE 1. CANADA, IMPORTS OF STEEL SCRAP, BY PROVINCE OF ENTRY, 1983-85

		1983		1984		1985P	
		World	U.S.	World	U.S.	World	U.S.
Nova Scotia	tonnes	86	86	-	-	-	-
	$000	6	6	-	-	-	-
New Brunswick	tonnes	19	19	5	5	109	109
	$000	2	2	374	374	19	19
Quebec	tonnes	26 998	26 952	28 216	28 199	27 548	27 368
	$000	3,479	3,446	5,846	5,843	2,897	2,727
Ontario	tonnes	262 360	262 281	430 038	429 980	402 019	402 015
	$000	20,783	20,726	41,697	41,673	38,691	38,691
Manitoba	tonnes	25 815	25 815	44 998	44 998	41 886	41 886
	$000	1,852	1,852	4,135	4,135	3,420	3,420
Saskatchewan	tonnes	135 008	135 008	185 759	185 759	83 785	83 785
	$000	10,511	10,511	15,798	15,798	6,888	6,888
Alberta	tonnes	14 798	14 798	40 868	40 868	19 919	19 919
	$000	1,108	1,108	4,212	4,210	1,830	1,830
British Columbia	tonnes	1 489	1 483	2 186	2 186	2 413	2 413
	$000	537	536	995	495	265	265
Total	tonnes	466 573	466 442	732 084	731 996	577 678	577 499
	$000	38,278	38,187	72,684	72,655	54,010	53,841

Source: Statistics Canada.
P Preliminary; - Nil.

TABLE 2. CANADA, EXPORTS OF STEEL SCRAP, BY PROVINCE OF LADING, 1983-85

		1983		1984		1985P	
		World	U.S.	World	U.S.	World	U.S.
Newfoundland	tonnes	1 910	-	-	-	3 827	-
	$000	170	-	-	-	553	-
Nova Scotia	tonnes	38	38	-	-	32 695	8 147
	$000	60	60	-	-	4,112	1,222
New Brunswick	tonnes	475	475	221	171	2 811	2 811
	$000	37	37	49	46	388	388
Quebec	tonnes	105 496	3 415	199 055	15 914	245 469	17 491
	$000	10,437	416	20,121	2,029	29,778	2,068
Ontario	tonnes	549 008	438 215	376 182	348 002	414 688	373 167
	$000	42,398	31,095	34,288	30,994	38,149	32,421
Manitoba	tonnes	836	836	1 171	1 171	991	991
	$000	87	87	205	205	93	93
Saskatchewan	tonnes	161	161	-	-	-	-
	$000	30	30	-	-	-	-
Alberta	tonnes	607	587	832	832	583	170
	$000	106	100	90	90	193	24
British Columbia	tonnes	130 178	128 471	140 012	139 657	108 746	101 795
	$000	11,529	11,209	14,485	14,399	10,886	9,842
Yukon	tonnes	-	-	-	-	230	230
	$000	-	-	-	-	41	41
Total	tonnes	788 709	572 198	717 455	505 746	810 040	504 802
	$000	64,854	43,034	69,237	47,763	84,193	46,100

Source: Statistics Canada.
P Preliminary; - Nil.

TABLE 3. CANADA, EXPORTS OF STAINLESS STEEL SCRAP, BY PROVINCE OF LADING, 1983-85

		1983		1984		1985P	
		World	U.S.	World	U.S.	World	U.S.
Newfoundland	tonnes	-	-	-	-	-	-
	$000	-	-	-	-	-	-
Nova Scotia	tonnes	46	5	100	20	74	-
	$000	42	12	80	13	67	-
New Brunswick	tonnes	83	-	332	23	120	-
	$000	68	-	337	23	105	-
Quebec	tonnes	2 108	1 172	3 221	767	4 301	1 507
	$000	1,696	876	2,906	710	3,725	1,294
Ontario	tonnes	14 905	11 328	17 364	6 240	21 850	16 775
	$000	9,310	6,718	15,914	4,208	94,973	6,479
Manitoba	tonnes	177	177	182	166	352	205
	$000	121	121	100	87	263	130
Saskatchewan	tonnes	-	-	-	-	-	-
	$000	-	-	-	-	-	-
Alberta	tonnes	137	137	46	46	2	-
	$000	74	74	28	28	60	-
British Columbia	tonnes	1 460	543	1 548	591	1 520	368
	$000	944	196	1,068	233	1,194	143
Total	tonnes	18 916	13 362	22 793	7 854	28 218	11 577
	$000	12,255	7,997	20,433	5,302	22,190	8,046

Source: Statistics Canada.
P Preliminary; - Nil.

TABLE 4. CANADIAN CONSUMPTION OF IRON AND STEEL SCRAP

	1975	1976	1977	1978	1979	1980	1981	1982	1983[r]	1984[r]	1985[p]
						(000 tonnes)					
Used in steel furnaces	5 997	5 658	5 708	7 076	7 250	7 501	6 845	5 492[2]	6 449	7 400	6 950
Used in iron foundries	544	550	524	518	604	470	500	448	416	500	500
Other[1]	846	824	938	865	868	770	926	837	475	500	550
Total	7 387	7 032	7 170	8 459	8 722	8 741	8 271	6 777	7 337	8 400	8 000

Sources: 1982 Annual Census of Manufactures. 1983 and 1984 Catalogue 41-001 Primary Iron and Steel.
[1] Includes mainly steel pipe mills, motor vehicle parts industries, and railway rolling stock industries.
[2] The number from Catalogue 41-001 was 4,619 or within 2.3 per cent.
[p] Preliminary; [r] Revised.

TABLE 5. AUTOMOBILE SHREDDERS IN CANADA

Company	Location	Capacity (tonnes/month)
Intermetco Limited	Hamilton, Ontario	8 000
United Steel and Metal division of USACO Limited	Hamilton, Ontario	5 000
Bakermet Inc.	Ottawa, Ontario	8 000
Industrial Metals a division of Lake Ontario Steel Company Limited	Toronto, Ontario	10 000
Zalev Brothers Limited	Windsor, Ontario	8 000
Sidbec-Feruni inc.	Contrecoeur, Quebec	8 300
Fers et Metaux Recyclés Ltée	Longueuil, Quebec	4 000
	Laprairie, Quebec	4 000
Associated Steel Industries Ltd.	Montreal, Quebec	8 000
Native Auto Shredders	Regina, Saskatchewan	6 000
Cyclomet	Moncton, New Brunswick	4 000
Navajo Metals division of General Scrap and Shredder Ltd.	Calgary, Alberta	3 000
Stelco Inc.	Edmonton, Alberta	8 000
Richmond Steel Recycling Limited	Richmond, British Columbia	5 800
General Scrap & Car Shredder Ltd.	Winnipeg, Manitoba	3 000
Total		85 100

Fluorspar

M.A. BOUCHER

BACKGROUND

Fluorspar is the commercial name for the mineral fluorite (CaF_2) which is the most important source of fluorine (F). Fluorspar is used in 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.

During the 1960s, world fluorspar production grew rapidly in response to increasing demands in the steel, aluminum and chemical industries. However, both production and consumption stagnated in the early and mid-1970s due to a combination of technical, economic and environmental developments.

World production increased slightly during the second half of the 1970s, declined from 1980 to 1983, and started to recover again in 1984. In 1980 and 1981 Mexico and South Africa (two very large producers) raised the price of fluorspar considerably. The higher prices allowed China and Mongolia to expand production, undercut the new prices and increase their share of the world markets. In 1983 world prices of fluorspar decreased considerably.

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.

Domestic production of fluorspar ceased when Alcan Smelters and Chemicals Limited closed its mine at St. Lawrence in Newfoundland in February 1978. Concentrates from St. Lawrence were shipped to Alcan's aluminum smelter at Arvida, Quebec. Total production from the district was more than 6 million t of ore. The fluorspar veins on Burin Peninsula are genetically related to two large stocks of alakite (granitic intrusive). Most of this favourable area is obscured by shallow overburden, but innumerable showings and float blocks containing fluorspar are known.

Minworth Ltd. of England plans to start production of fluorspar at St. Lawrence in late 1986,with the development of the Blue Beach North deposit estimated to contain 2.5 million t of ore with an average grade of 45 per cent CaF_2. The ore is contained in sub-vertical veins measuring 4-5 m wide which will be mined from underground. Theore will be upgraded through heavy media separation followed by flotation. Capital investment is estimated at $15 million for an annual production of 75 000 tpy of acid grade fluorspar.

Allied Chemical division of Allied Canada Inc. imports acid-grade fluorspar mainly from Mexico, and Spain for the production of hydrofluoric acid (HF) at Amherstburg, Ontario. The plant has an annual production capacity of 50 000 t of HF. Most of the acid is exported and utilized in the manufacture of fluorocarbons. Allied at Amherstburg, and Du Pont Canada Inc. at Maitland, Ontario are the only companies that manufacture fluorocarbons in Canada.

Alcan started production of aluminum trifluoride (AlF_3) during the fourth quarter of 1985 at a new plant located at Jonquière, Quebec. Capital investment is reported to be $130 million for a production capacity of 40 000 tpy of AlF_3. Close to two thirds of the AlF_3 produced at the plant will be used by Alcan smelters in Quebec and in Kentucky; a quarter will be sold to Canadian Reynolds Metals Company, Limited on long-term contract; and the remainder will be sold on the open market. To produce

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AlF_3, hydrofluoric acid (HF) must be prepared first by reacting fluorite with sulphuric acid. HF is then reacted at high temperature with partially dehydrated alumina hydrate. The production of 40 000 t of AlF_3 requires about 60 000 t of acid grade fluorspar, most of which is expected to be imported from Morocco and Spain.

Eaglet Mines Limited of Vancouver has delineated 24 million t of fluorspar with an average grade of 11.5 per cent CaF_2. The deposit is located near Quesnel Lake about 200 km north of Kamloops. A prefeasibility study indicates that the ore could be mined underground at a rate of 5 000 tpd. The ore would then be crushed, followed by heavy media concentration and flotation. Sulphides (of silver, lead, molybdenum and zinc) present in the ore, would also be recovered. Both acid (+97 per cent CaF_2) and metallurgical (+83 per cent CaF_2) grade fluorspar could be produced.

A barite-fluorite deposit east of Lake Ainslie, Cape Breton Island, containing indicated reserves of 2.7 million t, grading 28 per cent barite and 19 per cent fluorite is under license to Conwest Exploration Company Limited. Pilot plant testing, with the objective of producing an acid-grade concentrate at an acceptable rate of recovery, has yet to prove successful. A large uranium-bearing, medium-grade fluorspar deposit adjacent to the Canadian National Railway line at Birch Island, about 95 km north of Kamloops, is controlled by Consolidated Rexspar Minerals & Chemicals Limited. Deposits in the Liard River area of British Columbia are also of interest.

MARKETS AND USES

Fluorspar is marketed in three grades according to end-use: acid grade, containing a minimum of 97 per cent CaF_2; metallurgical grade, containing a minimum of 60 per cent effective* CaF_2; and ceramic grade No. 1 containing 95 to 96 per cent CaF_2; and No. 2 containing 85 to 90 per cent CaF_2.

Acid grade. Roughly 40 per cent of the world's fluorspar requirement is for acid grade 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, 2 to 3 t of ore must be mined to produce 1 t of acid-grade fluorspar concentrate, and the production of 1 t of hydrofluoric acid requires 2 t of acid-grade concentrate and almost 3 t of sulphuric acid. Hydrofluoric acid, produced according to the reaction:

$$CaF_2 + H_2SO_4 \longrightarrow CaSO_4 + 2HF$$

has a variety of uses, but by far the most important is in the chemical and aluminum industries, which together account for some 80 per cent of consumption.

Between 50 and 60 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. Fluorocarbons (more specifically, chloro-fluorocarbons use in aerosols) have been under study for many years as potentially harmful atmospheric pollutants and because of this, consumption slowed considerably during the 1970s and 1980s.

About 15 per cent 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. The acid is also reacted with alumina hydrate to produce AlF_3. In recent years, fluorspar requirements per tonne of aluminum produced have declined through improved technology and recycling, and the trend is likely to continue. Currently the production of aluminum requires 20-25 kg of fluorine contained in the form of aluminium trifluoride and cryolite.

Fluorspar is also used in uranium refining where 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, the feedstock for plants requiring enriched uranium. For each tonne of uranium processed into uranium hexafluoride, 1.1 t of HF is required.

Metallurgical grade. About half of the world's fluorspar production is consumed as a metallurgical fluxing agent (metspar),

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* Obtained by subtracting 2.5 times the silica content of the concentrate from its total CaF_2 contents. Ex. An 85 per cent CaF_2 concentrate containing 6 per cent silica is a 70 per cent effective grade.

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.

Currently the amount of fluorspar used per tonne of steel produced varies from 1 to 6 kg depending on fluorspar availability and the type of steel furnace in use. Due to environmental constraints which are forcing plants to reduce emissions, more fluorspar is being recycled; also the use of substitutes such as olivine and dolomitic limestone is increasing in some countries. Consequently consumption of fluorspar per tonne of steel produced is also decreasing.

Ceramic grade. Ceramic-grade fluorspar is used as flux and as an opacifier in enamels, flint glass, white or opal glass. It is also used in the manufacture of fiberglass insulation.

TRADE AND CONSUMPTION

Canada's major suppliers of fluorspar include Mexico, followed by Morocco and Spain. Consumption in Canada is in the order of 170 000 tpy, and most fluorspar is used in the production of fluorocarbons and aluminium.

WORLD PRODUCTION

Mexico, the U.S.S.R., Mongolia and China are the principal world producers of fluorspar. U.S. production has rapidly declined since 1978 while production has increased very rapidly in China and Mongolia. Production capacity utilization in 1984 was down, compared with 1978, in Mexico and Spain.

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. A combination of economies in fluorspar use and environmental constraints is expected to continue to have a negative effect on consumption. Consequently, only a modest growth in consumption can be expected in the short to medium term.

PRICES

	$US (per tonne)					
	1976	1979	1980	1981-82	1983	1985
Mexican fluorspar, fob Tampico,						
Acid grade filtercake	85	92	115-132	148-154	119	110
Metallurgical grade						72-77
South African acid grade dry basis, fob Durban						110
USA, Illinois district, bulk						
Acidspar						185-190
Ceramic grade (95-96% CaF_2)						187
(88-90% CaF_2)						110

Sources: Industrial Minerals December 1985; Engineering & Mining Journal, December 1985.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
CANADA					
29600-1	Fluorspar	free	free	free	free
UNITED STATES					
522.21	Acid grade		2.06 per tonne		
522.24	Fluorspar, containing not over 97% calcium fluoride		13.5%		

Sources: The Customs Tariff, 1985, Revenue Canada, Custom and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register, Vol. 44, No. 241.

TABLE 1. CANADA, FLUORSPAR PRODUCTION AND TRADE, 1982-85

	1982		1983		1984		1985	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production (shipments)	-	-	-	-	-	-	-	-
							Jan.-Sept. 1985)	
Imports								
Mexico	50 903	8,616	79 178	10,626	93 221	11,600	41 135	5,551
Morocco	34 304	7,046	27 010	6,139	33 610	4,505	9 277	1,353
Spain	26 401	4,942	20 546	3,093	30 895	4,325	9 081	1,304
United States	14 986	1,573	7 001	1,650	8 916	2,274	5 708	1,584
Italy	-	-	8 193	1,525	-	-	-	-
Other countries	-	-	-	-	67	13	-	-
Total	126 594	22,177	141 928	23,034	166,709	22,717	65 201	9,792

Sources: Statistics Canada; Energy, Mines and Resources, Canada.
- Nil.

TABLE 2. CANADA, FLUORSPAR CONSUMPTION, 1982-84

	1982r	1983	1984P
		(tonnes)	
Consumption[1] (available data)			
Metallurgical flux	19 372	17 134	14 402
Foundries	9 753	10 508	9 621
Other[2]	144 306	135 802	152 829
Total	173 431	163 444	176 852

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] As reported by known consumers.
[2] Includes consumption in the production of aluminum, chemicals, petroleum refining and other miscellaneous uses.
P Preliminary; r Revised.

TABLE 3. MAJOR CONSUMERS OF FLUORSPAR BY GRADE IN CANADA

Product	Major Consumers
Metallurgical grade (used as gravel or briquettes)	Alcan Aluminium Limited, Stelco Inc. Ford Motor Company of Canada, Limited Sydney Steel Corporation Dofasco Inc. Atlas Steels Division of Rio Algom Limited
Ceramic grade (used as powder)	The Algoma Steel Corporation, Limited Ferro Industrial Products Limited A.P. Green Refractories
Acid grade (used as powder)	Allied Chemical division of Allied Canada Inc. Timminco Limited

TABLE 4. WORLD FLUORSPAR PRODUCTION, 1978 AND 1983-84

	1978	1983e	1984e
		(000 tonnes)	
Mexico	959	667	700
U.S.S.R.	509	595	600
South Africa	393	295	350
People's Republic of China	399	528	530
Spain	397	206	220
Mongolia	454	761	800
France	314	264	270
Italy	171	176	180
United Kingdom	188	220	230
Thailand	230	227	240
Kenya	106	88	100
United States	117	61	70
Other countries	548	612	710
Total	4 792	4 700	5 000

Sources: U.S. Bureau of Mines, Mineral Commodity Summaries.
e Estimated.

Gold

D. LAW-WEST

Gold prices declined in 1985 for the third consecutive year and averaged $US 317 an oz., compared to $360 in 1984 and $424 in 1983. A five year low of $US 284.25 an oz. occurred in February.

Despite weakening prices, several new Canadian gold mines came into production, notably, three in the Hemlo area of northern Ontario. Several other countries, including Australia and United States also opened up new mines.

In South Africa, gold production was disrupted somewhat by social and labour unrest. Production of the Kruggerrand was halted by year-end due to a ban on those coins, by the United States and several other countries.

Average gold prices are expected to change little in 1986 from the levels recorded in 1985. Canadian production will increase significantly in 1986 primarily due to more production at Hemlo.

CANADIAN DEVELOPMENTS

Canada's production of primary gold in 1985 is estimated at 86 040 kg, which is 3 per cent higher than the 83 450 kg produced in 1984. The largest increase occurred in Ontario where three new Hemlo mines came into production.

Gold production in Atlantic Canada dropped, mainly due to the closure of ASARCO Incorporated's Buchans mine in Newfoundland.

BP Resources Canada Limited continued to evaluate the Chetwynd gold deposit on the southwest coast of Newfoundland. By year-end the company had estimated reserves of 11.2 million t grading 4.59 g/t. Metallurgical tests concluded that conventional milling could recover 90 per cent of the contained gold. As well, 9 300 t of ore was heap leached and a 61 per cent recovery rate was obtained. Further tests will be conducted.

In Nova Scotia, gold exploration and development work increased significantly in 1985. Several companies secured financing for more detailed work and feasibility studies.

Agnico-Eagle Mines Limited succeeded in increasing gold production at its Telbel mine near Joutel in northern Quebec. The new Telbel shaft improved operating procedures and permitted an increase in production to 2 240 kg of gold in 1985 compared to 1 900 kg in 1984. In 1986, production is expected to be 2 770 kg.

In mid-August, Louvem Mining Company Inc. reopened the Chimo mine following a six month shutdown, during which time additional development work was carried out.

Early in the year, Teck Corporation closed the Lamaque mine at Val d'Or, Quebec due to the exhaustion of ore reserves. The mine is expected to be maintained on stand-by, while an exploration program on the property is carried out. Lamaque has been Quebec's largest gold mine, having produced 140 t of gold over its 50 year history.

Gold exploration was very active in the Casa Berardi region of northern Quebec, between the Ontario border and Joutel.

Inco Limited in a 60/40 per cent joint venture program with Golden Knight Resources Inc., began a $7.2 million underground exploration program on its Casa Berardi property. The program is expected to last one year and should provide sufficient data to complete a feasibility study. The drill indicated reserves are 6.0 million t grading 7.2 g/t.

Also in the Casa Berardi region, Teck Corporation in a joint venture with Golden Hope Resources Inc. and Golden Group Explorations Inc., encountered significant gold values in a diamond drilling program. However, follow-up drilling showed lower

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gold grades. This region will continue to be active throughout the next few years. Exploration is complicated by overburden which varies from about 4 m to over 50 m in thickness.

In Ontario, three new gold mines came into production in the Hemlo region, making this one of the most important gold producing regions in the country. Noranda Inc., Teck-Corona Operating Corporation and Lac Minerals Ltd. all started production during the year.

Noranda poured the first bar of gold at its Golden Giant mine in early-April. Noranda had spent close to $115 million to bring the mine-mill complex into production and by year-end the mine had produced some 3 050 kg of gold. The operation currently has a design capacity of 1 250 tpd but this is expected to be increased to 3 000 tpd by 1988, and annual gold production should then reach 10 000 kg. The mine reserves are currently quoted at 20 million t grading 10.1 g/t. Noranda also plans to recover the associated molybdenite.

The Teck-Corona Operating Corporation, a joint venture of Teck Corporation (55 per cent) and International Corona Resources Ltd. (45 per cent) started production in late-May. The company spent $84 million to bring its 1 000 tpd mine-mill complex into production, which was $10 million under budget and one month ahead of schedule. The company's ore reserves have been estimated at 7.6 million t grading 12.13 g/t, sufficient to support a 360 000 tpy operation for 20 years. At full production the company expects to be annually producing in excess of 4 000 kg of gold.

Lac Minerals poured its first gold bar from its Page-Williams gold mine, early in December. The reserves outlined to date total some 50 million t grading 5.3 g/t. Initial production will be 3 300 tpd followed by an increase to 6 600 tpd by mid-1989. At full production Lac expects its Hemlo mine to be annually producing over 12 000 kg of gold. By year-end, the company had spent $165 million out of a total expected cost of $275 million.

The three Hemlo gold mines will employ a total of 1,200 workers by 1989, when full capacity is reached. Annual production is expected to reach about 25 000 kg of gold. Production costs should average below $195 per oz. of gold.

By year-end, the law suit by International Corona Resources Ltd. against Lac Minerals had not been resolved. Corona's suit for $3 billion against Lac depends upon whether Lac received confidential information from Corona about the property which Lac subsequently acquired and then developed into its Hemlo mine. The case was further complicated by a countersuit by Lac against Corona.

Also in Ontario, Kidd Creek Mines Ltd. announced a decision to develop the Hoyle Pond mine. At year-end some development ore had been removed and sent for custom milling. Commercial production is expected by early-1986. The company is adding a 300 tpd gold recovery circuit at its metallurgical plant to handle production from the Owl Creek and Hoyle Pond mines.

Production will stop at Dome Mines, Limited's Detour Lake open-pit mine in September 1986, and will be followed by 17 months of underground development work, after which time a decision will be made on the future of the mine. Detour's operating costs including depreciation are $576 per ounce.

In Manitoba, Inco Limited, through its partly-owned subsidiary, San Antonio Resources Inc., can earn a 50 per cent interest in the San Antonio gold mine by spending $7.5 million by 1988. The remaining 50 per cent would be held by Brinco Limited's Cassiar Asbestos division. The program's goal is to outline additional reserves at depth, in order to support renewed mining.

Sherritt Gordon Mines Limited announced plans to spend $30 million to bring its 1 000 tpd MacLellan gold mine near Lynn Lake into commercial production by the fall of 1986. Mineable reserves of 1.7 million t grading 6.4 g/t have been outlined. The company plans to refurbish the former base-metal milling complex and to install a carbon in pulp circuit, for gold recovery.

Most of the miners from the now closed Fox mine will be transferred to the MacLellan mine. Operating costs including royalties have been estimated at $257 per ounce.

Hudson Bay Mining and Smelting Co., Limited and Manitoba Mineral Resources Ltd., in a joint venture, have discovered some interesting prospects also near Lynn Lake. As well, Granges Exploration Ltd. announced a significant gold discovery just west of Lynn Lake.

In Saskatchewan, the La Ronge region has become a very active gold exploration and development area.

The Saskatchewan Mining Development Corporation and Starrex Mining Corporation Ltd. are spending $11.5 million on the Star Lake gold mine-mill complex near La Ronge. Current development includes a decline being driven to the orebody, which is a pipe-like structure containing 230 000 t of ore grading 15.6 g/t. A 230 tpd mill has been proposed to treat the ore.

Placer Development Limited is evaluating the nearby Seabee property. Drilling has outlined reserves of 1.12 million t grading 10.0 g/t, however, additional drilling was being planned at year-end.

In British Columbia, Erickson Gold Mines Ltd. announced the discovery of three high-grade gold veins near its Cassiar operations. The company is preparing an underground exploration decline. The company began a three month shutdown at the end of November in order to modernize its mill and also to conduct further examination of the new vein structure. However, the company faced a major set back in early-1986 when a fire destroyed the mill as it was being upgraded.

Mascot Gold Mines Limited decided to proceed with development of a 1 800 tpd open-pit mining and milling project at Hedley, British Columbia. The project is expected to cost some $43 million. Exploration drilling has outlined mineable reserves of 4.1 million t grading 4.7 g/t. Mining costs are expected to be marginally below $200 per oz.

In the Yukon Territory, Erickson Gold Mines proceeded towards a March 1986 start-up of the Mount Skukum gold project, 70 km south of Whitehorse. The deposit, first discovered by AGIP Canada Ltd. in 1981, has reserves of 181 000 t grading 18.7 g/t in one zone and there are four other zones which may later be developed. The mill will have a nominal capacity of 300 tpd.

In the Northwest Territories, International Corona Resources Ltd., through its 42 per cent owned Royex Gold Mining Corporation, closed its Cullaton Lake gold mine. The mine-mill complex has been placed on a care and maintenance basis and can be reactivated should gold prices increase substantially.

Terra Mines Ltd. continued the surface and underground exploration program at its Bullmoose Lake gold prospect. In addition the company is installing a 75 tpd pilot plant mill. The mill is expected to be operational by mid-1986.

At Echo Bay Mines Ltd.'s Lupin mine near Contwoyto Lake, the major development was a deepening of the original 370 m shaft to 790 m. This will permit mining of the deeper ore.

The popularity of the Canadian Gold Maple Leaf bullion coins, increased substantially in 1985. The major reason was the official banning of sales of South Africa's gold bullion Krugerrand in many major coin markets, including the United States. Sales of the Maple Leaf were expected to have reached close to 2 million oz. of gold in 1985, up from the previous year's sales of 1.2 million oz. and surpassing world sales of the Krugerrand for the first time. However, the Maple Leaf will begin facing stiffer competition as the United States, Australia and Japan are planning to start minting bullion coins by late-1986.

WORLD DEVELOPMENTS

In South Africa mine production for 1985 was down slightly to an estimated 675 t from 681 t the previous year. One factor contributing to the decrease was the number of work stoppages due to labour unrest.

The United States' ban on the importation of Krugerrands was the major factor which led to a sharp fall in the demand for Krugerrands and which forced South Africa to halt production of the coin at year-end. Since the Krugerrand was introduced in 1970, 43 million ounces of gold have been sold in this form.

In the United States, Homestake Mining Company commissioned its McLaughlin gold mine in northern California, in late-September. The operation is expected to produce 300,000 oz. of gold per year for 20 years. The project was completed at a cost of $280 million, operating costs are expected to average $US 300 per oz. over the life of the mine.

Two Canadian companies, Asamera Minerals (U.S.) Inc. (51 per cent) and Breakwater Resources Ltd. (49 per cent) brought the Cannon mine near Wenatchee, Washington into production. The 1 800 tpd operation, has ore reserves of 3.5 million t grading 7.8 g/t, and a life expectancy of six or more years, depending on the price of gold. Operating costs for the mine are about $US 150 per oz.

AMAX Inc. has given approval for the development of the Sleeper gold mine in northwestern Nevada. The mine is expected to produce 1 650 kg of gold and 1 460 kg of silver annually. Mine construction is scheduled to begin in mid-1986 with commercial operations starting by 1988.

Gold production in Australia increased sharply with the start-up of the Kidston mine in northern Queensland. The mine, 70 per cent owned by Placer Development Limited, produced some 4 160 kg of gold and 1 940 kg of silver during its first nine months of operation. The mine will be Australia's largest producer, when it is at full capacity, of some 8 700 kg of gold per year. The mine has reserves of 49.4 million t grading 1.79 g/t of gold and 2.22 g/t of silver.

Pancontinental Mining Ltd. opened in mid-year its $300 million gold mine at Paddington, north of Kalgoorlie, in Western Australia. The company expects to annually produce 2 800 kg of gold.

During 1985, 30 new gold mines commenced operations in Australia, and production from these mines totalled 13 545 kg of gold. In addition, there are nine additional projects which are expected to begin production during the next two years which could produce between 15 000 kg to 17 000 kg of gold per year.

The large Ok Tedi gold mine in Papua New Guinea continued to have operating problems in 1985. The government, a 20 per cent shareholder in the project, closed down the operation early in the year due to dissatisfaction about the schedule for construction of copper facilities at the operation. After a five week closure, the operation reopened with an agreement between the government and Ok Tedi Mining Ltd. which provides for development of the infrastructure for copper mining. The schedule will be based upon a feasibility study to be conducted in early-1987.

Ok Tedi is a consortium project involving BHP Minerals Ltd. (30 per cent), Cyprus Minerals Company (PNG) (30 per cent), Papua New Guinea government (20 per cent), Metallgesellschaft AG (7.5 per cent), Degussa AG (7.5 per cent) and the West German Development Co. (5 per cent).

PRICES

Gold prices declined and averaged $US 317 ($Cdn 433) in 1985 on the London Gold Market's afternoon fixing compared to $US 360 ($Cdn 467) in 1984.

Gold prices on world markets remained weak through the first quarter hitting a five year low of $US 284.25 in February. The price rebounded in the second quarter and then in August the year's high of $US 340.90 was reached. The price remained relatively stable during the last quarter and averaged $US 324.

CONSUMPTION AND USE

The use of new gold for jewellery, coin and industrial purposes recovered in 1984 in the western world to 1 221 t, from 1 002 t in 1983. The falling price of gold and improved economic conditions substantially increased sales of carat jewellery in India, the Far East, Japan and the United States.

Jewellery demand for gold in both industrialized and developing countries increased substantially by 14.4 per cent to 436 t and 79.0 per cent, to 383 t, respectively, over the previous year. The large increase by developing countries is due to increased prosperity in India and the Far East, combined with lower gold prices during the year.

The consumption of gold in electronic components made a further increase of 20 per cent to 122.8 t in 1984. The largest improvements occurred in Japan and the United States. While the electronics industry has cut the amount of gold used per electronic unit, increased consumer sales of equipment such as videos and home computers have more than offset the decreased unit consumption. In addition, the exceptional corrosion resistance, as well as good conductivity, of gold does not allow substitution in applications where performance is vital, especially in the defence and aerospace industries.

Worldwide demand for gold in dentistry remained unchanged in 1984 at 53 t. The gold content of dental alloys has been reduced over the years. Substitution into non-gold bearing ceramic materials is also evident in some countries, indicating that the gold consumption for dental purposes will continue to decline.

The use of gold in miscellaneous applications such as decorative plating, liquid gold, rolled gold and various industrial chemicals remained relatively constant at 53.3 t in 1984. Applications of these products include glass and porcelain decorations, gold plated jewellery as well as industrial and laboratory chemicals. The largest markets are the United States, Japan and western Europe.

The falling price of gold created a record 334 t of investment purchases of gold during the year. The largest increases occurred in Japan and the Far East where the low prices were particularly attractive to investors.

OUTLOOK

Canadian gold production is expected to continue to increase through the end of this decade. The major contributor to this increase will be the three Hemlo producers. These mines are expected to account for about 25 per cent of Canada's forecast of 100 t of production in 1990.

The discovery of the Hemlo gold camp has encouraged an increase in gold exploration in several parts of Canada.

Exploration in the Casa Berardi region of northern Quebec was active during the year and this should continue for at least the next two years, as several of the senior mining companies conduct intensive exploration programs. This area appears to have good potential for a new mine.

The La Ronge region of Saskatchewan and the adjoining area in Manitoba will likely have two new gold mines in the near future. Exploration by other companies in this area also indicated potential mines and development decisions are expected in 1986.

British Columbia and the Yukon Territories are increasing their gold production by the development of new gold mines and both have well defined potential for further increases.

Canada is in a good position to maintain or to increase its gold production past the end of the decade. Given the current level of gold exploration in the country, it is possible that major new gold mining camps will be developed.

The level of exploration and new mine development is not unique to Canada. Both Australia and the United States are quickly adding new gold production facilities. As well, other countries such as Brazil, China and the Philippines have excellent potential to develop new mines.

It is interesting that world gold production has increased in recent years, despite falling gold prices. This can be explained by the fact that even at the 1985 average price of $US 317, average mine production costs are well below the price. In addition, the currencies of several gold producing countries, including those of Canada, Australia and South Africa have declined in value relative to the $U.S. dollar.

The demand for gold is elastic as was demonstrated in 1980 when world consumption fell by over 60 per cent from the previous year, in response to historically high prices. The recent lower prices have created increased fabrication demand, especially in the carat jewellery and the electronics industry.

The bullion coin market suffered a setback when South Africa discontinued the production of Krugerrands. The Krugerrands has been losing public appeal for a period of time, but during 1985 a number of countries banned the importation of the coin and as a result the Krugerrand was selling at a discount to other bullion coins. The Canadian Maple Leaf benefited significantly and its sales reached a record high but total global bullion coin sales were still down markedly. It has been noted several other countries will begin minting their own bullion coins and the question will be whether public confidence in bullion coins can be rebuilt and new demand created. The problem that the bullion coin market now faces is that the vacuum created by the loss of the Kruggerrand have been partially filled by gold in other forms such as wafer and bars. Major advertising campaigns need to be launched to help recover the bullion coin market.

Gold prices in 1986 are expected to be in the $US 310-360 range. Inflation is again expected to be relatively low and this will be a factor limiting the increase in the price of gold.

TABLE 1. CANADA, GOLD PRODUCTION AND TRADE, 1983-85

	1983	1984p	1985e
	(grams)		
Production			
Newfoundland	-	35 120	-
New Brunswick	345 773	780 850	252 000
Quebec	27 349 139	28 631 550	29 303 000
Ontario	23 760 877	28 291 700	31 670 200
Manitoba	2 194 181	2 154 100	2 101 100
Saskatchewan	134 585	187 860	190 440
Alberta	15 484	16 440	8 400
British Columbia	8 071 951	7 656 250	6 440 750
Yukon	3 006 299	2 959 880	3 097 910
Northwest Territories	8 634 193	12 732 110	12 980 550
Total	73 512 482	83 445 925	86 044 389
Total Value ($Cdn)	1 123 886 000	1 252 283 179	1 197 051 203

	1983		1984		Jan.-Sept. 1985	
	(kilograms)	($000)	(kilograms)	($000)	(kilograms)	($000)
Imports						
Gold in ores and concentrates						
United States	772	9,959	275	4,137	128	1,618
Peru	177	2,656	155	1,965	99	1,202
Other countries	2	31	160	2,140	32	419
Total	951	12,646	590	8,242	259	3,239
Gold						
United States	38 788	668,938	48 382	748,440	50 157	689,926
Switzerland	1 740	30,470	759	11,897	533	7,447
West Germany	139	2,393	255	3,897	375	5,269
Other countries	935	15,377	42	253	46	643
Total	41 602	717,178	49 438	764,487	51 111	703,285
Gold alloys						
United States	13 086	218,734	11 845	167,660	11 952	133,257
Peru	2 444	38,641	2 448	37,735	1 492	18,679
Nicaragua	3 220	20,719	3 199	15,429	1 614	9,308
Papua New Guinea	-	-	306	3,137	2 427	24,633
Other countries	5 115	49,752	630	7,952	147	1,706
Total	23 865	327,846	18 428	231,913	17 632	187,583
Exports						
Gold in ores and concentrates						
Japan	3 552	45,346	4 022	46,761	3 853	40,981
United States	1 400	19,848	1 033	14,709	125	1,665
Taiwan	376	4,683	113	152	192	1,562
Switzerland	337	4,352	112	1,283	-	-
Other countries	481	5,380	844	10,263	165	1,834
Total	6 146	79,609	6 024	73,168	4 335	46,092
Gold						
United States	73 628	1,237,154	109 984	1,663,212	74 990	1,043,294
Japan	2 287	28,276	9 296	141,107	3 528	48,096
West Germany	431	6,960	446	7,584	280	8,946
Hong Kong	546	7,908	862	12,671	1 027	13,337
Panama	125	2,216	394	5,807	1 397	19,605
Other countries	810	13,851	629	9,474	604	8,197
Total	77 827	1,296,365	121 611	1,839,855	81 826	1,136,475
Gold Alloys						
United States	370	3,687	122	1,030	150	1,183
Trinidad - Tobago	384	3,535	282	2,245	90	529
West Germany	-	-	2 084	30,289	1 872	22,453
Other countries	3	20	9	77	4	131
Total	757	7,242	2 497	33,641	2 116	24,296

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; e Estimated; - Nil.

TABLE 2. CANADA, GOLD PRODUCTION BY SOURCE, 1970, 1975 AND 1979-84

	Auriferous Quartz Mines		Placer Operations		Base-Metal Ores		Total	
	(grams)	(%)	(grams)	(%)	(grams)	(%)	(grams)	(%)
1970	58 591 610	78.2	228 890	0.3	16 094 525	21.5	74 915 025	100.0
1975	37 529 456	73.0	335 077	0.6	13 568 581	26.4	51 433 114	100.0
1979	33 794 332	66.1	899 202	1.7	16 448 825	32.2	51 142 359	100.0
1980	31 928 594	63.1	2 059 727	4.0	16 631 942	32.9	50 620 263	100.0
1981	35 876 992	69.0	1 632 720	3.1	14 524 569	27.9	52 034 281	100.0
1982	47 865 658	74.0	2 476 468	3.8	14 393 104	22.2	64 735 230	100.0
1983	55 521 686	75.5	3 235 019	4.4	14 755 774	20.1	73 512 482	100.0
1984P	62 553 528	75.0	3 393 003	4.1	17 499 394	20.9	83 445 925	100.0

Sources: Statistics Canada; Energy, Mines and Resources Canada.
P Preliminary.

TABLE 3. CANADA, GOLD PRODUCTION, AVERAGE VALUE PER GRAM AND RELATIONSHIP TO TOTAL VALUE OF ALL MINERAL PRODUCTION[1], 1970, 1975 AND 1979-85

	Total Production	Total Value	Average Value per Gram[1]	Gold as Per cent of Total Value of Mineral Production
	(grams)	($Cdn)	($Cdn)	(per cent)
1970	74 915 025	88,057,464	1.18	1.5
1975	51 433 114	270,830,389	5.27	2.0
1979	51 142 359	590,766,328	11.55	2.3
1980	50 620 263	1,165,416,873	23.02	3.7
1981	52 034 281	922,089,087	17.72	2.9
1982	64 735 230	968,012,000	14.95	2.9
1983	73 512 482	1,230,886,000	16.74	3.3
1984P	83 445 925	1,252,283,179	15.01	2.9
1985e	86 044 389	1,197,051,203	13.91	2.7

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Value not necessarily based on average annual gold price.
P Preliminary; e Estimate.

TABLE 4. GOLD MINE PRODUCTION IN THE NON-COMMUNIST WORLD

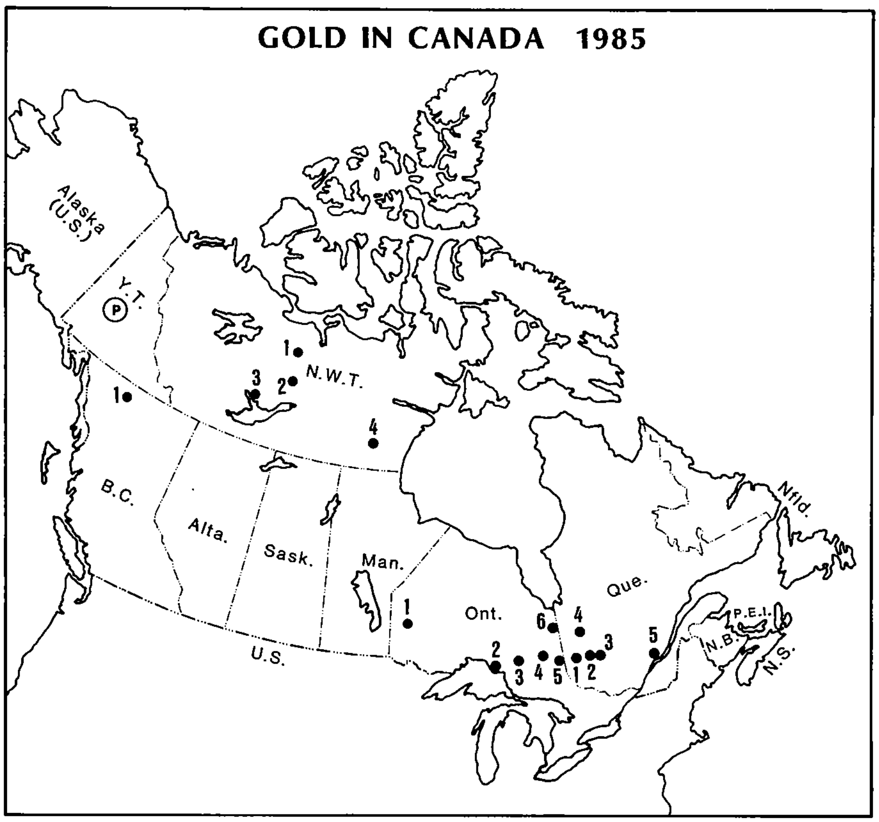
	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
						(tonnes)					
South Africa	758.6	713.4	713.4	699.9	706.4	705.4	675.1	657.6	664.3	679.7	683.3
Canada	52.2	51.4	52.4	54.0	54.0	51.1	50.6	52.0	64.7	73.5	83.4
United States	35.1	32.4	32.2	32.0	31.1	29.8	30.2	42.9	45.0	60.9	71.5
Other Africa:											
Ghana	19.1	16.3	16.6	16.9	14.2	11.5	10.8	11.6	12.0	11.8	11.6
Zimbabwe	10.4	11.0	12.0	12.5	12.4	12.0	11.4	11.6	13.4	14.1	14.5
Zaire	4.4	3.6	4.0	3.0	1.0	2.3	3.0	3.2	4.2	6.0	10.0
Other	1.5	1.5	1.5	1.5	2.0	2.5	8.0	12.0	15.0	15.0	15.0
Total Other Africa	35.4	32.4	34.1	33.9	29.6	28.3	33.2	38.4	44.6	46.9	51.1
Latin America:											
Brazil	13.8	12.5	13.6	15.9	22.0	25.0	35.0	35.0	34.8	58.7	55.1
Colombia	8.2	10.8	10.3	9.2	9.0	10.0	17.0	17.7	15.5	17.9	21.3
Dominican Republic	-	3.0	12.7	10.7	10.8	11.0	11.5	12.8	11.8	10.8	10.8
Chile	3.7	4.1	3.0	3.0	3.3	4.3	6.5	12.2	18.9	19.0	18.0
Peru	2.7	2.9	3.0	3.4	3.9	4.7	5.0	7.2	7.2	9.9	10.5
Mexico	3.9	4.7	5.4	6.7	6.2	5.5	5.9	5.0	5.2	7.4	6.8
Nicaragua	2.4	1.9	2.0	2.0	2.3	1.9	1.5	1.6	2.9	1.7	1.5
Other	2.2	1.9	5.0	5.0	5.2	3.7	5.9	8.1	9.0	16.5	18.1
Total Latin America	36.9	41.8	55.0	55.9	62.7	66.1	88.3	99.6	105.3	141.9	142.1
Asia:											
Philippines	17.3	16.1	16.3	19.4	20.2	19.1	22.0	24.9	26.0	33.3	34.1
Japan	4.5	4.8	4.5	4.8	4.8	4.3	3.4	3.3	3.6	3.4	3.5
India	3.2	3.0	3.3	2.9	2.8	2.7	2.6	2.6	2.2	2.2	2.0
Other	2.7	2.7	3.0	3.0	3.5	4.0	4.5	4.6	5.2	5.3	5.7
Total Asia	27.7	26.6	27.1	30.1	31.3	30.1	32.5	35.4	37.0	44.2	45.3
Europe	11.6	11.0	11.4	13.2	12.5	10.0	11.8	11.9	12.4	14.1	15.0
Oceania:											
Papau/New Guinea	20.5	17.9	20.5	22.3	23.4	19.7	14.3	17.2	17.8	18.4	18.3
Australia	16.2	16.3	15.4	19.2	20.1	18.6	17.0	18.4	27.0	30.6	39.0
Other	2.2	2.2	2.3	1.8	1.1	1.0	1.0	1.1	1.2	1.8	1.8
Total Oceania	38.9	36.4	38.2	43.3	44.6	39.3	32.3	36.7	46.4	50.8	59.1
TOTAL	996.3	945.7	963.7	962.3	971.9	959.3	954.4	976.7	1 025.1	1 112.0	1 148.7

Source: Consolidated Gold Fields PLC, Gold 1984, p. 16.
- Nil.

TABLE 5. ANNUAL GOLD PRODUCTION FORECAST

	Non-communist World[1,2]	Canadian
	(tonnes)	
1979	1 153.9	51.1
1980	1 029.5	50.6
1981	1 234.8	52.5
1982	1 231.7	64.7
1983	1 265.9	73.5
1984p	1 280.0	83.0
1985f	1 310.0	86.0
1986f	1 315.0	87.0
1987f	1 315.0	87.0
1988f	1 310.0	88.0
1989f	1 310.0	95.0
1990f	1 310.0	100.0

[1] Mine production; does not include recycled material. [2] Market economy country production plus sales from East Bloc Countries.
[p] Preliminary; [f] Forecast.


GOLD IN CANADA 1985
Alaska (U.S.)
Y.T.
P
N.W.T.
1
2
3
4
1
B.C.
Alta.
Sask.
Man.
Ont.
Que.
Nfld.
P.E.I.
N.B.
N.S.
U.S.
1
2
3
4
5
6
1
2
3
4
5

MAJOR PRIMARY CANADIAN GOLD PRODUCERS 1986

Yukon Territories:

(P) Various placer operations.

Northwest Territories:

1. Echo Bay Mines Ltd. - Lupin Mine
2. Giant Yellowknife Mines Limited - Salmita Mine
3. Giant Yellowknife Mines Limited - Giant Mine
   Cominco Ltd. - Con and Rycon Mines
4. Royex Gold Mining Corporation - Cullaton Lake Mine

British Columbia:

1. Erickson Gold Mines Ltd.

Ontario:

1. Red Lake Area
   Campbell Red Lake Mines Limited
   Dickenson-Sullivan Joint Venture
2. Hemlo Area
   Lac Minerals Ltd. - Page-Williams Mine
   Noranda Inc./Golden Giant Mines Ltd./Golden Sceptre Resources Ltd. Joint Venture - Golden Giant Mines
   Teck-Corona Operating Corporation
3. American Barrick Resources Corporation/Royex Gold Mining Corporation - Renabie Mine
4. Timmins Area
   Dome Mines, Limited - Dome Mine
   Pamour Porcupine Mines Limited (Jimberlana Minerals NL) - Pamour #1, Timmins, and Ross Mines
   Kidd Creek Mines Ltd. (Falconbridge) - Owl Creek, Hoyle Pond
5. Kirkland Lake Area
   Lac Minerals Ltd. - Macassa, Lake Shore Mines
   Kerr Addison Mines Limited
   Inco Limited/Queenston Gold Mines Limited Joint Venture - McBean Mine
6. Campbell Red Lake Mines Limited/Amoco Canada Petroleum Company Ltd. Joint Venture-Detour Lake Mine

Quebec:

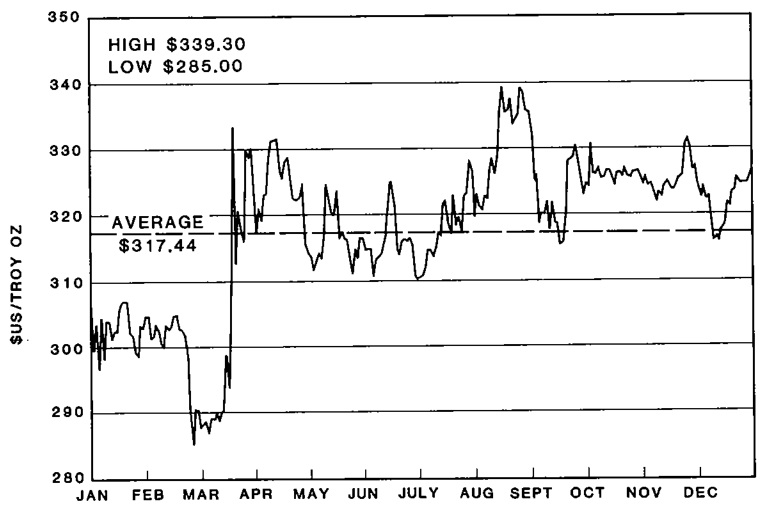
1,2,3 Noranda/Rouyn - Val d'Or Area
- Corporation Falconbridge Copper - Lake Shortt
- Lac Minerals Ltd. - La Mine Doyon/La Mine de Bousquet
- American Barrick Resources Corporation - Camflo
- Belmoral Mines Ltd.
- Kiena Gold Mines Limited - Kiena Mine
- Sigma Mines (Quebec) Limited - Sigma Mine
- Louvem Mining Company Inc. - Chimo Mine

4. Agnico-Eagle Mines Limited - Telbel Mine
5. Muscocho Explorations Limited - Montauban Mine

Note:
1. For detailed production and ore grade information refer to the Table of Nonferrous Mines immediately following the Zinc chapter.
2. For more accurate geographical locations refer to EMR's Map 900A.

GOLD PRICE 1985

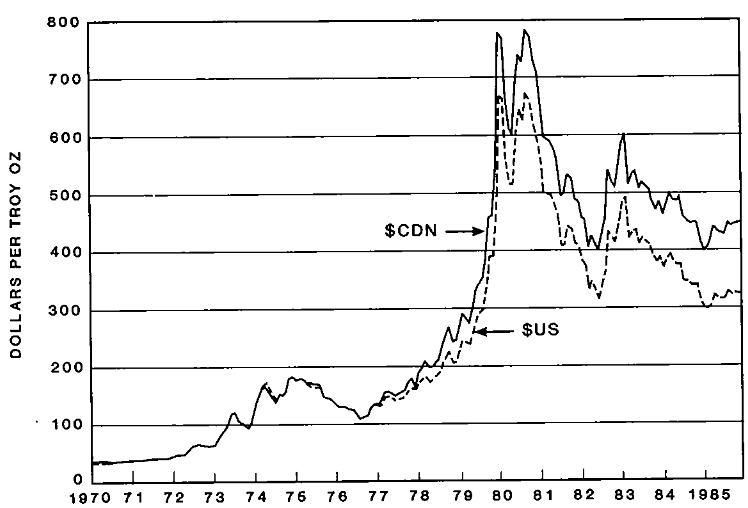
LONDON GOLD MARKET AM FIX



BASED ON DAILY PRICES

GOLD PRICES 1970 - 1985

MONTHLY AVERAGE LONDON AM FIX



Graphite

M. PRUD'HOMME

SUMMARY

Canadian production of graphite is carried out by only one operation, Asbury Graphite Quebec Inc. which mines and processes flake graphite ore at Notre-Dame-du-Laus, on an intermittent basis. Shipments in 1985 have increased slightly. Most of the shipments are for exports to the United States; the remainder is shipped locally to supply the domestic refractories industry and foundries.

Imports of crude graphite for the first nine months of 1985 were valued at $1,636,000, an increase of 17 per cent compared with the same period last year. The United States accounts for 90 per cent of total crude graphite imports which are mainly going into Ontario (76 per cent) and Quebec (15 per cent). Other supplying countries include Norway, Madagascar, West Germany, France and the United Kingdom.

During 1985, exploration and developments activities were quite intensive in Quebec and Ontario. Possible association of graphite and gold has spurred further investigation, especially in the Township of Laurier and of Maria, in eastern Ontario. Several companies have been promoting some development works and market researchs in order to become a new reliable source of supply for the graphite markets in the United States, Japan and western Europe.

For the last two years, prices of natural graphite have remained basically stable. Anticipated price increases for 1985 have been estimated at 5-8 per cent for large flake crystalline graphite only. Low growth for fine crystalline graphite has precluded any price increase. Supplies are still sufficient to satisfy increasing demand so prices should then remain basically stable for 1986.

With slow recovery in most metallurgy industries, graphite demand is expected to increase slightly. New producers would encounter problems in finding markets, especially for low-grade natural graphite powders. However, slow growth is expected with the development of new products requiring flake graphite for use in mag-carbon refractory brick, brake and clutch lining replacing asbestos. Expanded graphite has good potential for gasket and insulation applications.

NATURAL GRAPHITE

Graphite is a natural form of carbon. Natural graphite is a lustreous, black carbon mineral, crystallized in the hexagonal system with rhombohedral symmetry. Flake graphite is opaque, flexible and sectile, and exhibits perfect basal cleavage. Natural graphite is unctuous and is relatively soft with a hardness of 1 to 2 on Mohs' scale. It has a black colour and a black streak on glazed porcelain. Its specific gravity is 2.266 g/cm^3. Graphite is an excellent conductor of heat and electricity; and it has a high melting temperature of 3 000°C. It is extremely resistant to acid, chemically inert and highly refractory.

Natural graphite is widely distributed throughout the world and is of common occurrence in metamorphic rocks produced by regional or contact metamorphism. Amorphous graphite is a microcrystalline graphite formed by crystallization of the carbon from organic sediments such as coal. The graphite occurs as distorted seams of minute microcrystalline particles intermixed with ungraphitized materials. The graphite content may vary from 15 per cent to 98 per cent depending on the degree of metamorphism and the original carbon content in the sediments. Crystalline lump, or vein graphite, occurs in the form of massive vein or circular accumulation formed probably from hydrothermal origin. The graphite occurs along the contacts of intrusive rocks with limestones. Such occurrences appear in foliated or columnar forms. Crystalline flake graphite is found disseminated in metamorphosed siliceous or calcareous sediments such as marble, gneiss and schist.

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Commercially, natural graphite is classified as crystalline flake or amorphous graphite depending on its particle size. Crystalline flake is defined as thin flakes which could be classified from coarse to fine and which are graded according to their graphitic carbon content. Amorphous grade is applied to microcrystalline graphite sold for low-value uses such as foundry facings. It is graded on graphitic carbon content which may vary between 50 per cent and 90 per cent carbon.

Graphite is also termed as plumbago, black lead, silver lead, carburet of iron, potelot, crayon noir, carbo mineralis and reissblei.

Graphite is considered as a strategic mineral which is defined as a mineral that is largely or entirely supplied by a foreign source, that is difficult to substitute, and that is important to a nation's economy.

SITUATION IN CANADA

Production and Occurrences

Deposits of graphite have been recorded in eastern Canada and, though some have been worked, production has been essentially small and intermittent. The more important producing areas have been in the Township of Elmsley in Ontario, and in the Township of McGill in Quebec.

Ontario graphite production started in 1870 at the Port Elmsley deposit. In 1884, the Black Donald mine at Calabogie commenced operation until the exhaustion of its reserves in 1954. In Quebec, since 1950, there has been only two operations, although on the same deposit, near Notre-Dame-du-Laus. The graphite deposit has been initially mined by Graphex Mines Inc. which has been acquired by Asbury Carbons Inc. of New Jersey.

Since 1980, Asbury Graphite Quebec Inc. has been operating the crystalline flake open-pit mine. Graphite ore is a crystalline limestone associated with biotite quartzite. Graphite content could reach 20 per cent but is around 10 per cent on average. Reserves are estimated at 500 000 t.

Production rate at the nearby mill is 350 tpd of graphite ore and production schedule is 3 to 4 months per year. Asbury Graphite Quebec Inc. produces flaky graphite in three sizes: +40 mesh, -40 + 100 mesh and -100 mesh. These products are suitable for refractories and for foundry moulds. Most of its concentrates are shipped to Asbury Carbons Inc. in New Jersey, with some remaining shipments to Canadian Asbury Wilkinson Graphite and Foundry Supply Co. in Toronto.

In 1984, the processing plant was in operation during the summer and production was recorded at more than 175 per cent compared to 1983. This increase was necessary to raise stock levels in anticipation of shutdowns in 1985 for improvements of the mill.

In 1984, Orrwell Energy Corporation Ltd. was developing a graphite deposit near Mont-Laurier in Quebec. Some 2.7 million t of in situ crystalline-graphitic ore grading between 7-9 per cent C has been proven. Construction of a 1 300 tpy flotation plant was planned. The project has been suspended due to a legal conflict. However, in 1985, some exploration work has been done near this property.

Graphite deposits in Canada occur principally in rocks of the Grenville series of eastern Canada. The mineral is found in disseminated crystalline flake and vein forms. Most Canadian graphite deposits are associated with graphite gneiss and crystalline limestones which have been subjected to contact metamorphism associated with tectonic features such as folding, compression and fracturing, and with pegmatic intrusions. The richest ore zones occur as a succession of veins or lenticular bodies that gradually merge into the adjacent non-graphitic host rock, and that are bordered by lenses of lower grade ore.

Flake graphite deposits have been reported mainly in New Brunswick, Nova Scotia, Quebec, Ontario, and Saskatchewan.

In New Brunswick, graphite deposits found in limestone have been worked near Split Rock and Marble Cove in Lancaster Parish. The graphitic bands occur in argillites and sub-crystalline limestones and may vary from 0.3 to 3 metres (m) in thickness. Graphite is associated with pyrite.

In Nova Scotia, graphite occurrences were recorded in Cape Breton, in crystalline limestones, shales and slates which are intruded by granite. The largest occurrence is located near Glendale, Inverness County, where microcrystalline graphite occurs.

In Quebec, graphite deposits are located mainly along the Grenville series in several Townships: Buckingham, Argenteuil and Pontiac.

The disseminated flake graphite variety is dominant, in biotite gneiss and crystalline limestone associated with biotite quartzite, but the vein variety is also reported along the contact of intrusive rocks and crystalline limestone. Occurrences of graphite are associated with metasedimentary rocks which have been subjected to several deformation phases and where metamorphism has reached amphibolitic or granulitic phases.

In Ontario, graphite deposits occur within crystalline limestone and gneiss. The occurrences of major interests are in semi-pelitic and pelitic gneiss units within paragneiss sequences. Graphite is present in amounts up to 10 per cent and grain sizes may vary from 2 to 10 mm. Accessory minerals consist of biotite, garnet and pyrite; trace elements in these graphitic rocks are nickel, cobalt, boron, vanadium and also gold which has attracted sufficient attention to warrant further investigation.

In northern Saskatchewan, graphite ore in coarse grain biotite-gneiss occurs near the southwestern shore of Deep Bay near Reindeer Lake. The mineralized area is several miles long and contains about 10 per cent graphite carbon. Reserves are estimated at about 3 million t. Engineering feasibility studies were carried out by the Saskatchewan Mining Development Corporation and Superior Graphite Co. Ltd., of the United States. Plans for a 10 900 tpy flotation mill and open-pit operation were completed but economic considerations have precluded development for the last two years.

Exploration and Research

Since 1982, interest in graphite is at a high level with exploration work and research being conducted in several provinces, especially Quebec and Ontario.

In Quebec, geologists from the Department of Energy and Resources have carried out an airborne survey, and detailed cartography in four areas in the regions of Gatineau and Mont-Laurier. Exploration work has spurred since the release of this information, especially in the Townships of July, Argenteuil, Buckingham, Papineau, LaSalle and the Counties of Bouthillier, McGill, Lochaber, Cameron, Boyer, Hartwell, Mulgrave and Suffolk.

In Ontario, exploration activity was mainly carried out in the eastern region; however, some occurrences were recorded in northwestern Ontario near Wabigoon, Mulrie and Laval. In eastern Ontario, field evaluation programs on graphite properties have been done by geologists from the Department of Natural Resources. Exploration was concentrated in the Townships of Maria, Butt, Ryerson, North Burgess, Bedford, North Elmsley, Cardiff, Western Olden, Monmouth. The potential for gold associated with graphite led to further exploration work in Maria and Laurier Townships in the Algonquin Region.

Research and development on graphite products was carried out during 1983 and 1984 for the National Research Council of Canada at its Industrial Materials Research Institute in Boucherville, Quebec. Studies were made on the behaviour of Mag-carbon refractories under stress and on physical and chemical characterization of graphite-epoxy composites. Studies have also been conducted on surface-treatment of graphite electrodes for arc furnaces, and on non-destructive evaluation of advanced materials such as graphite-epoxy composites used in the aerospace industry.

The CANMET Extractive Metallurgy Laboratory in Ottawa is conducting a study on bacterial leaching for flakes liberation.

Le Centre de Recherche Minêrale in Quebec has worked on a concentration process for graphitic ores from Hartwell County and Mont-Laurier.

USES AND SPECIFICATIONS

The uses of natural graphite depend on its physical and chemical properties. The strength of graphite increases as its temperature rises. It has a high thermal conductivity and a low absorption coefficient for x-rays and electrons. Flake graphite enhances anisotropy in bodies where forming processes, such as extrusion and pressing, align the flakes. It resists oxidation better than granular graphite.

Flake graphite is used in the manufacture of crucible for the steel, nonferrous and precious metals industries. It is preferred to microcrystalline graphite because it burns more slowly, has a high attrition resistance and imparts structural strength through the orientation of the flakes. For this application, graphite must be of large flake size, above 150 microns, with a carbon content of 90 per cent, although finer flake size with a carbon content of 80 per cent is also used due to the current shift from clay-graphite crucible to silicon carbide-graphite crucible.

In ramming mixes, graphite imparts high refractoriness, low thermal expansion and high resistance at elevated temperature. Microcrystalline graphite of high purity, 80-90 per cent C, is required.

The emergence of magnesia-carbon brick in steel furnace linings, of alumina-carbon refractories in ladles and nozzles, and of silicon carbide-carbon refractories in blast furnaces has increased the demand for graphite as it improves resistance to thermal shocks and erosion. Large flake graphite, above 425 microns, is required with a carbon content over 85 per cent, and an ash content below 10 per cent. Impurities such as silica, alumina and iron are detrimental.

The use of graphite in brake linings reduces the wear rate. High carbon fine crystalline graphite, below 75 microns, is used with a minimum carbon content of 98 per cent, although a concentrate of 90 per cent can be used if abrasive impurities such as silica are at a low level.

Traditionally, graphite has been used in dry cell zinc-carbon batteries due to its electrical conductivity. Fine grain carbon, below 75 microns, or microcrystalline graphite with a minimum carbon content between 85-90 per cent is required. Alkaline batteries require a purer natural graphite with a carbon content of at least 98 per cent or a synthetic grade. Carbon material should be free of metallic impurities such as copper, cobalt or antimony.

Electric motor components use a wide variety of graphite, natural or synthetic. Powdered graphite, 150 microns, with a minimum carbon content of 95-99 per cent is used. Lump graphite, low-silica microcrystalline graphite and synthetic graphite are usually utilized.

In powder metallurgy where steel is reinforced by the absorption of carbon, high purity graphite is required for the sintering. It also acts as a lubricant and as a source of carbon. Dry powder graphite should be of an average particle size of 5 microns and must have a carbon content between 96-99 per cent.

Lubricants for industrial usage are also made from graphite because of its softness, low friction, inertness and heat resistance. High carbon fine crystalline graphite, below one micron, is specified with a carbon content of 96-99 per cent.

In paint manufacture, graphite is used to protect metal surfaces exposed to corrosive environment, and to eliminate the accumulation of static electricity in floor coating. Microcrystalline graphite of low carbon content, 50-55 per cent, is usually required.

In the manufacture of lead pencil, natural graphite is used because of its marking properties. The degree of hardness of a pencil is determined by the clay to graphite ratio of its lead. Microcrystalline graphite, 80-82 per cent, is used in the cheaper grades of leads. However, a finely ground graphite with a higher carbon content, over 90 per cent, is usually required.

For foundry application such as mould coating, graphite prevents the adhesion of metals. Foundry facings are usually made of lump graphite or microcrystalline graphite, between 53-75 microns, with a low carbon content, 40-70 per cent.

Iron foundries use microcrystalline graphite as a recarburiser for raising the carbon content of iron melted in electrical furnace from charges containing large proportions of scrap. A wide variety of material may serve as a substitute: synthetic graphite and coke.

Other uses for natural graphite include engineering components, mechanical seals, polishes, rubber products and explosives.

For any usage, consumers should require only minimal specifications necessary in their operation because of the prices of all types of graphite commercially available.

CANADIAN PRODUCTION AND TRADE

Canada does not produce microcrystalline graphite but produces small quantities of crystalline flake graphite. Asbury Graphite Quebec Inc. operates a plant located near Notre-Dame-du-Laus, Quebec on an intermittent basis.

In 1984, imports of crude graphite were from the United States ($1,788,000), West Germany ($138,000) and the Republic of China ($4,000), for a total value of $1,930,000. Shipments into Ontario accounted for 81 per cent of total imports, followed by Quebec with 14 per cent.

In 1985, for a nine-month period, crude graphite imports were valued at $1,636,000, an increase of 17 per cent, compared to the same period last year. Imports are mainly from the United States accounting for 90 per cent of total crude graphite imports. Other supplying countries are Norway, Madagascar, West Germany, France and the United Kingdom.

WORLD PRODUCTION AND REVIEW

In 1984, world production remained around 560 000 t for all types of natural graphite. China produced nearly 184 000 t followed by the U.S.S.R., 80 000 t; Czechoslovakia, 50 000 t; Austria, 43 790 t and Mexico, 41 500 t.

United States

U.S. consumption of natural graphite for 1984 was about 31 900 t, of which 20 900 t were microcrystalline grade mainly for use in foundries and steelmaking (27 per cent), brake linings (12 per cent), and lubricants (6 per cent). Refractories usage accounts for 25 per cent of consumption of natural graphite - all forms. In 1983, total consumption for natural graphite was 32 700 t; amorphous graphite consumption was near 22 500 t.

In 1984, U.S. imports increased by 34 per cent to 52 830 t. Shipments from Mexico, the largest supplier by volume, increased by 26 per cent to 25 275 t. Imports of crystalline flake graphite, the largest category by value, increased by 53 per cent to 9 725 t because of higher shipments from Canada and Brazil. China is a major supplier of crystalline flake accounting for 43 per cent of total United States flakes imports in 1984.

In the United States, only one amorphous graphite mine has been in operation since 1982. United Minerals Co. near Townsend, Montana, operates on an intermittent basis an open-pit mine of low-grade amorphous graphitic material, with an average of 25 per cent of fixed carbon, which is sold mostly to steel-related users. Reserves are estimated to be over 2 million t. Graphite Sales Inc. is the sales representative.

U.S. Graphite Inc. has purchased the Graphitar products line from Wickes Companies, Inc.; Dixon Ticonderoga Company closed its operations at Jersey City, New Jersey, and its crucible plant in Philadelphia, Pennsylvania; Superior Graphite Co. Ltd. bought a plant at Russelville in Arkansas from The Dow Chemical Company which was producing graphite electrodes.

China

A large deposit of graphite with an average carbon content of 12 per cent has been discovered in Luobei County. Reserves are estimated at 615 million t.

Czechoslovakia

A new flotation plant was built at Male Urbno to process ore, averaging 30-40 per cent graphite, from the Konstantin microcrystalline graphite mine.

France

Vesuvius Crucible Co. concluded a purchase agreement for a refractory plant to produce graphite-alumina refractories in northern France.

Italy

Societa Talco e Grafite Val Chisone S.p.A closed its microcrystalline graphite mine near Pinerolo.

Madagascar

La Société Minière de la Grande Ile (SMGI), Madagascar, has appointed F&S Alloys and Minerals Corp. of New York as sales representatives in North America.

INTERNATIONAL TRADE AND MARKET

Although graphite occurrences are widespread and many potentially important deposits are undeveloped, the international trade in graphite represents a relatively small market. Few countries supply natural graphite and production is usually limited to one major category. Small volumes of graphite are consumed by producers.

The principal natural graphite exporter is Mexico which is the major source of United States imports. Other major exporting countries are China, South Korea, North Korea, Austria, Madagascar, Norway and Brazil. Sri Lanka is still the leading supplier of crystalline vein graphite. The largest world importers are the United States and Japan, followed by West Germany, the United Kingdom and Poland.

Security and diversification of supplies is a concern for many consuming nations which are attempting to substitute different types of graphite and to locate new secure sources of supply. Political developments, exhaustion of reserves and operational problems are adversely affecting production in traditional producing and exporting countries. These realignments between users and suppliers present opportunities for potential new suppliers such as Canada.

However, new suppliers in the international trade will have to overcome market barriers such as traditional linkages between producers and suppliers and strong price competition.

Market in 1984

In 1984, demand for natural graphite has been adequately met by traditional and new producers as microcrystalline graphite was more freely available. Major suppliers were Mexico, Republic of China and South Korea. Small quantities of microcrystalline graphite continued to be produced at Townsend, Montana. Crystalline vein graphite is mainly produced in Sri Lanka. Supplies were more than sufficient to meet demand even though crystalline flake graphite is increasing its share of the market. Crystalline flake graphite suppliers are China, Madagascar and Brazil. Supplies are sufficient to meet all demand requirements which are very dependent upon growth in metallurgy industries. New grades of flake graphite have been developed for batteries, graphite foils and refractory bricks. China is supplying over one quarter of all world demand and has the potential to meet the total world's requirements for flake graphite; however, increasing domestic demand should limit export capacity until new production capacity is added. Demand for Madagascar flake graphite has increased especially in the United Kingdom.

PRICE

Published prices for natural graphite represent only a range of prices. Actual prices are negotiated between suppliers and consumers. The prices for flake graphite are higher than for microcrystalline graphite because of the nature of the mining and processing operations. The prices of flake graphite concentrates vary depending on its carbon content and the size of the flakes.

Prices have remained basically unchanged in 1984. Prices for microcrystalline graphite have been moderated by devaluation of the Mexican peso. Since January 1985, Norwegian prices have increased by 7 per cent, in line with the inflation index, and the Madagascar price increased by 10 per cent.

OUTLOOK

From a 1983 base, demand for natural graphite is expected to increase at an average annual rate of about 1.5 per cent through year 2000 from 573 200 t to 743 740 t. American consumption of crystalline flake graphite is forecast at 26 300 t in the year 2000, and nearly 30 800 t for microcrystalline graphite, by the U.S. Bureau of Mines. Demand for natural graphite will be limited by technological shifts to the use of plasma arc furnace and by the availability of alternative materials. Anticipated declines in demand for microcrystalline will be slightly offset by growth in crystalline flake usage.

Significant growth, 3.5-3.9 per cent, is anticipated for carbon-related refractories products such as mixes, bricks and shapes, crucibles, nozzles and parts. However, lower demand for crucible will slightly offset the growth in graphite consumption in continuous casting. Demand in steelmaking will remain steady because of strong price competition from alternative materials. A slight growth of 1.1 per cent is forecast for batteries and pencils; increasing markets will be controlled by competition from substitutes and by new technologies. Demand for graphite in brake linings will be increasing as an alternative to asbestos-related products. In foundries, demand is expected to decline due to heavy competition from lower-priced substitutes such as coal and coke.

North America will remain largely dependent on foreign sources for graphite. No shortage of graphite is foreseen as world resources of natural graphite appear unlimited. However, the availability of the low-cost, high-grade graphite could be affected by the policies of foreign governments in supplying countries. Should this happen development of alternative sources of high-grade graphite will likely occur in order to secure industry, especially in Japan and the United States which will still have to rely on imports for coarse crystalline flake graphite.

PRICES

Representative year-end graphite prices[1], fob, $US per short ton

	1982	1983	1984
Flake and crystalline graphite, bags			
China	272 - 1,542	54 - 1,542	54 - 1,542
Germany, West	318 - 2,722	318 - 3,175	286 - 3,084
Madagascar	249 - 726	227 - 544	227 - 726
Norway	272 - 816	181 - 635	181 - 816
Sri Lanka	544 - 1,816	499 - 1,367	272 - 1,367

Amorphous, nonflake, microcrystalline graphite (80%-85% carbon)

	1982	1983	1984
Korea, South (bags)	82 - 109	82 - 109	82 - 109
Mexico (bulk)	77 - 109	64 - 91	64 - 109

"Industrial Minerals"[2] pricing quotation, cif, U.K. port, $US per tonne

	1985
Crystalline lump, 92-99% C	550 - 1,100
Crystalline large flake, 85-90% C	630 - 1,000
Crystalline medium flake, 85-90% C	490 - 860
Crystalline small flake, 80-95% C	300 - 800
Powder (200 mesh), 80-85% C	250 - 275
90-92% C	410 - 460
95-97% C	550 - 750
97-99% C	750 - £1,000
Amorphous powder, 80-85% C	175 - 350

"Chemical Marketing Reporter"[3], fob, bags, $US per pound

	1984	1985
Crystalline, powder, 88-90%	.30 - .60	.30 - .60
90-92%	.40 - .75	.40 - .75
95-96%	.60 - .90	.60 - .90
97% and up	.80 - 1.20	.80 - 1.20
Flake, No. 1, 90-95%	.65 - .75	.65 - .75
No. 2, 90-95%	.65 - .75	.65 - .75
Amorphous, powder	.16 - .40	.16 - .40
powder, 97% and up	.80 - 1.20	.80 - 1.20

[1] U.S. Bureau of Mines, quoted from Engineering and Mining Journal. [2] IM, November 1985.
[3] CMR, December, 1985.
fob Free on board; cif Cost, insurance and freight.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
31300-1	Plumbago, not ground or otherwise manufactured	free	free	10	free
31400-1	Plumbago, ground, and manufactures of, nop, and foundry facings of all kinds	10.7	10.7	25	7
31400-2	Plumbago flakes	4.3	4.3	25	2.5
31405-1	Graphite blocks exceeding forty inches in diameter and fifteen inches in thickness for use in the manufacture of moulds for castings wheels for railway vehicles, including locomotives and tenders	free	5	25	free
31500-1	Carbons or carbon electrodes over three inches in circumference or outside measurement and not exceeding thirty-five inches in circumference or outside measurement; carbons of a class or kind not produced in Canada, when imported for use in the manufacture of dry batteries and dry cells	free	free	free	free
31505-1	Carbons or carbon electrodes exceeding thirty-five inches in circumference or outside measurement	free	16.3	20	free
31600-1	Electric light and arc carbons pointed or not, and contact carbons, nop	13.5	13.5	35	9

MFN Reductions under GATT (effective January 1 of year given)	1985	1986	1987
		(%)	
31400-1	10.7	9.9	9.2
31400-2	4.3	4.1	4.0
31505-1	16.3	15.6	15.0
31600-1	13.5	12.4	11.3

		Most Favoured Nation 1985	Most Favoured Nation 1987	Non-MFN 1985
UNITED STATES				
517.21	Crystalline flake flake dust), valued not over 5.5¢/lb.	4.1% ad val	3% ad val	1.65¢/lb

TARIFFS (cont'd)

Item No.		Most Favoured Nation 1985	Most Favoured Nation 1987	Non-MFN 1985
UNITED STATES (cont'd)				
517.24	Crystalline flake (not including flake dust), valued over 5.5¢/lb.	0.3¢lb	0.3¢/lb	1.65¢/lb
517.27	Lump and chip	free	free	30% ad val
517.31	Other	free	free	10% ad val
517.61	Electrodes, in part of carbon or graphite, for electric furnace or electrolytic purposes	3.3% ad val	2.47% ad val	45% ad val
517.71	Carbons and electrodes for producing electric arc light, under 0.5 inch in diameter	3.9% ad val	2.8% ad val	60% ad val
517.74	Carbons and electrodes, for producing electric arc light, 0.5 inch or more in diameter	3.3% ad val	2.4% ad val	45% ad val
517.81	Brushes for electric motor, and other forms for manufacturing brushes	4% ad val	3.7% ad val	45% ad val
517.91	Articles not specially provided for, of carbon or graphite	5.6% ad val	4.9% ad val	45% ad val

Sources: The Customs Tariff, (1985), Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610.

TABLE 1. IMPORTS OF CRUDE GRAPHITE AND GRAPHITE RELATED PRODUCTS INTO CANADA 1979-85

	1979		1980		1981		1982		1983		1984		Jan.- Sept. 1985P	
	tonnes	$000	tonnes	$000	tonnes	$000	tonnes	$000	tonnes	$000	tonnes	$000	tonnes	$000
Graphite, crude														
United States	..	1,446	..	1,012	..	1,261	..	1,589	..	1,505	..	1,788	..	1,460
West Germany	..	118	..	9	..	8	..	12	..	30	..	138	..	54
Mexico	..	95	..	90	..	178	..	134	..	116	..	0	..	0
Sri Lanka	..	0	..	0	..	0	..	0	..	23	..	0	..	0
United Kingdom	..	0	..	0	..	0	..	2	..	1	..	0	..	0
Other countries	..	52	..	184	..	142	..	114	..	0	..	4	..	122
Total	..	1,711	..	1,295	..	1,589	..	1,851	..	1,675	..	1,930	..	1,636
Graphite and carbon brush stock														
United States	131	1,228	92	944	84	1,001	87	1,307	69	1,025	61	1,296	99	1,616
West Germany	1	12	2	26	2	25	1	20	1	29	..	0	1	10
Other countries	3	24	2	23	4	53	5	62	2	51	1	6	4	36
Total	135	1,264	96	993	90	1,079	93	1,389	72	1,105	62	1,302	104	1,662
Graphite electrodes														
United States	4 521	8,582	3 491	8,351	2 090	5,413	1 645	5,443	1 770	5,316	3 981	10,141	2 059	6,025
Japan	879	2,160	366	1,165	686	2,398	1 288	4,129	1 074	3,233	2 545	6,269	1 530	4,374
Other countries	317	620	226	327	270	821	233	581	70	212	670	1,702	23	741
Total	5 717	11,362	4 083	9,843	3 046	8,632	3 166	10,153	2 914	8,761	7 196	18,112	3 912	11,140
Carbon or carbon electrodes, nes														
United States	7 659	8,111	8 926	12,054	11 337	10,608	980	2,390	1 408	4,233	7 321	7,538	41 417	29,108
Italy	1 866	2,110	1 914	2,600	2 650	4,700	1 598	2,693	2 517	4,390	2 186	3,566	1 378	2,428
Japan	1 296	1,897	813	1,772	377	1,138	913	3,069	469	1,320	861	2,652	310	1,072
United Kingdom	5	39	886	2,196	265	727	15	71	38	89	67	141	4	47
Other countries	561	683	648	310	403	599	1 286	807	1 146	1,390	2 322	3,147	1 762	2,590
Total	11 387	12,840	13 187	18,932	15 032	17,772	4 792	9,030	5 578	11,422	12 757	17,044	44 871	35,245
Graphite and carbon crucibles														
United States	..	809	..	915	..	759	..	807	..	522	..	865	..	983
United Kingdom	..	556	..	766	..	431	..	322	..	455	..	487	..	10
France	..	41	..	86	..	41	..	71	..	145	..	177	..	65
Other countries	..	10	..	60	..	103	..	34	..	10	..	20	..	4
Total	..	1,416	..	1,827	..	1,334	..	1,234	..	1,120	..	1,549	..	1,062
Graphite and carbon refractories, nes														
United States	..	2,871	..	3,968	..	4,349	..	1,694	..	1,414	..	1,579	..	990
United Kingdom	..	10	..	80	..	67	..	478	..	6	..	317	..	84
Japan	..	93	..	571	..	73	..	329	..	44	..	282	..	555
West Germany	..	53	..	629	..	19	..	81	..	438	..	5	..	4
Other countries	..	0	..	3	..	23	..	0	..	0	..	0	..	42
Total	..	3,027	..	5,251	..	4,531	..	2,582	..	1,902	..	2,953	..	1,675
Graphite and carbon basic products, nes														
United States	..	5,391	..	8,986	..	8,570	..	5,501	..	7,618	..	14,480	..	12,790
Japan	..	914	..	4,625	..	4,854	..	11,124	..	457	..	906	..	581
Other countries	..	536	..	584	..	629	..	1,331	..	1,121	..	1,727	..	6,378
Total	..	6,841	..	14,195	..	14,053	..	17,956	..	9,196	..	17,113	..	19,653

Source: Statistics Canada.
P Preliminary; .. Not available; nes Not elsewhere specified.

TABLE 2. END-USES OF GRAPHITE SUBSTITUTES AND NATURAL GRAPHITE

Product	Manufacturing Goods	Industrial Sector
Activated Carbons (oxidized organic materials)	Absorbants Decolorizers Purifiers Solvents	Automobiles, chemicals Food Water treatments Chemicals
Amorphous carbon (petroleum coke)	Anode, electrode	Alumina, aluminum Calcium carbide Ferrosilicon, ferromanganese and ferrochromium
	Carbon bricks, inner carbon lining, crucibles and retorts	Alumina smelters Blast furnace Foundry cupolas
	Sealing rings, bushings, washings and wear rings	Pump, turbine, motor nuclear reactors, mechanical engineering
	Carbon arc lighting and flame arc	Light therapy, photo-engraving, irradiation, graphic art
Carbon and graphite fibres (pyrolized organic fibres, pitch)	reinforcing fibers	Aircraft, aerospace, sporting goods, automobile, textile, medical and musical equipment
Carbon black-soot	Pigments Synthetic rubber	Ink, paints, plastics, paper Motor vehicles tires
Manufacturing Graphite (baked carbon)	Anode Electrode	Chlor-alkalies Electric arc furnaces (steel) spectroscopy
	Moderators, reflectors and thermally stable components	Aerospace vehicles, nuclear reactors
	Motor brushes	Electrical motors
Natural Graphite (microcrystalline, flake, vein)	Carbon raiser Carbonaceous additives and refractories Pencils	Steelmaking Foundries Metallurgy industries
	Dry batteries cells Lubricants Brake linings	Electronic industries Mechanical engineering Automobile

TABLE 3. GRAPHITE, WORLD PRODUCTION, ALL TYPES, 1980-84

Country	1980	1981	1982	1983	1984[e]	Type of Graphite
			(tonnes)			
China[e]	160 000	184 000	184 000	184 000	184 000	flakes, microcrystalline
U.S.S.R.[e]	80 000	70 000	70 000	75 000	80 000	flakes, microcrystalline
Czechoslovakia[e]	50 000	50 000	50 000	50 000	50 000	microcrystalline
Austria	36 690	23 800	24 450	40 420	43 790	microcrystalline
Mexico	44 500	41 130	34 360	34 010	40 000	microcrystalline
(Mexico)	350	1 150	1 800	1 500	1 500	flakes
India	54 960	72 790	52 360	35 010	36 000	flakes, run of mill
South Korea	59 140	34 040	36 330	30 020	30 000	microcrystalline
(South Korea)	1 430	840	630	800	600	flakes
North Korea[e]	25 400	25 400	25 400	25 400	25 400	microcrystalline
Brazil	21 290	17 500	15 410	16 500	20 000	flakes
Madagascar	12 250	13 330	15 350	13 550	13 550	flakes
West Germany	11 000	10 000	10 000	11 800	9 000	flakes
Sri Lanka	7 790	7 570	8 800	8 000	9 000	crystalline vein
Zimbabwe	7 380	11 220	8 220	8 000	8 000	microcrystalline
Norway	10 400	8 660	7 440	8 060	7 600	flakes
Others	16 380	4 270	22 030	8 280	3 890	all types
Total	598 960	575 700	556 530	550 350	562 330	

[e] Estimated.

TABLE 4. WORLD, NATURAL GRAPHITE, MAJOR TRADE FOR SELECTED COUNTRIES, 1983-84

Exporting Countries	Importing Countries: Austria	Germany, W. (11 months)	Japan	United Kingdom	United States	Total Exports
			(tonnes)			
1984						
Brazil	-	-	51	-	2 463	..
China	-	8 575	39 254	5 566	13 815	..
Germany, W.	-	n.a.	29	-	780	..
Italy	4 112	-	-	-	-	..
Korea, N.	-	-	11 026	-	-	..
Korea, S.	-	-	30 829	-	-	..
Madagascar	-	-	972	5 310	2 722	11 000
Mexico	-	-	-	-	25 273	-
Norway	-	1 825	-	5 077	-	8 900
Sri Lanka	-	-	1 719	2 000	809	7 000
Other	1 963	17 204	1 129	1 586	6 964	..
Total	6 075	27 604	85 009	19 539	52 826	n.a.
1983						
Brazil	770	-	910	530	2 802	4 700
China	-	6 700	27 769	4 759	9 203	50 700
Germany, W.	-	n.a.	21	927	760	8 430
Italy	1 221	140	-	-	-	2 740
Korea, N.	-	-	1 400	-	-	..
Korea, S.	-	-	20 717	-	-	32 694
Madagascar	-	1 790	1 197	4 729	-	-
Mexico	-	-	-	-	20 066	20 180
Norway	-	2 640	-	4 049	51	7 311
Sri Lanka	-	140	917	790	681	5 000
Other	1 747	16 180	1 264	840	3 110	..
Total	3 738	27 590	54 195	16 624	39 533	n.a.

- No trade reported; n.a. Not applicable; .. Data not available.

TABLE 5. CONSUMPTION OF NATURAL GRAPHITE IN CANADA, 1976-1984

	1976	1977	1978	1979	1980	1981	1982	1983	1984P
Consumption unmanufactured natural graphite									
Foundry facing	3,677	3,060	2,234	2,800	3,078	3,850	1,476	4,309	5,297
Metallurgical	239	460	55	505	468	556	2,835	3,710	4,725
Refractories	709	667	1,024	477	583	497	10,155	515	761
Batteries	123	81	68	31	10	67	138	178	216
Other[1]	760	769	771	1,967	1,778	1,602	949	901	1,604
Total	5,508	5,037	4,152	5,780	5,917	6,572	15,553	9,613	12,603

Source: Energy, Mines and Resources Canada.
[1] Included brake linings, chemicals, abrasives, rubber and other end uses.
P Preliminary.

Gypsum and Anhydrite

D.H. STONEHOUSE

SUMMARY 1985

The strong demand for gypsum wallboard by the building construction industry in the United States continued through 1985. In support of this demand exports of crude gypsum, particularly from producers in Atlantic Canada, were close to the record level reached in 1984. Exports of gypsum wallboard to the United States also reached record amounts in 1984 at nearly 72 million square metres but fell in 1985 principally because of production and shipping difficulties resulting from a 4-month strike at the Caldonia, Ontario mine and wallboard plant of Domtar Inc. Canadian demand for wallboard increased during the year as the building construction industry began to show signs of limited recovery, particularly in eastern Canada. Housing starts in 1984 were at the second lowest level since 1966 but should show significant improvement in 1985. Gypsum wallboard imports were up greatly in 1985 compensating for reduced Canadian production during four critical months of the building season. Spot shortages, at retail outlets, and to contract builders, were not uncommon during the year and prices increased accordingly.

During 1985 Domtar Inc. acquired the gypsum wallboard manufacturing facilities of Genstar Gypsum Limited at Edmonton and Saskatoon. The company supplies at least part of the gypsum requirements of the Edmonton plant as well as those of its Calgary plant from its new open-pit quarrying operation at Lussier River, British Columbia. Genstar Gypsum's third western Canada wallboard plant, at Vancouver, was taken over in June, 1985 by Westroc Industries Limited, which had announced previously that its own Vancouver plant would be closed. Westroc intends to make production and warehousing improvements to enable greater penetration of developing export markets.

Canadian Gypsum Company, Limited installed an electric board-drying unit at its Montreal wallboard plant during 1985. The supply and cost of paper to a wallboard plant are critical factors in its successful operation. Canadian Gypsum is considering developing a paper mill at its Joliette plant to supply board paper.

CANADIAN DEVELOPMENTS

Gypsum production in Canada is in direct response to demand from the wallboard industries in Canada and the United States, which in turn satisfy demand from the building construction sector for residential, institutional and commercial construction projects. The fire retardant qualities of gypsum wallboard have encouraged its greater application in the non-residential area in recent years. This, together with increasing amounts used in renovation of older buildings, has made housing starts a less-than-accurate indicator of wallboard demand.

The portland cement industry uses as much as 5 per cent by weight of gypsum intimately ground with cement clinker to act as a set inhibitor. This could amount to nearly 0.5 million tpy in Canada.

Canadian production of crude gypsum is mainly from Atlantic Canada where major deposits, principally in Nova Scotia and Newfoundland, have been worked for many years by Canadian subsidiaries of United States gypsum products producers. The region accounts for over 75 per cent of Canadian gypsum production and for the major portion of exported gypsum which usually is about 70 per cent of total production but which was 80 per cent of production in 1984. Shipments are made from quarries in the Atlantic region to wallboard plants and portland cement plants in Quebec and Ontario. New Brunswick production is used locally by a cement

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producer. Ontario production is used on-site except that from the Westroc Industries Limited mine at Drumbo which is shipped to its Mississauga wallboard plant. Manitoba production, and output from Windermere, Lussier River and Falkland in British Columbia, supply the prairie markets and most of the British Columbia markets. Imports from Mexico and the United States are used by both wallboard and cement producers in British Columbia.

Because gypsum is a relatively low-cost, high-bulk mineral commodity it is generally produced from deposits situated as conveniently as possible to areas in which markets for gypsum products exist. Exceptions occur if deposits of unusually high quality are available, even at some distance from markets, if comparatively easy and inexpensive mining methods are applicable, or if low-cost, high-bulk shipping facilities are accessible. Nova Scotia and Newfoundland deposits meet all three of these criteria and have been operated for many years by, and for, United States companies in preference to some known but unexploited United States deposits. Imports of gypsum to Canada and the United States from Mexico have been made possible because these criteria have been met and recently, with high demand, good prices, low production costs and competitive shipping arrangements, gypsum from Spain has been back-hauled to United States ports.

In Canada occurrences besides those currently being exploited are known in the southwest lowlands, west of the Long Range Mountains in Newfoundland; throughout the central and northern mainland of Nova Scotia as well as on Cape Breton Island; in the southeastern counties of New Brunswick; on the Magdalen Islands of Quebec; in the Moose River, James Bay and southwestern regions of Ontario; 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, at Canal Flats, and Loos 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.

WORLD DEVELOPMENTS AND TRADE

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 extremely large and are conservatively estimated at over 2 billion t. After the United States, Canada is the world's second largest producer of natural gypsum. Together they produce about 24 per cent of world output.

Gypsum products, particularly wallboard, have limited market range because of high unit weight, friability, high transportation costs and relatively low unit values. These factors generally dictate that markets are supplied from the closest producer. There are exceptions, however, and gypsum wallboard has been shipped not only between the United States and Canada over rather surprisingly great distances but shiploads of wallboard have been received at United States southeast ports from European producers. The Canada-United States trade is usually in truckload lots of 20 to 25 t for delivery to warehousing or to job sites. However, with recent high demand requiring shipments beyond the economic limits of trucking facilities, shipments by rail have become common.

USES

Gypsum is a hydrous calcium sulphate ($CaSO_4.2H_2O$) which, when calcined at temperatures ranging from 120° to 205°C, 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, an 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 unwinding rolls of absorbent paper, the result is a continuous "sandwich" of wet board. As the stucco hardens, the board is cut to predetermined lengths, dried, bundled and stacked for shipment.

Grinding, calcining and drying are the main energy-using steps in the manufacture of gypsum wallboard. In the interests of energy conservation and process cost reduction in general, significant savings have been achieved by recycling heat from calcining kettles for use in preheating and in board drying. One-step grinding and calcining as an alternative to either the batch kettle or the continuous kettle has been adopted by one producer. There is also a trend towards using less calcined gypsum in board while using greater amounts of foam and more effective dispersing agents to obtain a lighter-weight unit with equal or greater strength.

Keene's cement is made by converting crushed gypsum to insoluble anhydrite by calcining at temperatures as high as 700°C, usually in rotary kilns. The ground calcine, mixed with a set accelerator, produces a harder and stronger plaster product than ordinary gypsum plaster.

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 salt cake in glass manufacture and as a soil conditioner.

Byproduct gypsum, produced from the acidulation of phosphate rock in phosphate fertilizer manufacture, has not been utilized in Canada despite available technology from European countries and from Japan. In these countries, byproduct gypsum is used in the manufacture of gypsum products, by cement manufacturing plants, and also for soil stabilization. Recent experiments in France have produced paper with a 20 per cent phosphogypsum content as filler. Studies have indicated that a potential radiation hazard exists in the use of phosphogypsum produced from sedimentary phosphate rock which can contain significant quantities of uranium and radium. Fluorogypsum is a byproduct of the manufacture of hydrofluoric acid. Cooperative research programs have been conducted to determine the suitability of using waste fluorogypsum from Allied Chemical Canada, Ltd.'s, Amherstburg, Ontario plant at St. Lawrence Cement Inc.'s Clarkson, Ontario cement plant.

The use of lime or limestone to desulphurize stack gases from utility or industrial plants burning high-sulphur fuel will also result in production of large amounts of waste gypsum in the form of a sludge which will present disposal problems if profitable uses are not developed.

Canadian Standards Association (CSA) Standards A 82.20 and A 82.35 relate to gypsum and gypsum products.

OUTLOOK

Canada's economic recovery has lagged uncommonly far behind recovery in the United States since 1982. The construction industry in the United States became very active following the 1980-81 recession and demand for the materials of construction presented opportunities for Canadian producer-exporters of cement, clinker, gypsum and gypsum wallboard. Canadian business investment remained low and construction expenditures, particularly in engineering projects actually decreased. Housing starts dropped to 125,860 in 1982, rebounded to 162,645 in 1983, dropped again in 1984 to 134,900 and will be in the range of 150,000 in 1985. Residential, commercial and institutional building construction have been more active, accounting for steady but slow increases in the building construction sector as a whole. A few indicators provide a positive outlook for the building construction sector: housing starts are increasing, inflation is relatively low, and the unemployment rate is falling. However, direct spending on construction could be tempered by increased taxes on building materials and by government spending cuts. On a regional basis the construction outlook is fairly good in eastern Canada but less encouraging in the western region where the effects of depressed world oil prices will likely mean less investment.

The Canadian Construction Association is predicting increases in the non-residential contract construction industry constant dollar expenditures of 4.5 per cent through 1986 to 1995 based upon the influences of the Western Accord and the May 1985 budget. The construction industry as a whole has expressed concern that Canada's large infrastructure network needs attention, leading to major renovation and upkeep projects similar to those begun on the United States highway system. Such a program would permit the construction industry and that portion of the mining industry which depends on it to plan five to ten years ahead with obvious benefits in efficiency, rather than to invest with short-term survival as the main incentive. Construction of homes, apartments, schools and offices will continue in the building construction sector 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 its low price, ease of installation and well-recognized insulating and fire-retarding properties. The 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 to supply at least some of the unusually high demand from the United States.

ANHYDRITE

Production and trade statistics for anhydrite are included with gypsum statistics. Anhydrite is produced 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 1984**, production of anhydrite in that year was 176 529 t. 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

Item No.		British Preferential	Most Favoured Nation		General	General Preferential
			(%)			
CANADA						
29200-1	Gypsum, crude	free	free		free	free
29300-1	Plaster of paris, or gypsum, calcined, and prepared wall plaster, weight of package to be included in weight for duty; per hundred pounds	free	4.5¢		12.5¢	free
29400-1	Gypsum, ground, not calcined	free	free		15	free
28410-1	Gypsum tile	10.7	10.7		25	7.0
19200-7	Gypsum wallboard	10.9	10.9		35	free
	on and after January 1, 1986	10.1	10.1		35	free
	on and after January 1, 1987	9.4	9.4		35	free
MFN Reductions under GATT (effective January 1 of year given)			1985	1986	1987	
29300-1			4.5¢	4.3¢	4.0¢	
28410-1			10.7%	9.9%	9.2%	
UNITED STATES (MFN)						
512.21	Gypsum crude		free			
			1985	1986	1987	
512.24	Gypsum, ground calcined, per ton		46¢	44¢	42¢	
245.70	Gypsum or plaster building boards and lath, ad valorem		3.3%	2.9%	2.5%	

Sources: The Customs Tariff, 1985, Revenue Canada, Custom and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register, Vol. 44, No. 241.

TABLE 1. CANADA, GYPSUM PRODUCTION AND TRADE, 1983-85

	1983		1984		1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production (shipments)						
Crude gypsum						
Nova Scotia	5 397 000	37,064	5 476 643	38,373	6 281 417	52,216
Ontario	907 000	11,354	1 183 193	12,716	1 046 631	15,823
British Columbia	460 000	4,917	411 829	4,076	377 772	4,340
Newfoundland	553 000	3,731	530 761	4,549	450 000	5,337
Manitoba	190 000	2,231	172 656	1,848	227 718	2,605
Total[1]	7 507 000	59,297	7 775 082	61,562	8 383 538	80,321
					(Jan.-Sept.)	
Imports						
Crude gypsum						
Spain	-	-	83 914	2,876	10 839	362
Mexico	97 444	2,949	43 449	1,385	65 270	2,162
United States	3 479	128	4 357	110	13 582	412
Hong Kong	16	1	89	3	57	2
Total	100 939	3,078	131 809	4,374	89 748	2,937
Plaster of paris and wall plaster						
United States	24 717	4,630	21 383	4,529	19 386	4,609
France	-	-	20	4	-	-
United Kingdom	-	-	6	2	-	-
Italy	-	-	4	2	-	-
Other countries	11	3	12	1	5	2
Total	24 728	4,633	21 427	4,538	19 391	4,611
	(square metres)		(square metres)		(square metres)	
Gypsum lath, wall-board and basic products						
United States	485 614	722	276 466	649	1 298 573	2,047
Other countries	5 942	8	-	-	14 238	40
Total	491 556	730	276 466	649	1 312 811	2,087
Total imports gypsum and gypsum products		8,441		9,561		9,635
	(tonnes)		(tonnes)		(tonnes)	
Exports						
Crude gypsum						
United States	5 186 529	33,331	6 195 225	48,579	4 349 531	36,334
Other	503	6	29 349	217	12 416	78
Total	5 187 032	33,337	6 224 574	48,796	4 361 947	36,412
	(square metres)		(square metres)		(square metres)	
Gypsum lath, wallboard and basic products						
United States	25 836 909	28,435	71 692 814	104,978	33 645 225	62,708
Saudi Arabia	195 192	189	171 165	341	44 592	121
Algeria	45 970	65	140 050	230	51 971	68
Bermuda	154 418	485	60 853	189	50 091	74
Other countries	247 445	345	218 724	366	290 569	640
Total	26 479 934	29,519	72 283 606	106,104	34 082 448	63,611
Total exports of gypsum and gypsum products		62,856		154,900		100,023

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Totals do not include gypsum produced by or shipped for use by Canadian portland cement producers.
P Preliminary; - Nil; N.B. Totals may not add due to rounding.

TABLE 2. CANADA, GYPSUM MINING AND GYPSUM PRODUCTS MANUFACTURING OPERATIONS, 1985

Company	Location	Operation
Newfoundland		
Flintkote Holdings Limited	Flat Bay	Open-pit mining of gypsum
Atlantic Gypsum Limited	Corner Brook	Wallboard manufacture
Nova Scotia		
Domtar Inc.	McKay Settlement	Open-pit mining of gypsum by contract
	Windsor	Plaster and "Gypcrete" manufacture
Fundy Gypsum Company Limited	Wentworth and Miller Creek	Open-pit mining of gypsum and anhydrite
Georgia-Pacific Corporation	River Denys	Open-pit mining of gypsum
Little Narrows Gypsum Company Limited	Little Narrows	Open-pit mining of gypsum and anhydrite
National Gypsum (Canada) Ltd.	Milford	Open-pit mining of gypsum
New Brunswick		
Canada Cement Lafarge Ltd.	Havelock	Open-pit mining of gypsum for cement manufacture
Quebec		
Canadian Gypsum Company, Limited	Montreal	Wallboard manufacture
	St-Jerome	Wallboard manufacture - closed mid-1982, reopened early-1984
Domtar Inc.	Montreal	Wallboard plant now used only as distribution terminal
Westroc Industries Limited	Ste. Catherine d'Alexandrie	Wallboard manufacture
Ontario		
Canadian Gypsum Company, Limited	Hagersville	Underground mining and wallboard manufacture
Domtar Inc.	Caledonia	Underground mining and wallboard manufacture
Westroc Industries Limited	Drumbo	Underground mining
	Clarkson	Wallboard manufacture
Manitoba		
Domtar Inc.	Gypsumville	Open-pit mining
	Winnipeg	Wallboard manufacture
Westroc Industries Limited	Amaranth	Open-pit mining
	Winnipeg	Wallboard manufacture
Saskatchewan		
Domtar Inc.	Saskatoon[1]	Wallboard manufacture
Alberta		
Domtar Inc.	Calgary	Wallboard and "Gypcrete" manufacture
	Edmonton[1]	Wallboard manufacture
Westroc Industries Limited	Calgary	Wallboard manufacture
British Columbia		
Domtar Inc.	Lussier River	Open-pit mining
	Vancouver	Gypsum products manufacture
Westroc Industries Limited	Vancouver[2]	Gypsum products manufacture
	Windermere	Open-pit mining
	Vancouver[3]	Gypsum products manufacture

[1] Genstar plants in Saskatoon and Edmonton acquired by Domtar Inc. in June 1985. [2] Genstar plant in Vancouver acquired by Westroc Industries Limited in June 1985. [3] Westroc Industries Limited Vancouver plant closed in June 1985.

TABLE 3. CANADA, GYPSUM PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975, 1979-84

	Production[1]	Imports[2]	Exports[3]	Apparent Consumption[3]
		(tonnes)		
1970	5 732 068	35 271	4 402 843	1 364 496
1975	5 719 451	55 338	3 691 676	2 083 113
1979	8 098 166	152 953	5 474 765	2 776 354
1980	7 336 000	154 717	4 960 240	2 530 477
1981	7 025 000	143 500	5 094 873	2 073 627
1982	5 987 000	93 843	4 775 755	1 305 088
1983	7 507 000	100 939	5 187 032	2 420 907
1984	7 775 082	131 809	6 224 574	1 682 317

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments, crude gypsum. [2] Includes crude and ground, but not calcined.
[3] Production, plus imports, minus exports.

TABLE 4. CANADA, HOUSE CONSTRUCTION, BY PROVINCE, 1983 AND 1984

	Starts			Completions			Under Construction		
	1983	1984	% Diff.	1983	1984	% Diff.	1983	1984	% Diff.
Newfoundland	3,281	2,720	-17.1	3,176	3,134	-1.3	3,494	3,000	-14.1
Prince Edward Island	673	643	-4.4	548	581	5.7	316	379	19.9
Nova Scotia	5,697	4,598	-19.3	5,069	5,082	0.3	2,984	2,466	-17.4
New Brunswick	4,742	2,873	-39.4	3,487	3,923	12.5	2,346	1,242	-47.1
Total (Atlantic Provinces)	14,393	10,834	-24.7	12,280	12,720	3.6	9,140	7,087	-22.5
Quebec	40,318	41,902	3.9	35,681	43,410	21.7	18,320	16,309	-11.0
Ontario	54,939	48,171	-12.3	55,287	54,642	-1.2	30,243	23,529	-22.2
Manitoba	5,985	5,308	-11.3	4,076	5,865	43.9	3,048	2,474	-18.8
Saskatchewan	7,269	5,221	-28.2	8,090	5,722	-29.3	3,667	3,187	-13.1
Alberta	17,134	7,295	-57.4	24,693	12,057	-51.2	8,336	2,943	-64.7
Total (Prairie Provinces)	30,388	17,824	-41.3	36,859	23,644	-35.9	15,051	8,604	-42.8
British Columbia	22,607	16,169	-28.5	22,901	18,596	-18.8	12,176	8,370	-31.3
Total Canada	162,645	134,900	-17.1	163,008	153,012	-6.1	84,930	63,899	-24.8

Source: Canada Mortgage and Housing Corporation.

TABLE 5. CANADA, VALUE OF CONSTRUCTION[1] BY TYPE, 1983-85

	1983	1984	1985
		($ millions)	
Building Construction			
Residential	16,851	16,497	16,912
Industrial	2,450	2,707	2,967
Commercial	6,482	7,034	7,374
Institutional	3,065	3,028	3,186
Other building	1,905	2,068	2,143
Total	30,753	31,334	32,582
Engineering Construction			
Marine	426	459	500
Highways, airport runways	4,326	4,345	4,873
Waterworks, sewage systems	2,229	2,222	2,292
Dams, irrigation	291	294	288
Electric power	4,397	3,691	3,483
Railway, telephones	2,469	2,552	2,732
Gas and oil facilities	8,128	8,339	8,879
Other engineering	2,929	2,894	3,333
Total	25,195	24,796	26,380
Total construction	55,948	56,130	58,962

Source: Statistics Canada.
[1] Actual expenditures 1983, preliminary actual 1984, intentions 1985.

TABLE 6. WORLD PRODUCTION OF GYPSUM, 1983 AND 1984

	1983	1984[e]
	(000 tonnes)	
United States	11 688	12 973
Canada	7 507	8 725
Japan	6 622	6 533
France	5 987	6 350
U.S.S.R.	5 443	5 625
Iran	5 443	5 352
Spain	4 990	4 990
People's Republic of China	3 629	3 629
United Kingdom	3 084	3 084
Mexico	2 359	2 812
West Germany	1 814	1 905
Other market economy countries	14 588	14 696
Other central economy countries	4 726	4 808
World total	77 880	81 482

Sources: Energy, Mines and Resources Canada; United States Bureau of Mines Mineral Commodity Summaries, January 1985.
[e] Estimated.

Indium

J. BIGAUSKAS

Indium (chemical symbol, In) occurs mainly as a minor constituent of polymetallic sulphide ores of zinc, lead and copper. Generally, production is associated with the processing of the mineral sphalerite, the major zinc mineral. Typically indium is concentrated in leach residue produced from fumes, dusts and concentrates mostly at electrolytic zinc plants.

The residues are often processed at a lead smelter which indium either reports to blast furnace slag or accumulates in dross or fume from pre-decopperized lead bullion. Indium-bearing dross or fume can be treated by pyrometallurgical/electrolytic or chemical means until purities of 99.97 per cent indium or higher are reached and other associated metals are recovered.

CANADIAN DEVELOPMENTS

Indium was first domestically recovered from the zinc-lead metallurgical operations of Cominco Ltd. at Trail, British Columbia. The presence of indium in the zinc-lead-silver ores of Cominco's Sullivan mine at Kimberley, British Columbia had been known for many years. In 1942, 13.6 kg were produced on a laboratory scale. After a decade of intensive research and development, commercial production began in 1952.

Today Cominco produces both a standard-grade and high-purity grades of indium. Standard-grade metal is cast into ingots and shot while high-purity (99.999 per cent or "five nines") metal is cast into ingots only. Alloys and chemical products containing indium are also produced.

WESTERN WORLD DEVELOPMENTS

Detailed statistics for consumption and production of indium are not available but estimates of western world consumption are between 60 and 80 tpy while refined indium production is variously estimated at 50 to 100 tpy. The People's Republic of China, and to a lesser extent the U.S.S.R., are sporadic exporters of indium metal to the western world.

Major western world mine producers of indium-containing ores and concentrates are similar to the list of major zinc mine producers which produce from mixed zinc and polymetallic ores - namely Canada, Australia, Peru and Mexico. The U.S.S.R., the People's Republic of China and the People's Democratic Republic of Korea are the major producers in the socialist world. Major producers of refined indium are Canada, the United States, Peru, Belgium, the Federal Republic of Germany, France, the United Kingdom and Japan.

In the United States, two major producers dominate the production of indium, Indium Corp. of America and Arconium Corp. of America. The U.S. Bureau of Mines also reports that these firms sporadically recover indium from old scrap.*

A strike at Empresa Minera del Centro del Peru S.A.'s (Centromin-Peru) anodic slimes plant in Peru lasted from August 21 to September 12. Some loss of output was reported, but production was believed to be back to expected levels by November.

Metallurgie Hoboken-Overpelt SA's (M.H.O.) plant at Hoboken, Antwerp is a major European supplier of indium. The lead smelter is fed mainly by a variety of metallurgical byproducts from primary zinc, lead and copper smelters around the world; some complex concentrates as well as scrap. From this, a variety of precious metals and minor metals including indium are produced. A new five-year plan was announced in 1985 for all of M.H.O.'s production facilities which would include the modernization of furnaces at the Hoboken plant.

* "Indium" in Mineral Facts and Problems, Bureau of Mines Preprint, Bulletin 675, United States Dept. of the Interior, Washington, D.C., 1985.

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Preussag AG is the major producer of refined indium in West Germany. In late 1984 Preussag announced the creation of a new sales division to handle sales of high-purity metals and procurement of raw materials.

Société Minière et Métallurgique de Penarroya S.A. recovers indium and other minor metals at its Noyelles-Godault, France lead smelter. New projects have been under way in recent years to improve treatment of complex metallurgical feeds.

In Japan several plants have capacity to produce refined indium. The Nippon Mining Co. Ltd.'s Saganoseki lead smelting refining complex has capacity to produce about 24 tpy. The lead division purchases dust from the 120 000 tpy Mikkaichi, Japan electrothermic zinc plant. At the 156 000 tpy Iijima, Japan electrolytic zinc plant of Akita Zinc Co. Ltd. indium accumulates in the leach residue . This is treated and then sent to Dowa Mining Co. Ltd's Kosaka, Japan smelter for processing by solvent extraction and electrowinning. Output is about 200 kg per month. Toho Zinc Co. Ltd. produces indium at its 139 000 tpy electrolytic zinc plant.

USES

Indium is a silver-white metal that resembles tin in its physical and chemical properties. Its chief characteristics are its high malleability and ductility at room temperature, its low melting point (156° C) and high boiling point (2080° C). Its density at 20° C is 7.31 which is about the same as iron. Indium is not oxidized by air at ordinary temperatures but will react readily at high temperatures or in solution. It has a relatively low electrical resistivity and an ability to absorb neutron radiation.

Indium's low melting point makes it a very suitable alloying element for low-melting or fusible alloys. Indium and indium-containing alloys are utilized in fusible links, solders, bearings and glass sealing alloys. Other applications are found in holding optical stock during glass polishing; in dental alloys, coatings on electrical contacts; in low pressure sodium lamps, fibre optics equipment, infrared detectors and liquid crystal displays. Growth in use of indium in nuclear reactor control rods has stagnated since the late 1970s.

The amount of tin-lead solder used in the United States electronics market alone - some 15 to 20 million kg per year - has prompted an interest by the indium industry in the potential market of indium-containing solder. However, the lack of a Federal Stock Standard for indium-containing solder has been a factor in discourging use of this solder, according to Arconium Specialty Alloys. To test and promote the application of indium and gain at least a small proportion of the electronic solder market, the formation of an Indium Institute has been advocated by some industry.

Application of indium and tin oxide as a glass coating also has been identified as having large potential. Nevertheless, substitutes for conductive coatings such as Ford Motor Company of Canada Limited's silver and zinc oxide coating on optional defrosting automobiles windows, are already available.

PRICES

Indium Corp. of America listed its price at $US 3.10 per troy ounce at the beginning of 1985, but subsequently cut this to $2.80 on February 25 and $US 2.50 per troy ounce on March 14, 1985 where it remained for the rest of the year. The Belgium Producer Price and European Free Market Price as published in Metals Bulletin Inc. also declined by a similar amount.

OUTLOOK

Because of its byproduct nature, recovery of indium is dependent on the stable growth of supplies of indium-bearing materials and stability in various end markets.

Supply of indium is likely to improve due to increases in zinc production and due to increased recovery. During periods of low-base metal prices, interest in recovery of byproducts increases. The enhancement of byproduct recovery processes at major plants, particularly in Europe, will increase the amount and variety of feeds containing indium.

On the other hand, substitutes for indium in major applications and further miniaturization in electronics will likely continue to destabilize this market until a major application using a unique combination of indium's properties can be found.

TARIFFS

Canada - Not specifically enumerated in Canadian tariffs.

United States - Customs Tariffs.

Item No.		1985	1986	1987
			(per cent)	
628.25	Metal, unwrought, waste and scrap[1]	0.6	0.2	Free
628.50	Metal, wrought	5.0	4.3	3.6
423.96	Indium compounds	1.2	0.6	Free

Source: Tariff Schedules of the United States Annotated 1985, USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241.
[1] Duty on waste and scrap temporarily suspended.

Iron Ore

C.J. CAJKA AND F.B. TAYLOR

The significantly improved levels of world iron ore production, trade and consumption that were reached in 1984 were largely sustained in 1985. It is noteworthy however, that 1984 and 1985 production, trade and consumption were still some 10 per cent less than the record volumes reached in 1979. Demand improved in 1985 for some ore types, most notably pellets and lump ore, although the improvement did not result in higher prices.

Activity in the Canadian industry in 1985 reflected the generally improved world iron ore markets. Mine production was about the same as in 1984 while preliminary information indicates that exports were somewhat higher. Some pellet plants were able to operate at close to capacity.

The year 1985 marked the beginning of trial shipments from the huge Carajas project in Brazil. While the full impact on world markets of this new mining region will not be felt until 1988, it will have a significant effect starting in 1986 and increasing in 1987. In the meantime, world demand is forecasted to remain unchanged over the next two years with little opportunity for price increases, particularly in the case of sinter fines. The longer term outlook is for very slow growth (1.0 per cent per annum) in world consumption, with the rising consumption in newly industrialized countries being largely offset by a gradual decline in that of the more advanced market economies. This situation is expected to have a negative influence on Canadian exports in the long term because Canadian iron ore exporters are not well located geographically to participate in the growth segment of the market.

CANADIAN DEVELOPMENTS

Canadian mine shipments, expressed in dry weight, increased marginally in 1985 to 40.3 million t from 39.9 million t in 1984 (Table I).

The main preoccupation of Canadian iron ore producers since the beginning of the decade has been activities directed at ensuring their survival. Among the actions taken were the closure of higher-cost operations, the rationalizing of production at others, and the paring of the work force to respond to the new market reality. These efforts have resulted in substantially lower production costs as well as improved productivity and product quality. By April 1, 1986, nominal capacity in the Canadian industry will have declined to 50 million tpy from a peak of 72 million tpy in the late 1970s.

Other improvements that have been introduced in recent years include computerized mining programs, the addition of metallurgical and petroleum coke breeze to pellet feed as a partial replacement for bunker C oil in the pellet indurating process, modifications to improve iron recoveries and grade control, and the development of fluxed pellets. Also being pursued are tests on the use of coal-water slurry fuel, and research on alternative pellet binder materials.

Quebec-Labrador: The Quebec-Labrador mines operated at 68 per cent of capacity in 1984 and at 78 per cent in 1985.

In contrast to previous years, Iron Ore Company of Canada (IOC) did not close temporarily in either 1984 or 1985. Indeed, in response to increased pellet sales, the company re-activated an additional pellet line in March 1985, and had all six of its pellet lines in operation by the end of 1985. Employment was expanded to 2,600, a net increase of 150 employees after allowing for the termination of 75 jobs which were mainly in clerical and management categories. IOC had several new initiatives in progress during 1985 that included a computer dispatch system for ore trucks, increasing the size of ore trains to 260 cars, additional tests of coal-water slurry fuel as a

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substitute for fuel oil in the pellet plant and the introduction of Statistical Process Control, a method that can be useful for improving quality control.

Wabush Mines operated its Pointe Noire pellet plant at 92 per cent of capacity in 1985, only suspending production for a five-week period during the summer vacation months. The mine at Wabush operated continuously except for a four-week vacation shutdown.

Wabush Mines has been testing coal-water slurry fuel as a substitute for fuel oil, and in September 1985 it completed the installation of facilities for a 1,000 barrels per day processing plant at Pointe Noire. The project continued to give encouraging results and the company has decided to proceed with an expansion of the fuel plant to 3,000 barrels per day, which would be sufficient to satisfy the fuel requirement of its Pointe Noire pellet plant. Wabush Mines was also considering a proposal to do more extensive tests on the recovery of manganese from its ore. It is expected that the test work would be done in a 0.5 t per hour pilot plant at the Centre de Recherches Minérales in Quebec City.

There were no scheduled shutdowns at Quebec Cartier Mining Company (QCM) in 1985 and the company's mine at Mount Wright operated at about 80 per cent of capacity, well above the levels of recent years. The main factor contributing to this performance was the integration of the QCM mining and concentrating operations with the Sidbec-Normines Inc. (S-N) pellet plant at Port Cartier. With the permanent closure of the S-N Fire Lake mine and Lac Jeannine concentrator at the end of 1984, QCM leased and took over the operation of the Port Cartier pellet plant. Pellet feed was supplied in 1985 by the Mount Wright mine. The addition of the pellet feed to the ongoing concentrate sales called for a much higher mining rate at Mount Wright. The restructuring of the two companies also resulted in a transfer of some workers from the Fire Lake mine to the Mount Wright mine, and some loss of jobs associated mainly with the mining operations and the S-N administrative office at Port Cartier, for a net loss of some 340 jobs.

QCM produced 400 000 t of fluxed pellets during 1985 for more extensive furnace trials at Dofasco Inc.'s steel complex in Hamilton, Ontario. The company had produced some 100 000 t of fluxed pellets in 1984 for the initial furnace-scale trials.

The permanent closure of the S-N mining operations in 1984 removed the only economic base for the town of Gagnon. Nearly all residents of the community had moved by mid-1985 and the levelling of structures to restore the townsite to its natural state was well under way by the end of 1985.

Ontario: The Adams and Sherman Mines, both owned by Dofasco Inc. operated at capacity in 1985 apart from 5 weeks of summer vacation shutdowns. The transition to production of fluxed pellets at the Sherman Mine was completed in June of 1985, and the Adams Mine is scheduled to start fluxed pellet production in February, 1986. Employment at the two mines declined slightly in 1985, with 30 jobs lost to early retirements and natural attrition at the Adams Mine and 43 at the Sherman Mine.

The Algoma Steel Corporation, Limited operated its mine and sinter plant at Wawa at 67 per cent of capacity in 1985.

Algoma resumed tests in 1985 to evaluate a beneficiation process that shows promise for reducing the sulphur and silica content inherent in the ore, as well as reducing energy costs. The project was assisted in 1985 by a $61,000 grant from the federal Department of Energy, Mines and Resources, which, together with a similar grant in 1984, brought total federal assistance on the $282,000 project to $141,000.

The Ontario government announced in December 1985 new limits for sulphur dioxide emissions. A 1973 Control Order limited sulphur dioxide emissions at Algoma's Wawa sinter plant to 285 000 tpy. Allowable emissions have been reduced by the new program to 180 000 tpy immediately and to 125 000 tpy by 1994.

Stelco Inc. operated its Griffith Mine near Red Lake at about 50 per cent of capacity in 1985. The complex was closed for 3 months during the summer and only 2 of the 3 pellet furnaces were in use during the rest of the year. According to an announcement made by the company in December 1984, the Griffith Mine is to be permanently closed at the end of March 1986. Stelco plans to increase purchases from the Quebec-Labrador region if the company finds it necessary to replace any of the ore lost through the closure of the Griffith Mine.

WORLD DEVELOPMENTS

World iron ore consumption in 1985 was estimated to be of the order of 821 million t as compared to 812 million t in 1984. This 1.1 per cent increase reflected an estimated world crude steel production of 718 million t in 1985 as compared to 710 million t in 1984. The pattern of steel consumption in 1985 versus 1984 was uneven, with the major industrial countries as a group down 2 per cent, and the developing countries up 3 per cent. The most important change was in the United States, where consumption declined by about 4 per cent in 1985 and was forecasted to decline by a further 6 per cent in 1986.

Based on the expectation that 1986 world crude steel production will be about the same as in 1985, iron ore consumption in 1986 should be similar to that of 1985, with some likelihood of a slight reduction to reflect the effect on iron ore consumption of higher percentages of electric furnace steelmaking and continuous casting.

Due to some construction delays at the minesite, volume shipments of Brazil's Carajas ore from Ponta de Madeira were not scheduled to start until April 1986. The operations have been scheduled to reach an annual rate of 25 million t by July 1, 1986, and the full 35 million tpy rate by January 1, 1987. While some of the Carajas ore is slated to replace reduced production from the older Brazilian iron ore mines, much of it will find its way into the international market. As a starting point, Companhia Vale do Rio Doce (CVRD) has substantial purchase commitments for its Carajas output from several major iron ore consumers in western Europe and the Far East. Ore from Carajas is bound to have a significant negative impact on the price and volume potential for other producing countries, including Canada, beginning in 1986.

Some thought was reportedly being given to the future installation of pelletizing facilities at Carajas.

Brazil and China decided to establish a joint venture company to develop the Timbopeba iron ore mine in the State of Minas Gerais, Brazil. Few details of the accord have been announced.

CVG Ferrominera del Orinoco C.A. of Venezuela announced the opening of its new Cerro San Isidro mine. The mine was to produce 2 million t of high-grade ore in 1985 and 4 million tpy thereafter. Ferrominera has two other producing iron ore mines in Venezuela.

China held extensive negotiations with Australian producers regarding the supply of iron ore for the first phase of the Baoshan steel complex. Negotiations have included a possible joint venture with Hamersley Iron Pty., Ltd. to develop a new deposit in the Pilbara region, which would have an initial output of 5 million tpy and provision for doubling this to 10 million tpy when required.

Lengthy negotiations were also being held with Romania for the supply of Australian iron ore from another new mine. The idea was in principle a barter arrangement under which Romania would supply mining, transportation and related capital equipment for the development of a new mine, and receive iron ore over an extended period from the project in payment. Another Romanian project, which also has Australian involvement, will improve ore handling facilities in the Black Sea port of Constanza. This improved facility will reportedly make it more economically viable to ship Australian ore, as well as ore from other sources, into Romania and other countries on the Danube River.

The Broken Hill Proprietary Company Limited (BHP) of Australia attained a majority ownership (85 per cent) in the Mt. Newman iron ore mine by acquiring the 25 per cent interest held by AMAX Inc. and the 30 per cent interest of Pilbara Iron Ltd.

The planned merger of some steelmaking facilities of West German Krupp Stahl AG and Klöckner Werke AG with Australia's CRA Limited was delayed indefinitely. This merger would have provided direct access into the West German market for Hamersley ore.

Based on forecasts of lower 1985 U.S. raw steel production, U.S. iron ore production was estimated to be somewhat below the 1984 level of about 50 million t. Noteworthy developments in the United States were as follows:

- The Butler Taconite operation, with a 2.65 million tpy pelletizing capacity, was closed permanently at the end of June, 1985.

- Reserve Mining Co. announced a 400 000 t (11 per cent) reduction in 1985 pellet production as compared to 1984.

- The Empire Mine was closed on September 1, 1985 for six weeks to adjust to lower than anticipated requirements.

The United States Department of Commerce undertook a countervale and dumping investigation of Brazilian pellets shipped to the U.S. market. The preliminary finding announced on May 22, 1985 indicated that there was a 5.15 per cent subsidy on pellets produced by Companhia Vale do Rio Doce (CVRD). There was still no final determination on the issue at 1985 year-end.

India's projected 1985 exports of iron ore are 28 million t as compared to 26 million t in 1984.

The Kudremukh Iron Ore Co. Ltd.'s 3 million tpy capacity pellet plant in India began operation in 1985. In addition to concentrate sales to Japan and Bahrain, the pellet plant will permit Kudremukh pellets to be offered in the Middle East and Mediterranean markets.

Liberia's National Iron Ore Company (NIOC) closed its small mine located near the border with Sierra Leone. The company was unable to find buyers for its ore and encountered severe financial difficulties.

Mines de fer du Sénégal Oriental (MIFERSO) in Senegal was seeking customer support as a basis for financing its proposed $800 million iron ore project. Romania has offered to take part of the output in exchange for work on the project.

A large iron ore discovery was reported in the Wellaga region in western Ethiopia.

Iran announced that exploration work has been completed on its Chadormelo Mine in Yazo Province in central Iran and that production would begin in the near future. The mine, with 351 million t of reserves assaying 58 per cent iron, 0.92 per cent phosphate and 0.17 per cent sulphur, is to have a production capacity of 6 million tpy.

The Soviet Union, Czechoslovakia, Hungary, German Democratic Republic and Romania were cooperating in a 14 million tpy concentrate operation in the U.S.S.R., which was scheduled to come on-stream in 1988.

UNCTAD Dialogue on Iron Ore

The United Nations Conference on Trade and Development (UNCTAD) held its Fourth Preparatory Meeting on Iron Ore in Geneva from October 21 to 26. This meeting had before it, among other items, a continuation of the dialogue on a) International measures on iron ore and b) Statistical issues. A decision was taken at the Fourth Meeting to recommend to the Trade and Development Board of UNCTAD, which is responsible for approving and acting on UNCTAD committee decisions, "to convene an Intergovernment Group of Experts on Iron Ore which shall meet in two sessions, with the first session to be held in 1986 and the second in 1987, to review market developments in iron ore and to report thereon to the Fifth Preparatory Meeting". In regard to statistics, the Fourth Preparatory Meeting provided clear direction to the UNCTAD Secretariat for the annual preparation and publication of statistics on iron ore. It was agreed that the publication of statistics on a quarterly basis was not feasible under the present circumstances.

The United States did not attend the Fourth Preparatory Meeting on Iron Ore.

Direct Reduction

The 1985 world production of direct reduced iron (DRI) was estimated at 11 million t, which would represent an increase of 19 per cent over 1984.

Sidbec produced 742 945 t of direct reduced iron in 1985 at its plant in Contrecoeur, Quebec, an increase of 48 per cent over the 502 297 t produced in 1984.

Efforts continued to reopen the Emden plant in West Germany, formerly operated by Norddeutsche Ferrowerke.

The Sabah plant of Sabah Gas Industries Sdn. Bhd. on Labuan Island, East Malaysia began full commercial production in December 1984 and was operated close to its rated capacity during intervals in 1985. This plant, with an annual capacity of

650 000 t of hot briquetted iron, was built to supply markets in the Far East and Europe. The plant is the first production-scale plant to employ the Midrex hot briquetting technology, which was developed to make DRI more easily storable and transportable by eliminating the problem of reoxidation inherent in non-briquetted DRI.

A 150 000 tpy direct reduction plant based on the SL/RN process is to be built at Chandil in the State of Bihan, India. Lurgi GmbH of Germany won the contract for the technical side of the project, which will require 30 months for completion. Bihar State Industrial Development Corp. and Modi Industries Ltd., Modinagar are the main shareholders. The product is intended for mini-mills in eastern and northern India.

Seaway Tolls

The St. Lawrence Seaway Authority announced higher toll charges on the Welland Canal for the 1986 navigation season. Tolls for bulk cargo will be increased from 31 cents to 36 cents per t, the vessel charge per gross registered ton (GRT) will be raised from 7 cents to 8 cents, and lockage charges will be increased from $250 per lock to $290 per lock for loaded vessels and from $187.50 per lock to $215 per lock for vessels in ballast.

The tolls for the Montreal-Lake Ontario Section will remain unchanged.

PRICES

1985 was a year of significant change in the North American pellet price structure. For many years, the major producers quoted virtually the same pellet price apart from minor differences in timing. More recently, a two-price system existed. In late 1984, further changes began to occur, the first of which was a quotation by Mineral Services Inc. of US 66.0 cents per iron unit at lower lake port, well below the US 80.5-86.9 cents quoted by other North American suppliers. By the end of August, even lower prices had been published. Additional details of these changes are provided in Table 6.

There was no change during 1985 in the reported prices for Mesabi non-bessemer and manganiferous ores.

The 1984 world iron ore prices resulted in a price differential between pellets and fines of less than US 10 cents per dry t iron unit, a differential which not long ago was US 20 cents. The 1985 world prices, which in general were marginally higher in the case of sinter fines while pellets remained unchanged, served to reduce the differential between pellets and sinter fines even further. At the recent differential, pellets were a relative bargain and this accounted for the strong demand for pellets in 1984 and 1985. The market for good quality screened lump was also strong, reflecting a tightness in the supply of this type of ore.

OUTLOOK

A pause in global economic growth that had been forecasted for early 1986 is now not expected until at least 1987. Hence, world demand for iron ore in 1986 is expected to grow marginally although total consumption will still remain well below the record consumption of 1979.

Most longer term forecasts show total world consumption growing at about 1.0 per cent per annum to the end of the decade. These forecasts take into account a number of significant trends including an annual growth rate for global steel production of 2.0 per cent, a steady increase in the ratio of scrap-based steel to ore-based steel, and further advances in the use of continuous casters that will also result in lower iron ore consumption per t of steel produced. Part of the trend toward lower ore consumption is offset by the phasing out of open-hearth furnaces, which are capable of using a higher ratio of scrap to pig iron than other steelmaking furnaces. The anticipated net effect of these factors is a slower growth rate in iron ore consumption than in crude steel production.

A significant feature of the long-term forecasts for iron ore consumption is a regional shift in the growth pattern. Developing countries as a group and the centrally planned economies of Europe are expected to show growth rates of 2.5 per cent and 1.0 per cent per annum respectively. The industrialized market economies are forecasted to experience a decline of 0.5 per cent per annum.

The problem of slow market growth in the iron ore market is compounded by a global production capability that is currently 20 per cent in excess of requirements. Total production capacity, including mines that have been permanently closed but are still largely intact, is obviously much larger. In spite of this ominous picture, new mines are being phased into full production in Brazil, India, Venezuela, Mauritania and the U.S.S.R., and there are reports of expansions and new projects under consideration in Australia, Brazil and elsewhere. Many of these new projects will be vying for markets in countries bordering the Atlantic basin, the natural markets for Canadian producers.

On the whole, the Canadian iron ore industry is fairly well positioned to meet the competition for the next few years. The restructuring, closure of high cost operations, introduction of cost-cutting measures, improved productivity, and attention to quality improvement and control provide a reasonable basis for expecting the Canadian industry to maintain annual shipments at the 40 millon t level. Capacity utilization at this annual rate of output would be about 80 per cent. Whether this level of Canadian shipments can be sustained over the longer term, even with some further lowering of production costs, is more problematic.

Many new mines in other countries, which are still in their early stages of commercial development, have yet to demonstrate reliability of supply and the ability to deliver ore to markets at costs at or below the world price. It should be noted that these new projects, usually purported to have low production costs, normally have high fixed costs directly related to debt financing.

A second important though unpredictable factor is currency exchange rates. Iron ore is priced on world markets in U.S. dollars. With most currencies undergoing severe devaluations in relation to the U.S. dollar in recent years, many ore producers outside of North America have been able to make good profits even though the price of their ores, denominated in U.S. dollars, has declined. A weakening of the U.S. dollar began to occur in late-1985 and further downward adjustments are anticipated.

Ocean freight rates are an additional consideration. These have been extremely depressed in recent years, with the result that the cost penalty inherent in supplying distant markets has been minimized, and the market horizons for most iron ore exporters have been expanded.

The heightened competition arising out of very low ocean freight costs has probably, on balance, worked to the disadvantage of Canadian iron ore exporters. Any firming of ocean freight rates would have the opposite effect, although there is no expectation of this happening in the immediate future.

Aside from considerations of cost competitiveness, the future of the Canadian iron ore industry depends to some degree on its success in improving product quality. The continuing shake-out in the world steel industry is certain to result in more stringent chemical and physical specifications for iron ore. The Canadian industry has started to produce fluxed pellets on a commercial basis, which will place it in a favourable position should the increased demand for these pellets, by the North American steel industry in particular, develop as anticipated. Furthermore, one Canadian producer is giving serious consideration to a process for the extraction and recovery of manganese from iron ore containing this particular element. Other projects are being considered or are under way. When viewed in the context of historical developments, these initiatives seem to indicate a renewed dedication to the long-term survival of the industry.

International iron ore prices have gradually decreased after reaching a peak in the early 1980s. In North America, the weakening of prices has appeared in the form of sales of important tonnages at prices that are significantly less than the published lower lake price. Ore destined for the European and Japanese markets fell in price between 1982 and 1985 by about 20 per cent for sinter fines and lump, and by about 30 per cent for pellets.

In the annual price negotiations for 1985 ore deliveries, Canadian shippers agreed to maintain 1984 prices while Australian and Brazilian producers, after prolonged and difficult negotiations, settled for increases of approximately 1.5 per cent for sinter fines and no change to slight decreases in pellet prices. The improvement in sinter fines prices, while marginal, was viewed by producers as symbolic of a reversal in price trends.

In addition to some evidence of price firming in 1985, supplies of pellet and good quality lump ore were tightening. Furthermore, the U.S. dollar weakened relative to European and Japanese currencies in the last quarter of 1985, in effect lowering ore costs for buyers in these countries. These factors should have provided producers with a much stronger argument for higher 1986 prices than had been the case for several years. However, surplus supply appears to have been the dominant consideration in recent contract negotiations, as early reports indicate that Canadian producers have accepted a 1.1 per cent price decrease in Europe for 1986 concentrate deliveries and the same price as in 1985 for pellets.

The longer term outlook for world prices is more complex. In general, production costs worldwide have been significantly reduced in recent years, which supports the case for continuing low prices. On the other hand, the world price is so low that profit margins for many producers are inadequate to yield a reasonable return on existing investment and, more importantly, to justify replacement or expansion investments as high-cost mines close and existing operating mines are depleted. Sinter fines could continue to be in ample supply for several more years, particularly with the expanding availability of Carajas ore beginning in 1986. Nevertheless, Carajas and other new producers would normally have to obtain prices sufficient to cover operating costs and significant debt service and repayment charges, which should set a lower limit on break-even prices determined by market forces. The recent history of the iron ore industry, however, suggests that such is frequently not the case.

The first visible evidence of divergence from the unique North American price structure has emerged and this trend could continue, although the ownership position of the iron ore consumers in the pellet producing companies has made this price somewhat artificial, difficult to predict and not too meaningful in the market place. Under normal circumstances, one would expect some narrowing of the differential between the North American and world prices as the average price in North America weakens and world prices, which are currently anomalously low, return to a more stable level.

TABLE 1. CANADA, IRON ORE PRODUCTION AND TRADE, 1983-85

	1983		1984		1985P	
	(tonnes)[1]	($000)	(tonnes)[1]	($000)	(tonnes)[1]	($000)
Production (mine shipments)						
Newfoundland	18 404 585	711,727	21 184 120	851,420	21 269 395	835,633
Quebec	10 246 761	372,880	14 019 912	403 398	14 800 000	C
Ontario	3 810 509	172,239	4 554 505	221 737	4 192 245	C
British Columbia	496 823	13,078	171 370	5 797	86 631	3,185
Total[2]	32 958 678	1,269,924	39 929 907	1 482 352	40 348 271	1,545,783
					(Jan.-Sept.)	
Imports						
Iron ore						
United States	3 977 869	231,976	4 775 875	288,105	3 623 543	233,359
Brazil	35 232	1,267	170 993	4,640	302 694	9,831
Netherlands	2	2	-	-	-	-
Italy	6	1	24	2	32	3
Total	4 013 109	233,246	4 946 892	292,747	3 926 269	243,193
Exports						
Iron ore, direct shipping						
United States	824 886	17,589	1 124 958	22,200	503 927	9,862
Italy	344 469	6,364	331 346	6,208	-	-
Belgium and Luxembourg	61 778	1,236	69 007	1,252	-	-
United Kingdom	57 030	1,084	175 629	3,398	246 549	4,694
Total	1 288 163	26,273	1 700 940	33,058	750 476	14,556
Iron ore, concentrates						
Japan	2 986 123	70,089	3 236 365	68,667	2 177 527	45,725
West Germany	2 015 388	53,069	2 033 196	45,593	1 723 248	39,539
United Kingdom	1 757 046	41,289	1 308 508	28,508	747 182	16,975
Netherlands	1 255 670	30,556	2 817 337	63,077	2 176 518	50,113
United States	1 188 091	28,538	1 745 146	40,560	1 460 871	31,878
France	925 331	22,898	1 250 762	25,129	1 056 413	22,004
Yugoslavia	319 995	10,842	673 320	20,581	393 528	13,473
Italy	442 408	10,516	406 559	8,771	545 215	12,330
Philippines	307 588	7,222	346 968	7,441	208 949	4,325
Austria	213 388	6,035	87 691	1,697	121 331	2,503
Belgium and Luxembourg	203 893	4,893	237 861	5,333	190 342	4,528
Portugal	110 036	2,723	140 399	3,535	44 000	1,051
Pakistan	99 745	2,192	170 200	3,720	192 803	4,045
Spain	61 471	1,977	-	-	53 099	1,259
Other countries	51 936	1,429	258 220	6,925	-	-
Total	11 938 109	294,268	14 712 532	329,537	11 091 026	249,748
Iron ore, agglomerated						
United States	6 852 094	376,612	9 182 394	528,037	5 312 931	312,617
United Kingdom	3 040 908	180,045	2 313 152	97,934	3 294 722	141,486
Netherlands	606 964	31,602	1 200 897	56,348	1 840 664	97,469
Italy	470 470	22,458	551 760	26,190	548 306	26,002
West Germany	144 648	8,704	825 049	31,461	1 089 744	49,293
France	141 274	3,851	-	-	486 878	18,076
Belgium and Luxembourg	36 490	2,226	84 321	3,826	281 768	14,010
Japan	148 645	3,383	-	-	-	-
Other countries	111 087	3,778	140 685	4,957	339 774	13,095
Total	11 552 580	632,659	14 298 258	748,753	13 194 787	672,048
Iron ore, nes						
Netherlands	304 853	7,148	-	-	-	-
United Kingdom	186 253	4,191	-	-	-	-
Yugoslavia	99 999	5,387	-	-	-	-
United States	59 080	1,596	25 729	708	81 896	1 663
Other countries	98 923	2,442	-	-	-	-
Total	749 108	20,764	25 729	708	81 896	1,663
Total exports, all classes						
United States	8 924 151	424,335	12 078 227	591,505	7 359 625	356,020
United Kingdom	5 041 237	226,609	3 797 289	129,840	4 288 453	163,155
Netherlands	2 167 487	69,306	4 018 234	119,425	4 017 182	147,582
West Germany	2 160 036	61,773	2 858 245	77,054	2 812 992	88,832
Japan	3 134 768	73,472	3 236 365	68,667	2 177 527	45,725
Italy	1 257 347	39,338	1 289 665	41,169	1 093 521	38,332
Belgium and Luxembourg	302 161	8,355	391 189	10,411	472 110	18,538
France	1 066 605	26,749	1 250 762	25,129	1 543 291	40,080
Philippines	307 588	7,222	346 968	7,441	208 949	4,325
Yugoslavia	419 994	16,229	673 320	20,581	393 528	13,473
Other countries	746 586	20,576	797 195	20,834	751 007	21,953
Total	25 527 960	973,964	30 737 459	1,112,056	25 118 185	938,015
Consumption of iron ore at Canadian iron and steel plants	13 102 908	..	14 620 016	..	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada; American Iron Ore Association.
[1] Dry tonnes for production (shipments) by province; wet tonnes for imports and exports. [2] Total iron ore shipments include shipments of byproduct iron ore.
P Preliminary; C Withheld to avoid disclosing company proprietary data; - Nil; .. Not available; nes Not elsewhere specified.

TABLE 2. CANADA, IRON ORE PRODUCTION (SHIPMENTS), 1982-85

Company and Location	Ore Mined	Product Shipped	1982	1983	1984	1985P
			(000 tonnes, natural or wet)			
Adams Mine, Kirkland Lake, Ont.	Magnetite	Pellets	964	865	1 105	1 141
Algoma Ore division of The Algoma Steel Corp. Ltd., Wawa, Ont.	Siderite	Sinter	871	1 247	1 280	1 400
Griffith Mine, Bruce Lake, Ont.	Magnetite	Pellets	910	790	954	483
Iron Ore Company of Canada Schefferville, Que.	Hematite, goethite and limonite	Direct shipping	1 675	1 366	1 525[1,2]	1 830[1,2]
Carol Lake, Lab.	Specular hematite and magnetite	Concentrate	5 609	5 618	5 753	4 893
		Pellets	5 830	6 590	7 956	8 431
Sept Iles, Que.	Schefferville "treat ore"	Pellets	129[2]	235[2]	303[2]	-
Quebec Cartier Mining Company, Mount Wright, Que.	Specular hematite	Concentrate	9 048	6 683	9 898	9 088
		Pellets	-	-	-	6 800
Sidbec-Normines Inc. Fire Lake, Lac Jeannine, and Port Cartier, Que.	Specular hematite	Concentrate	47	-	-	-
		Pellets	3 803	3 706	4 883	-
Sherman Mine, Temagami, Ont.	Magnetite	Acid Pellets	850	760	1 015	474
		Fluxed Pellets	-	-	-	524
Wabush Mines, Wabush, Labrador and Pointe Noire, Que.	Specular hematite and magnetite	Pellets	3 048	5 180	6 319	5 600
British Columbia Producers	Magnetite	Pellet feed, Magnetite concentrate	763	492	155[2]	87[2]
Other Ontario	Pyrrhotite, magnetite	Pellets, Magnetite concentrate	-	-	187	140
			33 547	33 532	41 333	40 891

[1] Includes some Carol Lake concentrate. [2] Stockpile ore.
P Preliminary; - Nil.

TABLE 3. RECEIPTS AND CONSUMPTION OF IRON ORE AT CANADIAN IRON AND STEEL PLANTS, AND INVENTORIES, 1984 AND 1985

	1984	Jan.-Nov. 1985
	(tonnes)	
Receipts imported	5 180 488	5 176 989
Receipts from domestic sources	10 269 694	7 882 662
Total receipts at iron and steel plants	15 450 182	13 059 651
Consumption of iron ore	14 571 406	13 796 258
Inventory at docks, plants, mines and furnace yards, December 31	10 213 884	10 117 559
Inventory change	-2 278 080	-5 869

Source: American Iron Ore Association.

TABLE 4. WORLD IRON ORE PRODUCTION, 1982-84

	1982	1983	1984[e]
	(000 tonnes)		
U.S.S.R.	244 000	245 000	247 000
Brazil	93 100	92 100	97 000
Australia	87 700	71 040	90 000
People's Republic of China[e]	71 000	72 000	77 000
India	42 000	37 580	41 570
United States	37 080	38 560	52 100
Canada	35 590	30 330	37 810
Republic of South Africa	24 600	16 600	24 500
France	19 670	16 180	15 030
Liberia	18 000	15 410	16 100
Sweden	16 140	13 530	18 120
Venezuela	11 160	10 190	12 740
Other countries	76 890	76 900	79 930
Total	776 930	735 420	808 900

Source: Association of Iron Ore Exporting Countries (APEF).
[e] Estimated.

TABLE 5. CANADIAN CONSUMPTION OF IRON-BEARING MATERIALS BY INTEGRATED[1] IRON AND STEEL PRODUCERS, 1984

	Consumed In				
	Sinter	Direct	Iron and Steel Furnaces		
Material Consumed	Plants at Steel Mill	Reduction Plants	Production of Pig Iron	Steel Furnaces	Total in Furnaces
			(tonnes)		
Iron Ore					
Crude and concentrate	304 176	145 040	23 176	-	23 176
Pellets	-	677 169	9 842 469	49 223	9 891 692
Sinter	119 958	-	1 149 786	-	1 149 786
Sinter produced at steel plant	-	-	870 877	-	870 877
Direct reduced iron	163 496	-	20 222	529 837	550 059
Other iron-bearing materials including flue dust, mill scale, cinder, slag, etc.	451 384	-	297 966	72 253	370 219
Total	1 039 014	822 209	12 204 496	651 313	12 855 809

Source: Company data.
[1] Dofasco Inc.; Sidbec-Dosco Inc.; Sydney Steel Corporation; The Algoma Steel Corporation, Limited; Stelco Inc.
- Nil.

TABLE 6. NORTH AMERICAN PRICES OF SELECTED ORES AT YEAR-END, 1975 AND 1980-85

	1975	1980	1981	1982	1983	1984	1985
				($US)			
Mesabi Non-Bessemer[1]	18.21	28.05	32.02	31.73-32.01	32.25-32.53	30.03-31.53	30.03-31.53
Old Range Non-Bessemer and Manganiferous[1]	18.45	28.30	32.26	32.26	32.78	32.78	32.78
PELLETS: (per gross ton iron unit)[2]							
Lake Erie Base Price[3]	0.464	0.725	0.792	0.792-0.855	0.805-0.869	0.805-0.869	0.869
U.S. Steel Corp.[4]	-	-	-	-	-	-	0.725
Upper Lakes[5]	-	-	-	-	-	-	0.594
Wabush[6]	-	0.635	0.635	0.635	0.635	0.635	0.635
Mineral Services Inc.[4]	-	-	-	-	-	0.660	0.580
Direct Reduced Iron[7]	-	-	-	-	115-135	115-135	115-135

Sources: Skillings Mining Review; Iron Age.
[1] $US per gross ton, 51.5 per cent of iron natural, at rail of vessel, lower lake ports. [2] $US per gross ton natural iron unit. One iron unit equals 1 percentage point of iron content in a ton of ore; an ore containing 60 per cent iron, therefore, has 60 iron units. [3] Cleveland-Cliff Inc., M.A. Hanna Co., Oglebay Norton Co. at rail of vessel lower lake port. [4] At rail of vessel lower lake port. [5] Pickands Mather & Co. and Inland Steel Mining Co. in hold of vessel upper lake port. [6] fob Pointe Noire. [7] $US per tonne.
- Nil.

TABLE 7. SELECTED PRICES OF IRON ORE BOUND FOR JAPAN AND EUROPE 1980-85
(U.S. cents per Fe Unit DMT, FOB)

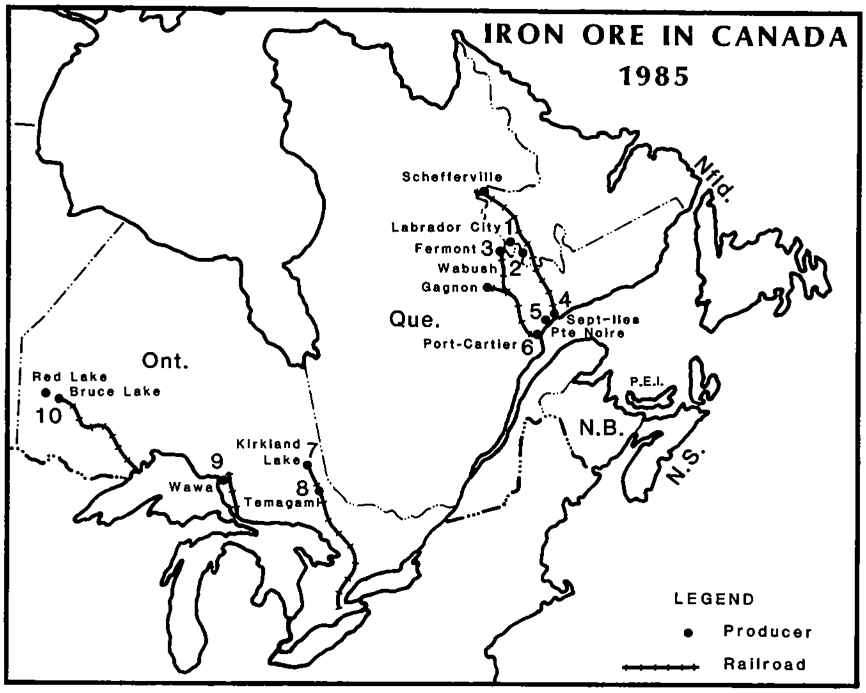
Ore	Market	Source	1980	1981	1982	1983	1984	1985
Fines (including concentrate)	Europe	CVRD	28.1	28.1	32.5	29.0	26.15	26.56
		Iscor	26.9	26.9	31.4	27.9	25.1	25.51
		Kiruna	34.5	33.0	34.7	30.1	27.7	28.5
		Carol Lake	29.3	29.3	33.0	29.3	26.8	26.8
		Mt. Wright	29.75	29.75	33.0	29.3	26.8	26.8
	Japan	CVRD	25.4	26.9	30.5	27.5	23.89	24.25
		Iscor	25.0	26.9	30.5	27.0	23.51	21.91
		Hamersley	27.6	29.7	34.2	30.5	26.25	26.62
		Carol Lake	25.1	27.0	29.8	26.7	23.0	23.0
Lump	Europe	CVRD	31.2	31.2	-	-	-	-
		Iscor	31.9	31.9	35.9	31.3	28.4	29.0
	Japan	CVRD	25.4	26.9	30.5	27.9	24.6	-
		Iscor	28.6	30.9	35.0	30.6	26.76	25.45
		Hamersley	31.2	34.2	40.0	34.9	30.38	31.05
Pellets	Europe	CVRD	47.1	43.1	47.5	39.0	36.0	36.0
		Kiruna	49.9	48.5	50.2	41.0	38.6	38.6
		Carol Lake & Pt. Cartier	-	-	-	-	-	36.5
	Japan	CVRD (Nibrasco)	50.3	55.2	53.6	42.9	36.72	35.68
		Savage River	46.2	48.9	53.4	-	37.7	36.51

Sources: The Tex Report, Metal Bulletin and Japan Commerce Daily.
- Not available; DMT dry metric tonne; FOB free on board.

TABLE 8. CAPACITY AND PRODUCTION OF DIRECT REDUCED IRON (DRI), 1984

Country	Capacity (million tpy)	Production (million t)
Argentina	0.93	0.90
Brazil	0.32	0.25
Burma	0.04	0.01
Canada	1.00	0.50
India	0.21	0.08
Indonesia	2.30	0.74
Iran	0.33	0.00
Iraq	0.49	0.00
Malaysia	0.65	0.04[e]
Mexico	2.02	1.47[e]
New Zealand	0.17	0.17
Nigeria	1.02	0.17
Peru	0.10	0.08
Quatar	0.40	0.50
South Africa	0.83	0.27[e]
Saudi Arabia	0.80	0.73
Sweden	0.07	0.02
Trinidad	0.84	0.24
United Kingdom	0.80	0.00
United States	0.70	0.12
U.S.S.R.	0.42	0.37[e]
Venezuela	0.50	2.49
West Germany	1.28	0.10[e]
Total	20.22	9.25

Source: Midrex Corp., North Carolina, United States.
[e] Estimated.



PRODUCERS
(numbers refer to numbers on map above)

1. IRON ORE COMPANY OF CANADA, CAROL DIVISION (mine/ concentrator/ pellet plant)
2. WABUSH MINES (mine/ concentrator)
3. QUEBEC CARTIER MINING COMPANY (mine/ concentrator)
4. IRON ORE COMPANY OF CANADA (port)
5. WABUSH MINES (pellet plant/ port)
6. QUEBEC CARTIER MINING COMPANY (pellet plant/ port)
7. ADAMS MINE OF DOFASCO INC. (mine/ concentrator/ pellet plant)
8. SHERMAN MINE OF DOFASCO INC. (mine/ concentrator/ pellet plant)
9. ALGOMA ORE DIVISION OF THE ALGOMA STEEL CORPORATION, LIMITED (mine/ concentrator/ sinter plant)
10. GRIFFITH MINE OF STELCO INC. (mine/ concentrator/ pellet plant)

Iron and Steel

R. McINNIS

Nineteen eighty-five was a year of continuing economic recovery in North America and in other western world nations. In Canada the consumer-led recovery that started in 1983 continued at a slower pace, while capital expenditures which began to increase in 1984, gained strength in 1985.

Canadian steel companies had backlogs on their order books for specific steel products on several occasions in 1985. However, overall world supplies of steel products continued to exceed demand in spite of additional closures of inefficient plants in the highly industrialized countries.

International trade in steel was characterized by national efforts to protect their respective steel industries from imports. Investigations into specific complaints on unfair trade practices resulted in the application of a variety of import restrictions, especially in the United States where Voluntary Restraint Agreements (VRA) were negotiated with most of its trading partners.

Canadian crude steel production in 1985 decreased marginally to 14.5 million t compared to the 14.6 million t produced in 1984. Domestic mill shipments of rolled steel, as well as those of ingots and semis, increased marginally in 1985 to 11.6 million t.

The operating rate of Canadian mills was 69 per cent of capacity at the beginning of January 1985, rose to a monthly high of 72 per cent in March, but based on preliminary data, averaged an estimated 67 per cent for the year.

A world oversupply of steel is forecast in the medium-term in spite of planned plant closures. Current global production capability is still well in excess of requirements. Furthermore, the installation of modern equipment based on new cost-saving technologies at existing plants will increase productivity in industrialized nations while new plants and expansions will add to the capacity of the developing nations. These developments will increase world output while steel consumption is projected to grow at a modest 2 per cent per annum.

CANADIAN DEVELOPMENTS

In early-May 1985 a Canadian Steel Trade Conference was held in Sault Ste Marie, Ontario where representatives from industry, labour and government met to discuss the changing patterns of world steel production and trade, the problem of labour force adjustment which has accompanied the drive to remain competitive, the concern with illegal and unfair competition from off-shore, and the importance of continued access to the U.S. market.

This conference resulted in the establishment of four joint labour - business groups whose task is to address the foregoing concerns. The final outcome in 1985 was a decision on the part of the steel companies and the union to create an ongoing forum for research and consultation on issues outside collective bargaining. This forum will be known as the Canadian Steel Trade Conference Inc.

Domestic orders for steel increased only marginally in 1985 although the economic recovery continued with strong demand for consumer durables, especially automobiles. In addition, capital expenditures for equipment and commercial construction began to increase significantly.

Capital expenditure intentions in the Canadian steel industry in 1985 were $679.9 million - a considerable increase from the $166.2 million of 1983 and $228.3 million of 1984. Many new projects have been completed and, therefore, capital expenditures will probably decrease in 1986. Highlights by company are as follows:

Stelco Inc. The steelmaking facilities at Edmonton, Contrecoeur and Nanticoke as well

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as the basic oxygen furnace shop at the Hilton Works in Hamilton, operated at or near capacity during the year.

In May 1985 the corporation announced the closure of its Notre Dame and St. Henry Works in Montreal and the continuous weld pipemill at its McMaster Works in Contrecoeur.

Capital investment was concentrated on the Hilton Works modernization program. In May, Stelco Inc. contracted with Mitsui & Co. (Canada), Ltd. for the design, fabrication and delivery of two continuous casting machines for this plant.

Stelco Inc. and Armco Canada Ltd. established the joint venture company Moly-Cop Canada in British Columbia to manufacture forged and heat-treated steel grinding balls for the Canadian mining industry. The plant will cost $11 million and will be the largest of its type in Canada.

Dofasco Inc. The company's steelmaking facilities operated near capacity throughout the year, with consolidated sales setting a company record of $522 million in the second quarter.

Dofasco plans to concentrate its capital expenditures during the next two years on the continuous cast slab program. Orders were placed for major equipment items such as the slab caster and reheat furnaces.

The Algoma Steel Corporation, Limited. Cost reductions and improvements in productivity were achieved during the year, with production records established on No. 7 blast furnace, the continuous slab caster and the 106 inch strip mill.

Direct capital expenditures by Algoma were $70 million. The Superior Limited Partnership, which will lease capital equipment to Algoma, will spend $53 million on new and existing seamless tube mills. Major projects included the construction of a new seamless tube mill, the modernization of the rail mill and the installation of an automatic gauge control system for the 106 inch strip mill.

Slater Steels Corporation. The decision by Slater to emphasize the production of specialty steels was both timely and beneficial for the company. Applications and demand for specialty steels have grown during a period when the demand for ordinary carbon steel has remained static. Carbon steel is being replaced to an increasing extent by other materials, causing some reduction in usage. The company posted a growth in both sales and earnings.

Capital expenditures were an historic high at $9.5 million. The main projects included the installation of a new ladle refining station at a cost of $6 million, with start-up in November and the installation of a new high-powered 40 MVA transformer on the 65 t smelting furnace. Slater also implemented the broader use of computer controlled systems and converted the teeming operations at the Sorel Forge Division to bottom pouring.

Although Slater had been considering the sale of the Slacan Division, the company announced in 1985 that it would be retained. The division was returned to profitability by cost reduction, trimming of operations and a modification of the organization structure. Sales were increased 12.5 per cent over the previous fiscal year.

IPSCO Inc. Nineteen eighty-five was a year when markets for pipe and tubing were volatile and the Canadian industry was under considerable competitive pressure from imported products. As a result, IPSCO sales of pipe were down although the company remained profitable. Its large-diameter pipe facilities in Edmonton and Regina remained essentially inoperative because there was no major pipeline construction under way and, consequently, demand was extremely weak.

IPSCO was making efforts to diversify its product lines and, to this end, created a new organization called the Flat-Rolled and Structural Steel Division. The latter will be responsible for scheduling, finishing, inventory control, and market policy for the company's flat-rolled and hollow structural sections. Specialized attention is to be given to customers in these markets.

Expansion and modernization programs have proceded on schedule. The $10 million slitter at Regina started running on May 5, a new $3 million pollution control facility for No. 5 electric furnace in Regina was on-stream, and the new tempering furnace installation in Calgary was completed on budget and on time. The modernization of IPSCO's Regina steel works, which will include a continuous slab caster and a reheat furnace, continued to be on schedule: one of the buildings was completed, a bid from a Canadian and United States joint venture engineering firm was accepted, and key subcontracts were let. This modernization project will dominate the company's expenditure program until the start-up of the new equipment, scheduled for early-1987. In December the company announced a downsizing of salaried staff that will involve job changes, transfers and terminations. About 16 per cent of its staff may be laid off.

Sidbec-Dosco Inc. Sales improved significantly in 1985, mainly due to a strong demand from the automobile industry and the start of recovery in the non-residential construction sector. The sales volume was not sufficient to move the company into a profit position but the losses were considerably less than those incurred in 1984.

Capital investments were being made for equipment to reduce production costs and improve product quality. The installation of annealing equipment was completed and a bottom-tapping system was installed on one of the electric furnaces at the Contrecoeur steel plant.

Ivaco Inc. The company operated profitably throughout 1985, although fierce competition from imported steel reduced profit margins.

Ivaco reported that it had raised $191 million through the issue of "Exchangeable Second Preferred Shares and Debentures which are exchangeable into the company's investment of approximately 6 million common shares of Dofasco at a conversion price of $32 per Dofasco share". This action raised working capital to a record level of $367.1 million.

The acquisition of The AHL Group Limited of Toronto was completed by the purchase of over 98 per cent of its outstanding shares. This acquisition further solidified Ivaco's position in the fasteners industry, because AHL is a major fasteners manufacturer.

Capital expenditures which totalled approximately $40 million in 1985, were undertaken with a view to improving production efficiency. One project included the modernization of continuous casting equipment at Laclede Steel Company in Alton, Illinois. A start was made in mid-1985 on the expansion of the rolling mill at L'Orignal, with completion scheduled for mid-1987 at a cost of approximately $20 million. This latter project will increase wire rod rolling capacity to 700 000 tpy. Bolt-making and heat treating lines at Marieville, Quebec will be expanded in 1986 at a cost of $10 million.

Sydney Steel Corporation. Stage one of the corporation's modernization program was completed on March 31, 1982 and included a new blast furnace.

The second stage of the modernization program was approved in 1985. This will start with the installation of an electric arc furnace for which the corporation will receive $150 million in grants. Seventy per cent of this total is to be provided by the Federal Government and 30 per cent by the Nova Scotia Government. Additional equipment planned for this stage of modernization includes ladle refining facilities, the modification and reactivation of the existing continuous casting facility, and the installation of a universal mill which would provide further quality improvements and allow forward integration into a wider variety of finished products.

Corporate profitability during 1985 was affected by weak markets for rail, the company's major product.

Lake Ontario Steel Company Limited (Lasco). Shipments of finished bar products improved by approximately 20 per cent in 1985 compared with 1984. This increased production was achieved by operating more shifts in the melt shop and adding one additional shift to the rolling mill operation. As a result, the workforce increased by about 200 new employees to bring the total to about 1,100.

In December a new ladle arc refining station was started in the number one melt shop. This equipment used in conjunction with the 55 t arc furnace, is intended to increase the shop's production capacity and should improve the quality of the steel produced. Lasco intends to penetrate new markets such as the manufacture of automotive forgings and fasteners with its higher quality steel.

More improvements were made on the tension free rolling system that was recently installed in the continuous bar mill. This equipment will improve the uniformity of the bar diameters.

The company is committed to the use of statistical process control (SPC) to achieve an improved product quality. An extensive training program in the use of SPC was under way.

WORLD DEVELOPMENTS

Rapid changes continued to occur within the steel industries of the western world. Developing nations were expanding their steelmaking capacities and exporting aggressively, while steel industries in the highly industrialized countries continued to react to depressed markets and oversupply by closing obsolete plants and rationalizing the rest of their facilities. In the United States, steel production capacity was reduced from the 1980 peak of 146 million t to 122 million t in 1985. A further 20 million t is likely to be closed in the next few years. In the European Community (EC9), capacity has been reduced from 195 million t in 1982 to 175 million t in 1985. Further reductions of about 15 million t are expected in the next 2 or 3 years.

The rationalization that has occurred in the highly industrialized nations has reduced the cost of producing steel, partially by a reduction of manning rates but also by investment in new steelmaking technologies such as continuous casting. Many companies have specialized in higher-quality, higher-value-added products. Consequently, many companies have been able to lower their break-even point considerably; that is, they are profitable at much lower levels of capacity utilization. These trends will continue and more capital investment will be made in the near future.

An indication of the improvements in productivity was the change in man-hours required to produce a tonne of steel. In the European Community this figure dropped from 8.2 in 1980 to 5.5 man-hours in 1984, and in the United States from 10.1 to 7.1 man-hours. Japan's productivity rate at slightly over 6, changed little during this period.

Developing nations increased their steel capacity from 33 million t in 1975 to 76 million t in 1985, an annual growth rate of 8.7 per cent. Growth for these countries in the next decade is expected to be in excess of 7 per cent per year. Productivity as measured in man-hours per t, is very high; for example, South Korea's rate was 4.0 in 1984.

The United States steel industry has made, and continues to make, significant changes to improve its relative competitiveness. In addition to closing obsolete capacity, operating costs at other plants have been reduced. The premium paid to steelworkers relative to other industrial workers has declined and will likely continue to decline. Productivity has also increased as critical capital investments, especially for continuous casting, has been made.

The strength of the U.S. dollar in the first half of 1985 contributed to the continuation of high levels of imported steel in the U.S. market. Imports averaged 25.6 per cent of the domestic market in the first 8 months of 1985, only slightly less than in 1984.

Government actions such as measures to restrict imports and countervail and dumping investigations, were again the leading influence on international trade in steel in 1985.

The United States negotiated voluntary restraint agreements (VRA) with its trading partners; fourteen countries and the European Community were covered by such agreements during 1985. The intention of these agreements was to limit imported steels to 20 per cent of the domestic market. The market shares that were negotiated totalled 18.72 per cent and did not include semi-finished steel from the European Community. At year-end, the United States unilaterally imposed a quota of 400 000 tpy of semi-finished steel, plus 200 000 tpy on a discretionary basis, on Community shipments until September 3, 1989. Community exports of these products averaged 900 000 tpy in 1984 and 1985. As steel from non-VAR countries averaged about 5 per cent of the U.S. market in 1984 and in the first 8 months of 1985, the target level for imports appeared to be unachievable in the near-term. However, a drop in the relative value of the U.S. dollar in the last quarter of 1985 and indications of further weakness, began to reduce the attractiveness of the U.S. market for steel exporters.

A combination of improved economic activity and plant closures resulted in a significant improvement in capacity utilization in the European Community, which averaged 73 per cent in the first 7 months of 1985. Exports were still very important to the EC industry. Exports accounted for over 18 per cent of EC steel sales, in 1985.

On December 17, 1985 the Department of National Revenue made a preliminary determination of dumping with respect to certain oil and gas well casings originating in or exported from Argentina, Austria, the Federal Republic of Germany, the Republic of Korea and the United States. The

Canadian Import Tribunal will hold an inquiry on the question of material injury in early-1986. If injury is found, anti-dumping duties may be imposed.

In summary, world steel capacity in 1985 was approximately 1 014 million t, considerably higher than production which was estimated by the International Iron and Steel Institute (IISI) to be 696 million t. Three years of economic recovery have occurred since the economic recession of 1982, and during these three years world steel consumption has increased by about 74 million t. A very slow growth rate in consumption is expected in the future. Consequently, the surplus of steel production capacity will likely persist for many years, as will intense competition for market share. Furthermore, developing nations are planning to add to their capacity, thereby aggravating and prolonging the world overcapacity.

PRICES

Continuing economic recovery and the beginning of a capital investment cycle increased the demand for steel and allowed some price increases. These increases were quite low because of the availability of low-priced imported steel which had a constraining impact on domestic prices.

Price changes are indicated by the Steel Industry Price Index, published by Statistics Canada. For 1984 the index average was 326.1, up slightly from 319.2 in 1982. It increased to 332.8 by September 1985.

Premium blends of coking coal, much of which is imported from the United States on a long-term contract basis, was $Cdn 72-75 a t at Ontario steel mills at year-end 1985. This was unchanged from year-end 1984 prices.

OUTLOOK

The Canadian steel industry can expect to experience a sustained demand for its products in 1986, with levels close to those of 1985. The robust demand for steel-intensive consumer durables that has been a characteristic of the economic recovery, is forecast to continue but it may decline slightly from the 1985 level. For example, automobile sales, which have been very brisk for the last two years, are projected to decline in 1986. Furthermore, imported cars are expected to gain market share, thereby compounding the impact of lower domestic car sales on the Canadian steel industry. Later in the decade, production from new automobile plants in Canada should increase the domestic demand for steel because cars that are now imported will be at least partially made in Canada. Renault, Honda, Toyota and Hyundai are the manufacturers involved.

Appliance sales are expected to improve in 1986 as lower interest rates continue to lead to growth in residential contruction and increased consumer spending.

Capital investment expenditures are forecasted to strengthen in 1986, and this is likely to increase the demand for steel products used in commercial construction and in the manufacture of industrial equipment.

In the intermediate-term (1987-88) the world economy is expected to be in a period of slow economic growth, albeit at high volume which could be accompanied by relatively high levels of capacity utilization and employment. However, there is unlikely to be any growth in steel production. A downturn in world economic activity is expected by the end of the decade. Steel consumption and production would fall in such circumstances.

Canadian steel production in 1995 is forecasted at 16 million t. Canada is expected to remain a net exporter of steel during the intervening period, with most of its exports going to the United States. Imports will likely maintain a significant market share and could continue to depress prices in the Canadian market. However, the efficiency of Canadian plants should improve considerably in the near future as current capital investment projects are completed, allowing Canadian firms to be more price competitive.

The worldwide oversupply of steel will likely persist for the next 10 years as developing nations increase their capacity and the highly industrialized countries continue to have capacity in excess of domestic consumption. Furthermore, the substitution of other materials for steel will probably continue, especially the substitution of plastics and aluminum alloys for steel in the production of automobiles, and the use of aluminum and plastic-fibre composites instead of steel in beverage containers. Industrial packaging will also continue to utilise less steel and more plastic and fibre composites for drums, pails and other containers.

TABLE 1. CANADA, GENERAL STATISTICS OF THE DOMESTIC PRIMARY IRON AND STEEL INDUSTRY, 1983-85

		1983	1984	Jan.-Sept. 1985P
Production				
Volume indexes				
Total industrial production	1971=100	129.7r	144.6r	145.7
Iron and steel mills[1]	1971=100	96.1r	125.6r	124.1
			($ million)	
Value of shipments, iron and steel mills[1]		6,195.9r	7,660.0	6,008.0
Value of unfilled orders, year-end, iron and steel mills		712.3	890.6	993.6
Value of inventory owned, year-end, iron and steel mills		1,717.7	1,950.0	1,823.8
			(number)	
Employment, iron and steel mills[1]				
Administrative		11,774r	11,927	
Hourly rated		35,919	37,921	
Total		47,693r	49,868	
			($)	
Average earnings per week, hourly rated		573.20r		
Average salaries and wages per week, all employees		590.10r		
			($ million)	
Expenditures, iron and steel mills[1] (investment intentions in 1985)				
Capital: on construction		14.1r	21.6r)	
on machinery		152.1r	202.3r)	679.9[3]
Total		166.2r	228.3r)	679.9
Repair: on construction		29.7r	34.6r	41.5
on machinery		624.5r	717.0r	743.3
Total		654.2r	751.6r	784.8
Total capital and repair		820.4r	979.9r	1,464.7
Trade, primary iron and steel[2]				
Exports		1,492.9	2,040.3	1,689.8
Imports		1,051.7r	1,451.6	1,349.2

Sources: Statistics Canada; Energy, Mines and Resources 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. This is a seasonally adjusted index. [2] Includes pig iron, steel ingots, steel castings, semis, hot and cold-rolled products, pipe, wire and forgings. Excludes sponge iron, iron castings. [3] Confidentiality requirements prevent the separation of capital spending intentions on construction and machinery in 1985.
P Preliminary; r Revised.

TABLE 2. CANADA, PIG IRON PRODUCTION, SHIPMENTS, TRADE AND CONSUMPTION, 1983-85

	1983	1984	Jan.-Sept. 1985P
		(tonnes)	
Furnace capacity January 1[1]			
Blast	9 907 000	13 570 000	13 902 150
Electric	600 000	600 000	700 000
Total	10 507 000	13 170 000	14 602 150
Production			
Basic iron	..	..	..
Foundry iron[2]	..	..	..
Total	8 566 621	9 643 260	6 424 409
Shipments	530 669	..	..
Imports			
Tonnes	4 855		
Value ($000)	951		
Exports			
Tonnes	348 281		
Value ($000)	69 973		
Consumption of pig iron			
Steel furnaces[3]	8 544 591	9 572 684	6 494 908
Consumption of iron and steel scrap			
Steel furnaces	6 222 820	7 382 914	4 841 760

Sources: Statistics Canada: Primary Iron and Steel (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. [3] Includes pre-reduced iron.
P Preliminary; .. Withheld to avoid disclosing company proprietory data.

TABLE 3. CANADA, CRUDE STEEL PRODUCTION, SHIPMENTS, TRADE AND CONSUMPTION, 1983-85

	1983	1984	1985
		(tonnes)	
Furnace capacity, January 1[1]			
Steel ingot			
Basic open-hearth	3 622 250	3 702 750	1 907 200
Basic oxygen converter	12 285 640	12 235 000	11 779 000
Electric	5 387 135	5 397 754	5 586 450
Total	21 295 025	21 335 504	19 272 650
Steel castings	471 444	573 971	797 053
Total furnace capacity	21 766 469	21 909 475	20 069 703
Production			**(Jan.-Nov.)**
Steel ingot			
Basic open-hearth	920 771)	10 734 502	9 716 000
Basic oxygen	8 495 536)		
Electric	3 312 068	3 833 337	3 637 000
Total	12 728 375	14 567 839	13 353 000
Continuously cast, included in total above	4 801 761	5 647 337	5 836 000
Steel castings[2]	104 102	131 365	98 750
Total steel production	12 832 477	14 699 204	13 451 745
Alloy steel in total	928 306	1 420 432	1 095 332
Shipments from plants			
Steel castings	93 721	117 339	92 090
Rolled steel products	9 997 656	11 559 252	10 883 742
Total	10 091 377	11 676 591	10 975 832
Steel ingots included with rolled steel products above	949 655	..	..
		(000 tonnes)	
Exports, equivalent steel ingots	2 856.0	3 273.6	3 553.9P
Imports, equivalent steel ingots	1 378.4	2 037.6	2 371.6

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; .. Not available.

TABLE 4. CANADA, VALUE[1] OF TRADE IN STEEL CASTINGS, INGOTS, ROLLED AND FABRICATED PRODUCTS, 1983-85

	Imports			Exports		
	1983r	1984r	1985p	1983r	1984r	1985p
	($000)					
Steel castings	24,174	31,236	44,032	7,656	13,340	8,133
Steel forgings	24,969	21,477	20,449	72,575	92,479	85,780
Steel ingots	1,523	12,586	2,036	31,456	30,621	16,096
Rolled products						
Semis	12,062	44,212	32,793	133,746	47,868	16,996
Other	671,187	927,877	1,157,588	876,330	1,248,485	1,453,253
Fabricated						
Pipe and tube	246,183	323,696	433,403	179,499	346,995	374,521
Wire	70,658	89,368	104,807	121,667	168,138	175,856
Total steel	1,050,756	1,450,452	1,795,108	1,422,929	1,947,926	2,130,635

Source: Statistics Canada.
[1] The values in this table correspond with the tonnages shown in Table 5.
p Preliminary; r Revised.

TABLE 5. CANADA, TRADE IN STEEL BY PRODUCT[1], 1983-1985

	Imports			Exports		
	1983r	1984r	1985p	1983r	1984r	1985p
	(000 tonnes)					
1. Steel castings (including grinding balls)	15.2	19.4	27.7	4.1	8.5	4.1
2. Ingots	1.7	50.5	1.2	122.7	109.7	45.7
3. Semi-finished steel blooms, billets, slabs	35.4	133.7	90.8	456.3	139.4	31.2
4. Total (1+2+3)	52.3	203.6	119.7	583.1	257.6	81.0
5. Finished steel						
A) Hot-rolled						
Rails	16.1	26.4	41.9	25.2	76.4	102.6
Wire rods	137.2	232.1	221.5	276.5	334.4	334.0
Structurals	162.1	234.5	237.8	226.8	252.2	290.4
Bars	126.6	153.5	112.8	275.6	257.7	297.3
Track material	4.0	7.4	5.6	13.0	31.8	2.6
Plate	144.0	198.7	261.1	139.7	178.8	166.3
Sheet and strip	135.9	152.7	409.9	251.5	487.1	751.5
Total hot-rolled	725.9	1 005.3	1 290.6	1 208.3	1 618.4	1 944.7
B) Cold-rolled						
Bars	13.4	21.9	23.6	26.6	42.3	47.1
Sheet and strip	73.2	128.5	124.6	76.9	133.1	138.9
Galvanized	53.7	71.6	88.5	209.0	286.8	262.5
Other[1]	128.4	148.2	161.6	183.9	181.4	211.5
Total cold-rolled	268.7	370.2	398.3	496.4	643.6	660.0
6. Total finished steel (A+B)	994.6	1 375.5	1 688.9	1 704.7	2 262.0	2 604.7
7. Total rolled steel (2+3+6)	1 031.7	1 559.7	1 780.9	2 283.7	2 511.1	2 681.6
8. Total steel (4+6)	1 046.9	1 579.1	1 808.6	2 287.8	2 519.6	2 685.7
9. Total steel (raw steel equivalent)[2]	1 378.4	2 037.6	2 371.6	2 856.0	3 273.6	3 553.9
10. Fabricated steel products						
Steel forgings	7.3	6.6	6.7	34.0	44.4	39.2
Pipe	217.0	316.1	432.6	241.6	411.7	447.2
Wire	64.2	78.2	93.1	133.5	173.1	171.1
11. Total fabricated	288.5	400.9	532.4	409.1	629.2	657.5
12. Total castings, rolled steel and fabricated (8+11)	1 335.4	1 980.0	2 341.0	2 696.9	3 148.8	3 343.2

Source: Statistics Canada.
[1] Includes steel for porcelain enameling, terneplate, tinplate and silicon steel sheet and strip.
[2] Calculation: finished steel (row 6) divided by 0.75, plus steel castings, ingots and semis (row 4).
p Preliminary; r Revised.

TABLE 6. PRICES FOR RAW MATERIALS AND SELECTED STEEL PRODUCTS, 1983-85[1]

	Currency	1983	1984	1985
Raw Materials				
Iron ore pellets, Lake Erie base price, per metric iron unit[2]	$US	0.792-0.85	86.9	86.9
Coal, blended metallurgical, imported for Ontario steel mills, per tonne	$Cdn	80.50	72-75	72-75
Scrap, Number 1 heavy melting, per tonne fob Contrecoeur	$US	73.71	86.12	69.50
Direct reduced iron, per tonne	$US	115.00	115.00	115.00
Basic pig iron, per tonne	$US	234.79	213.00	213.00
Steel Price Index 1971=100				
Structural steel shapes, unfabricated, heavy and intermediate		303.3	304.5	304.6
Steel and strip, hot rolled carbon		316.2	330.6	337.7
Sheet and strip, cold reduced, carbon, alloy and silicon		317.2	320.7	329.8
Plate, carbon and alloy		351.9	357.3	360.7

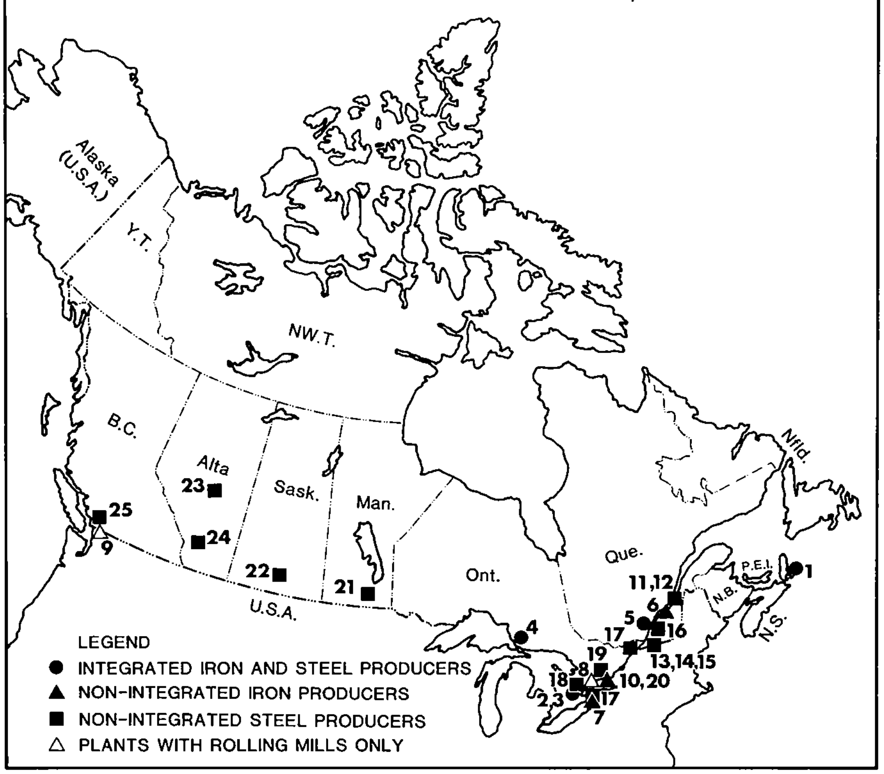
Sources: Statistics Canada; Skillings Mining Review; Iron Age; Energy, Mines and Resources Canada.
[1] Prices in effect at end of December of each year. [2] One iron unit equals one per cent of a tonne. Hence, iron ore pellets with a grade of 65 per cent iron would contain 65 iron units per tonne.

TABLE 7. WORLD RAW STEEL PRODUCTION, 1984 AND 1985

	1984	1985[e]
	(million tonnes)	
U.S.S.R.	154.3	154.0
Japan	105.6	105.9
United States	83.9	79.0
People's Rep. of China	43.4	45.6
West Germany	39.4	41.2
Italy	24.0	23.9
France	19.0	19.0
Poland	16.6	16.0
Czechoslovakia	15.5	15.3
United Kingdom	15.1	15.7
Brazil	18.4	20.2
Romania	14.3	14.0
Spain	13.5	14.0
South Korea	13.0	13.4
Canada	14.7	14.5
India	10.5	10.9
Belgium	11.3	10.7
East Germany	7.5	7.5
South Africa	7.7	8.0
Mexico	7.5	6.9
North Korea	6.5	6.5
Australia	6.2	6.3
Taiwan	5.0	5.3
Netherlands	5.7	5.5
Austria	4.9	4.6
Sweden	4.7	4.8
Yugoslavia	4.2	4.6
Hungary	3.8	3.8
Luxembourg	4.0	4.0
Argentina	2.6	2.8
Bulgaria	2.8	2.5
Others	10.1	9.8
Total	709.9	695.7

Source: International Iron and Steel Institute.
Note: Totals may not add due to rounding.
[e] Estimate.

IRON AND STEEL IN CANADA, 1985



Integrated iron and steel producers
(numbers refer to locations on map above)

1. Sydney Steel Corporation (Sydney)
2. Dofasco Inc. (Hamilton)
3. Stelco Inc. (Hamilton and Nanticoke)
4. The Algoma Steel Corporation, Limited (Sault Ste. Marie)
5. Sidbec-Dosco Inc. (Contrecoeur)

Non-integrated iron producers

6. QIT-Fer et Titane Inc. (Sorel)
7. Canadian Furnace Division of Algoma (Port Colborne)

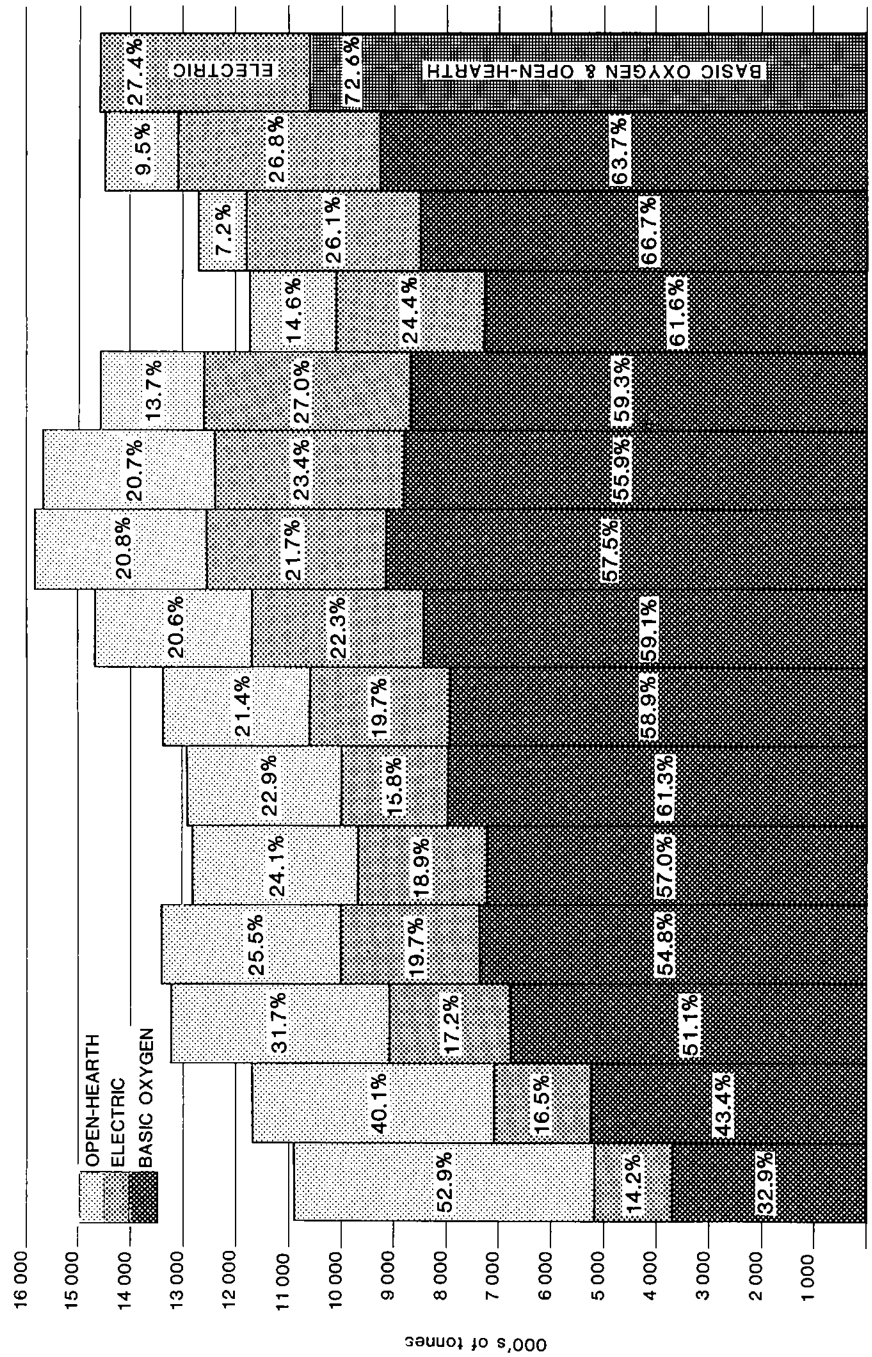
Plants with rolling mills only

8. Stanley Strip Steel division of Stanley Canada Inc. (Hamilton)
9. Pacific Continuous Steel Limited (Delta)

Non-integrated steel producers

10. Courtice Steel Limited
11. Stelco Inc. (Contrecoeur)
12. Atlas Steels division of Rio Algom Limited (Tracy)
13. Sorel Forge division of Slater Steels Corporation
14. Canadian Steel Foundries division of Hawker Siddeley Canada Inc. (Montreal)
15. Canadian Steel Wheel Limited (Montreal)
16. Sidbec-Dosco Inc. (Montreal and Longueuil)
17. Ivaco Inc. (L'Orignal)
18. Atlas Steels division of Rio Algom Limited (Welland)
19. Hamilton Specialty Bar division of Slater Steels Corporation (Hamilton)
20. Lake Ontario Steel Company Limited (Lasco) (Whitby)
21. Manitoba Rolling Mills division of AMCA International Limited (Selkirk)
22. IPSCO Inc. (Regina)
23. Stelco Inc. (Edmonton)
24. Western Canada Steel Limited (Calgary)
25. Western Canada Steel Limited (Vancouver)

CANADA PRODUCTION OF STEEL BY FURNACE TYPE



Lead

J. BIGAUSKAS

OVERVIEW

A drop in non-socialist world demand to 3.85 million t in 1984, and a major boost in mine and refined metal production in the United States was accompanied by a rise in U.S. producer stocks in early-1985 and a rise in London Metal Exchange (LME) stocks after July. Announced shutdowns and production cutbacks at major mining operations and at primary and secondary metallurgical plants did not resolve the non-socialist world's short-term metal supply-demand imbalance. The U.S. producer price fell from an average 25½ cents per pound in 1984 to 19 cents per pound in 1985, while the LME price fell from an average £332 per t in 1984 to £270 per t in 1985.

CANADIAN DEVELOPMENTS

Lead is principally mined as a coproduct of zinc in New Brunswick, British Columbia and the Northwest Territories, but smaller amounts are also produced as a byproduct of base-metal and precious-metal mines in Ontario, Manitoba and the Yukon Territory. The former zinc-lead producer - Cyprus Anvil Mining Corporation - remained shutdown in 1985. A proposal by Curragh Resources Corporation to resume production in 1986 could re-establish the Yukon Territory as a major mine producer of lead.

Primary lead metallurgical works are located in Belledune, New Brunswick and Trail, British Columbia. Capacities of the lead refineries are 72 000 tpy and 136 000 tpy, respectively. Nine secondary lead plants - those recycling lead scrap - have a combined capacity of 123 000 tpy. These are located in Quebec, Ontario, Manitoba and British Columbia. In 1985, Canadian mines produced an estimated 280 000 t of lead in concentrates, some 25 000 t less than in 1984. Production of refined lead from all sources totalled 250 000 t which was nearly the same as in 1984. Consumption of refined lead, as measured by producer shipments, is estimated at 110 000 t in 1985.

Brunswick Mining and Smelting Corporation Limited closed its No. 12 mine for two weeks over the 1985 Christmas period. Previous to this shutdown a 10 per cent production cutback was announced in October because of low zinc prices. Further production cuts at Brunswick's operations were also announced for 1986. Modifications at the concentrator continued throughout 1985. A broken tail rope interfered with ore hoisting at the No. 3 shaft from mid-February until the end of March. In May, Brunswick's Smelting Division acquired the fertilizer plant adjacent to the lead smelter for $5.3 million from Noranda Inc.

Kidd Creek Mines Ltd. - a copper-zinc-silver producer - also produces a small amount of low-grade lead concentrate as a byproduct of its "C" ore circuit at Timmins, Ontario.

During 1985, Noranda Inc. began work on a 19-claim property of Hucamp Mines near the Geco Mine. Mineralization is similar to that of Noranda's Geco Division. At Noranda Inc.'s wholly-owned Lyon Lake division and 60 per cent-owned Mattabi Mines Limited operations, workers went on strike June 20 to back demands for a new, two-year contract. Together these mines produce about 7 000 tpy of lead in concentrate. The operations were reported to be running between 25 per cent and 30 per cent of capacity in early-August, and concentrate shipments were affected. Agreement on the labour contract was reached in September.

Hudson Bay Mining and Smelting Co., Limited's Snow Lake and Flin Flon concentrators, which are fed by seven underground copper-zinc mines, produce a small amount of byproduct lead concentrate at the Snow Lake mill.

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In November, the federal government proposed a $69 million financial package to Cominco Ltd. which would be part of the company's $270 million program to replace its 40-year-old lead smelter at Trail, British Columbia. The conventional sinter-blast furnace smelter would be replaced by a new flash-smelting process with significant operating cost savings. The initial $140 million phase of modernization could be completed by 1988. Total cost of the project would be $270 million.

Westmin Resources Limited officially opened its new zinc-copper mine and mill complex at Myra Falls, on Vancouver Island, British Columbia in September 1985. Milling capacity at Myra Falls has been tripled to 2 700 tpd. The operation should continue to yield about 2 000 to 3 000 t of lead in concentrates annually.

It was reported in late-September that Regional Resources Ltd. and Nanisivik Mines Ltd. were planning a preliminary feasibility study on the Midway property near Watson Lake, Yukon Territory. The operator, Regional Resources, hopes to increase reserves to at least 2 million t at the richer Silver Creek zone to provide justification for a production decision.

Dome Petroleum Limited agreed to sell certain assets of Cyprus Anvil Mining Corporation to Curragh Resources Corporation for an undisclosed sum. The open-pit, zinc-lead mine at Faro, Yukon Territory was closed in June 1982 because of heavy cash losses. Curragh intends to resume operation of the mine in 1986. In 1981 the operation produced 66 000 t of lead and 107 000 t of zinc in concentrates.

Lower zinc and lead prices, higher stripping ratios and increased dewatering and exploration costs negatively affected Pine Point Mines Limited's open-pit, zinc-lead operations in 1985. With these difficulties Pine Point announced, in late-December, a renewed mining plan which the company expects will allow it to operate profitably over the next two years. The plan includes a boost in production rates to maximize cash flow while stressing exploration on the eastern part of the property. Meanwhile, in September 1985, Billiton Canada Ltd., a subsidiary of Billiton B.V. of The Netherlands, sold its 11.25 per cent interest in Nanisivik Mines Ltd. to Mineral Resources International Limited for $Cdn 3 million as part of an overall restructuring of its activities. Nanisivik produces a small amount of lead concentrate which is shipped to European smelters.

WORLD DEVELOPMENTS

Non-socialist world consumption of refined lead from all sources fell to an estimated 3.85 million t from 3.94 million t in 1984. Production of refined lead from both primary and secondary lead plants in the non-socialist world rose about 4.12 million t from 4.00 million in 1984. Mine production of lead also showed an increase to 2.52 million t from an estimated 2.36 million t of lead in concentrates in 1984. The largest mine producers of lead in the non-socialist world are Australia, the United States, Canada, Peru and Mexico. The largest refined metal producers, lead scrap recyclers, and consumers are Europe, the United States and Japan. Canada, Australia, Mexico and Peru also rank highly as refined lead producers but are not major consumers or recyclers of lead.

Consumption of refined lead in Europe fell from 1.64 million t to an estimated 1.60 million t. Lead-acid batteries represent the largest end-use with an estimated 45 per cent of the market. The declining usage of other end-uses in general will mean that the relative importance of batteries will continue to grow. In March 1985 the Council of European Communities passed directives to reduce the permissible lead content of leaded fuel to 0.15 g/l of lead and ensure the balanced distribution of unleaded petrol from October 1, 1989 or earlier. Gasoline additives account for only a small part of total European demand.

One major European secondary lead producer - the 40 000 tpy plant of Paul Bergsoe & Son A/S in Glostrup, Denmark - was closed permanently in early-1985. However, with subsequent improvements in the availability of scrap in Europe, total European recovery of secondary lead is expected to be comparable to the 760 000 t recovered in 1984.

The stagnation of consumption and low prices apparently did not affect the output of primary lead plants in Europe. Refined lead output from primary materials was about the same as in 1984 - 840 000 t. Europe's primary smelting and refining capacity - at about 914 000 tpy and 1 097 000 tpy, respectively, will be augmented by the start-up of a major 84 000 tpy lead smelter and 50 000 tpy refinery expansion in 1986 by SAMIM S.p.A. The opening of a new mine and expansion of existing ones will increase SAMIM's mine capacity by 13 000 t of lead.

In line with the trend established in recent years, Europe's mine production of lead fell to 396 000 t in 1985 from 422 000 t in 1984, although the drop was moderated slightly by the expansion of Asturiana de Zinc S.A.'s Reocin zinc-lead mine in Spain. About 9 000 tpy of lead-in-concentrate capacity was added there in 1985. Greenex A/S's Black Angel lead-zinc-silver mine in Greenland was intending to suspend production from late-November until the end of January 1986. However, agreements by the parent company, Vestgron Mines Limited, with Cominco Ltd. (62.5 per cent owner of Vestgron), bankers and the Governments of Greenland and Denmark require Greenex to decide by April 11, 1986 whether to continue operating the mine or permanently discontinue operations by June 1, 1986. Greenex lead concentrates have been an important source of feed for European smelters since 1974. Meanwhile, lead concentrate production in 1986 is expected to be cut by 50 per cent to 5 000 tpy at Tara Mines Ltd.'s Navan lead-zinc mine in County Meath, Ireland. Development of Bula Ltd.'s lead-zinc orebody near Navan, Ireland - a project which was expected to add 10 000 tpy of lead in concentrate in 1988 - is now not expected to proceed. Tara Mines Ltd. turned down an opportunity to purchase the company's assets and debts of 23.8 million Irish pounds.

In the United States, consumption of refined lead fell to an estimated 1.02 million t in 1985 from 1.09 million t in 1984. Demand from the lead-acid battery market accounts for over 70 per cent of total consumption. A drop in production of replacement batteries was accompanied by climbing inventories. Also, demand for other end-uses continued to deteriorate in 1984. The U.S. Environmental Protection Agency announced on March 25, 1985 its final rules on the use of lead in gasoline. After July 1985, gasoline refiners were required to limit lead in gasoline to 0.50 g/U.S. gal (0.13 g/l), down from the previous level of 1.10 g/U.S. gal (0.29 g/l). On January 1, 1986, this limit will again drop to 0.1 g/U.S. gal (.03 g/l). However, refiners who remain below the 0.50 limit in 1985 are allowed to bank, transfer or sell rights for the difference between the allowed and actual level through 1987. This will allow some flexibility during the adjustment process. Gasoline importers may also use the banking scheme. In 1984, some 90 000 tpy of lead was consumed for the manufacture of tetraethyl lead (TEL).

In 1984, 107 000 tpy of U.S. recycling capacity was shutdown indefinitely. A further 201 000 tpy of capacity was either permanently or indefinitely shutdown during 1985. Total production from secondary materials fell well under the 618 000 t level of 1984. This is not expected to improve in future since the U.S. Environmental Protection Agency, in late-1985, effectively categorized secondary lead smelters and battery breakers as hazardous waste treatment, storage or disposal facilities. Companies falling under this category require environmental impairment liability insurance to get Federal permits to continue operating. Secondary producers are already concerned with the viability of the U.S. lead-acid battery recycling industry in general. This will represent an additional cost burden.

In 1985, the U.S. primary lead industry's output grew in relation to 1984s strike-plagued levels. However, ASARCO Incorporated's 82 000 tpy El Paso, Texas smelter was shutdown indefinitely in September because of a shortage of concentrates; in late-October AMAX-Homestake Lead Tollers temporarily shutdown their 127 000 tpy Boss, Missouri smelter/refinery; and St. Joe Lead Co. experienced production problems at its 204 000 tpy smelter. In June, ASARCO Incorporated announced that its East Helena, Montana 82 000 tpy lead smelter would reduce operations from a seven to a five-day work week with a consequent drop in output of lead bullion of about 20 per cent. However, it was reported in September that the plant had returned to a seven-day schedule and was running at full capacity. Current primary smelter and refinery capacities in the United States are about 390 000 tpy and 470 000 tpy, respectively.

Mine production of lead rose by 110 000 t to an estimated 440 000 t in 1985. In 1984, strikes at St. Joe Lead Co.'s Viburnum Division and Amax Lead Company of Missouri's Buick Mine significantly affected output from April until the end of the year. With these mines back in operation and with the September opening of ASARCO Incorporated's new West Fork lead-zinc mine in Missouri (projected 46 000 tpy lead-in-concentrate output possibly by 1987), a major turnaround in mining output was achieved. In May 1985, the Alaskan Government passed a bill for a $175 million bond or note issue to finance the Delong Mountain transportation route to the 85 million t Red Dog deposit being developed by Cominco American Incorporated and Nana Regional Corp. Grades in the deposit are 17 per cent zinc, 5 per cent lead and 82 g/t of silver. The deposit could be a major producer of lead concentrates by 1989.

The U.S. Comprehensive Environmental Response, Compensation and Liability Act of 1980, known as CERCLA or Superfund, expired on September 30 although other provisions of the legislation continue in force. About 30 bills have been introduced in the U.S. Congress to make further provisions of $5-10 billion to the fund to clean up hazardous waste sites. Lead is included in the House bill as a taxable material.

Consumption of refined lead in Japan is expected to be close to 400 000 t in 1985 as a result of production boosts in the automobile and electronics sector. Total demand for lead in OEM (original equipment) and replacement batteries represents about 60 per cent of the Japanese market.

Japan's total recovery of lead from secondary materials is expected to remain unchanged in 1985 at 130 000 t. With secondary lead plant capacity about 126 000 tpy and limited mine capacity, Japanese requirements for concentrate remained high. Primary lead production is also expected to remain unchanged from the 230 000 t in 1984. Japan's primary smelting and refining capacities are 318 000 and 295 000 tpy, respectively. Mine production is expected to be about the same as in 1984 - about 50 000 t of lead in concentrates.

Mexico's mine production of lead continues to grow despite lower base-metal prices. Production of lead in concentrate is expected to be about 200 000 t in 1985. The high silver content of Mexican ores is still providing incentive to develop new capacity, although silver prices have been lower in recent years. Some 8 000 t of mine production capacity may be added by 1987. Most of this is processed at two large metallurgical plants with a combined capacity of nearly 300 000 t. Production of refined lead - including some 30 000 t of recycled lead in 1985 is estimated at 180 000 t.

Peru's mine and refined metal production are estimated to be nearly 200 000 t and 90 000 t, respectively, in 1985. Most refined lead is produced at Empresa Minera del Centro del Peru S.A.'s (Centromin Peru) 90 000 tpy conventional lead smelter. In 1986, production from FUDECONSA's new 12 000 tpy primary smelter/refinery is expected to boost output. Expansions at existing mines were offset to some extent by closures of small mines. However, mine production in 1986 will be boosted by three more projects with a combined output of 11 000 t of lead in concentrate.

Australia, which in 1983 supplanted the United States as the western world's largest mine producer of lead, produced an estimated 480 000 t of lead in concentrate for domestic and foreign smelters in 1985 - some 60 000 t higher than in 1984. The increase, which was in part attributable to the opening of the Woodcutters zinc-lead-silver, open-pit mine late in the year, was to a greater degree the result of increased output from existing major operations. Mine expansions may add another 20 000 tpy of production capacity by 1987. Most Australian concentrates are processed domestically to refined metal at the world's largest lead metallurgical plant, Broken Hill Associated Smelters Pty. Ltd.'s 250 000 tpy Port Pirie conventional smelter, to lead bullion at either Mount Isa Mines Ltd.'s 180 000 tpy smelter or the 30 000 tpy ISF plant of Sulphide Corp. Pty. Ltd. at Cockle Creek. Total refined metal production, alone, is expected to be about 220 000 t in 1985. Mount Isa Mines Ltd. installed and operated a second Isasmelt smelter in September. This boosted smelter production in 1985. Lead bullion from this plant is exported abroad. Australia is the world's largest exporter of refined lead, lead bullion and lead concentrates. Exports of mineral products in general have improved with the devaluation of the Australian dollar.

STOCKS

Month-end stocks of refined lead at the London Metal Exchange (LME) peaked in January at 56 000 t and then declined to about 35 000-36 000 t by the end of June. Thereafter, LME stocks increased steadily to reach 61 000 t by the end of 1985. A steady rise in producer stocks in the United States from 48 000 t at the end of 1984 to 118 000 t by the end of June 1985 was offset slightly by a reduction in Australian producer stocks, but stocks held by producers in general rose from 209 000 t at the end of 1984 to 264 000 t at the end of June 1985. Consumer and merchant stocks did not change greatly from the level at the end of 1984.

The U.S. Administration introduced a proposal to restructure the National Defense Stockpile of strategic materials. Under the terms of the plan, which classifies lead as a Tier II metal, stockpile requirements would be reduced to some 270 000 t - about one half of current stockpile levels. The proposal, including provisions for disposals, is not expected to take effect before September 30, 1986.

PRICES

The average U.S. producer price of refined lead as quoted by Metals Week, was 19 cents (U.S.) per pound in January 1985. It fell to 17.7 cents in March 1985 before rising to an average 20.1 cents in May. Thereafter the price of lead stabilized at about 19 cents per pound. The overall average for 1985 was 19 cents per pound (U.S.) some 6½ cents less than in 1984. The London Metal Exchange (LME) price fell from an average £332 per t in 1984 to £270 per t in 1985.

USES

Lead's malleability allows it to be rolled to thicknesses of 5 cm to 0.01 mm and in varying widths and shapes for use in gaskets, washers, impact extrusion blanks, soundproofing radiation protection and architectural applications. Lead can also be extruded in the form of pipe, rod, wire or other cross-sections and can also be extruded around power cables. Flux-cored, tin-lead solders and cable sheathing are typical extrusions. The low melting point of lead allows simple casting for massive counterweights, sailboat keels and minute diecastings for instruments. Type metal is noted for its ability to reproduce fine detail. Storage battery grids may be cast or rolled and expanded. Grids, together with battery posts and battery oxides represent the largest uses for lead. Lead shot may be used in ammunition, for weight or sound/radiation shielding where accessibility is a problem. Lead and lead alloy powder particles and flakes are added to pipe joint compounds, powder metallurgy products - such as bearings, brake linings, clutch facings - solder pastes, and may be incorporated into rubber and plastics for soundproofing curtains.

Calcium, antimony, tin or arsenic are generally added to impart castability, strength or hardness to lead alloys. When added to steel, brass or bronze, lead improves machineability. Alloyed with tin, lead is used as a hot-dip coating alloy to produce terne-coated steel. Lead oxides and other compounds are also used in paints, pigments, glazes and a wide variety of chemicals. Tetraethyl lead - a gasoline additive - continues to decline in importance but still represents a significant market particularly for primary refined lead. New uses and existing ones are being evaluated by the International Lead and Zinc Research Organization. Nuclear wastes are generated at about 15 300 tpy and this is expected to grow. One existing nuclear material container design would require 5.25 t of lead for each t of waste. Corrosion characteristics of lead and lead alloys in various environments are being tested for this application. Several projects are under way to optimize the performance of shallow-discharge (starting lighting/ignition type) and deep-discharge (traction type) lead-acid batteries, and to investigate glass mat separations for preventing acid spillage. Testing of a load-levelling battery for large users and producers of electricity may lead to a large potential market - perhaps 1 to 5 million t worldwide in the long-term. Antioxidants for asphalt are well into the testing stage and potentially could have a market of 50 000 tpy of lead for the United States alone.

OUTLOOK

In recent years the declining price of lead, shortages of scrap have affected the competitiveness of the lead recycling industry. With the closure of major lead recycling facilities both in the United States and in Europe and with further action by U.S. environmental authorities on the secondary lead industry, scrap availability may improve regionally despite persistently low lead prices. On the other hand, primary lead smelters, which now compete more directly with the secondary lead sector already face a tight supply particularly of clean lead concentrates. Falling treatment charges and falling or low prices of associated zinc, silver and copper will affect the economies of some primary smelters. New smelting technology apparently offers opportunities in the long-term for primary lead smelters to reduce operating costs, but financial and other considerations may demand more attention in the short-term.

Non-socialist world consumption is only expected to improve marginally in 1986, and stocks of refined lead available to the market are more likely to increase than decrease. In Canada consumption could be affected by three automakers' decisions to construct new assembly plants. In the long run, non-socialist world market growth is expected to be slow - about 1 per cent per annum. For both the short-term and the long term the price of lead is expected to remain low by historical standards.

For all lead producers, the need to control available inventory will be crucial in the short-term. No less important is the long-term need to support research into new applications and improvement of existing ones - a need which is particularly clear given recent developments in the lead market.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
32900-1	Ores of lead	free	free	free	free
33700-1	Lead, old scrap, pig and block	free	free	1¢/lb	free
33800-1	Lead in bars and in sheets	4.3	4.3	25	2.5
33900-1	Manufacturers of lead not otherwise provided for	12	12	30	free

MFN Reductions under GATT (effective January 1 of year given)	1985	1986	1987
		(%)	
33800-1	4.3	4.1	4.0
33900-1	12.0	11.1	10.2

UNITED STATES (MFN)

602.10	Lead bearing ores per lb of lead content	0.75¢
624.02	Lead bullion (lead content)	3.5%
624.03	Other unwrought unalloyed lead (effective until December 31, 1988)	3.0% but not less than 1.0625 cents per pound to December 31, 1988

		1985	1986	1987
			(%)	
624.04	Lead waste etc.	2.7	2.5	2.3

EUROPEAN ECONOMIC COMMUNITY: (MFN)		1985	Base Rate (%)	Concession Rate
26.01	Lead ores & concentrates	free	free	free
78.01	Lead unwrought	3.5	3.5	3.5
	Lead waste & scrap	free	free	free
JAPAN (MFN)				
26.01	Lead ores & concentrates	free	free	free
78.01	Lead unwrought			
	Unalloyed	6.4	7.5	6.0
	Alloyed	7.9	12.0	6.5
	Other	5.3	7.0	4.7
	Lead waste & scrap	3.2	5.0	3.2

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, Vol. 27, No. L 320, 1985; Customs Tariff Schedules of Japan, 1985.

TABLE 1. CANADA, LEAD PRODUCTION, TRADE AND CONSUMPTION

	1983		1984		1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production						
All forms[1]						
British Columbia	112 942	66,659	85 147	62,915	106 435	61,429
New Brunswick	70 346	41,518	71 732	53,003	73 399	42,362
Northwest Territories	81 161	47,901	90 198	66,647	77 631	44,804
Ontario	6 473	3,820	9 478	7,004	4 223	2,437
Newfoundland	-	-	4 845	3,580	-	-
Yukon	520	307	2 083	1,539	1 520	877
Manitoba	519	307	817	604	682	394
Total	271 961	160,512	264 301	195,292	263 890	152,304
Mine output[2]	251 383	..	311 391	..	280 000	..
Refined production[3]	178 043	..	174 987	..	180 000	..
					(Jan.-Sept.)	
Exports						
Lead contained in ores and concentrates						
Belgium-Luxembourg	53 545	9,518	38 499	8,207	-	-
France	1 810	418	2 200	516	1 175	225
Italy	3 702	684	2 626	672	4 062	796
Netherlands	-	-	2 973	1,325	-	-
West Germany	15 049	3,021	15 469	3,553	2 211	424
United Kingdom	4 914	1,009	2 311	606	2 442	456
United States	6 439	2,416	8 859	2,662	10 870	3,826
Japan	36 590	5,900	41 271	8,700	..	..
Total	122 049	22,966	114 208	26,241	..	..
Lead and alloy scrap, dross, etc. (gross weight)						
Belgium-Luxembourg	-	-	52	20	892	302
Netherlands	-	-	178	144	569	166
Spain	758	123	94	20	204	45
United Kingdom	332	119	147	64	190	107
West Germany	363	96	466	170	269	50
United States	4 960	1,925	3 634	1,802	1 806	876
Brazil	-	-	-	-	506	287
Korea, Republic of	756	165	136	66	447	76
Taiwan	125	25	678	112	59	8
Other non-socialist countries	236	98	77	20	264	36
Total	7 530	2,551	5 462	2,418	5 206	1,953
Lead pigs, blocks and shot						
Belgium and Luxembourg	13 008	6,981	6 155	3,944	4 721	2,552
Italy	4 735	2,643	2 566	1,724	302	193
West Germany	5 551	2,497	2 063	1,030	1 096	483
United Kingdom	28 780	12,699	27 075	13,492	19 918	8,569
United States	63 661	35,144	79 047	53,498	52 585	26,992
U.S.S.R.	12 498	6,337	1 500	3,923	-	-
P.R. China	999	436	16	3	-	-
Other non-socialist countries	18 031	9,570	5 727	3,020	3 367	1,758
Total	147 263	76,307	124 149	80,634	81 989	40,547
Lead fabricated materials nes						
United States	10 696	6,727	17 396	13,050	10 109	6,307
Other non-socialist countries	691	416	1 030	748	1 041	836
Total	11 387	7,143	18 426	13,798	11 150	7,143

TABLE 1. (cont'd)

	1983		1984		Jan.-Sept. 1985	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Imports						
Lead pigs, blocks and shot	2 551	1,642	6 314	4,352	4 000	2,469
Lead oxide, dioxide and tetroxide (gross weight)	1 409	1,419	1 224	1,381	1 241	1,125
Lead fabricated materials nes	1 298	1,526	653	974	347	633
Lead in concentrates	18 515	6,528	21 512	11,696	..	..
Lead in crude ores	34	5	52	12	270	86
Lead in dross, skimmings and sludge (gross weight)	271	47	46	10	-	-
Lead and lead alloy scrap (gross weight)	58 073	87,748	48 137	7,314	29 312	3,736

	1982			1983			1984P		
	Primary	Secondary[5]	Total	Primary	Secondary[5] (tonnes)	Total	Primary	Secondary[5]	Total
Consumption[4]									
Lead used for, or in the production of:									
Antimonial lead	1 471[r]	x	x	1 499	x	x	4 813	x	x
Battery and battery oxides	25 855[r]	6 708[r]	32 563[r]	27 792	5 555	33 347	35 228	5 208	40 436
Cable covering	x	x	x	x	x	x	x	x	x
Chemical uses; white lead, red lead, litharge, tetraethyl lead, etc.	16 623	4 643	21 266	14 834	4 515[r]	19 349[r]	15 651	4 572	20 223
Copper alloys; brass, bronze, etc.	110	24	134	139[r]	89	228[r]	187	102	288
Lead alloys:									
solders	1 752	7 495	9 247	1 812	7 633	9 445	1 527	19 690	21 217
others (including babbitt, type metals, etc.)	64	14 204	14 268	158	10 165	10 323	61	296	357
Semi-finished products: pipe, sheet, traps, bends, blocks for caulking, ammunition etc.	4 217	x	x	4 799	x	x	4 815	x	x
Other lead products	4 944	x	x	2 977	x	x	3 332	x	x
Total, all categories	55 036[r]	48 020[r]	103 056[r]	54 010[r]	40 830[r]	94 840	65 614	64 933	130 547

Sources: Energy, Mines and Resources Canada; 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] Available data, as reported by consumers. [5] Includes all remelt scrap lead used to make antimonial lead.
P Preliminary; [r] Revised; - Nil; .. Not available; nes Not elsewhere specified; x Confidential, but included in "other".

TABLE 2. CANADA, LEAD PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975, 1980-85

	Production		Exports				
	All forms[1]	Refined[2]	In ores and concentrates	Refined	Total	Imports Refined[3]	Consumption[4]
			(tonnes)				
1970	353 063	185 637	186 219	138 637	324 856	1 995	85 360
1975	349 133	171 516	211 909	110 882	322 791	1 962	89 192
1980	251 627	162 463	147 008	126 539	273 547	2 602	106 836
1981	268 556	168 450	146 307	119 816	266 123	9 220	110 931
1982	272 187	174 310	106 744	146 130	252 874	5 661	103 056
1983	271 961	178 043	85 459	147 263	232 722	2 550	94 840r
1984	264 301	174 987	114 208	124 149	238 357	6 314	130 547p
1985p	263 890		..	81 989[5]	..	4 000[5]	110 000e

Sources: Energy, Mines and Resources Canada; 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 as measured by survey of consumers except for 1985 estimate. [5] January to September 1985.
p Preliminary; r Revised; e Estimated; .. Not available.

TABLE 3. CANADA, PRIMARY REFINED LEAD CAPACITY, 1984

Company and Location	Annual Rated Capacity
	(tonnes of refined lead)
Brunswick Mining and Smelting Corporation Limited Belledune, New Brunswick	72 000
Cominco Ltd. Trail, British Columbia	136 000
Canada total	209 000

TABLE 4. NON-SOCIALIST WORLD REFINED LEAD PRODUCTION[1]

	1983	1984	1985e
		(tonnes)	
North America	1 206	1 175	1 257
Central and South America	358	362	386
Europe	1 521	1 604	1 581
Africa	150	140	166
Asia	438	494	508
Oceania	230	225	222
Total	3 903	4 000	4 120

[1] From all sources but excluding lead from secondary materials treated by remelting alone.
e Estimated.

TABLE 5. CANADA, MAJOR LEAD-BEARING DEPOSITS CONSIDERED MOST PROMISING FOR FUTURE PRODUCTION

Company and Location	Deposit Name	Indicated Tonnage	Per Cent Lead	Lead Content
		(000 tonnes)		(000 tonnes)
New Brunswick				
Anaconda Canada Exploration Ltd. Cominco Ltd.	Caribou	44 600	1.70	757
Kidd Creek Mines Ltd. and Bay Copper Mines Limited	Halfmile Lake	12 350	2.52	311
Northumberland Mines Limited Kennecott Minerals Company	Murray Brook	23 700	0.86	204
		80 650	1.6	1 272
British Columbia				
Nanisivik Mines Ltd. Regional Resources Ltd. Canamax Resources Inc. Procan Exploration Company	Midway Project	6 078	6.62	402
Curragh Resources Corporation Dome Petroleum Limited	Cirque	21 700	2.7	586
		27 778	3.6	988
Yukon Territory				
Curragh Resources Corporation	DY Zone	21 000	5.6	1 176
	Swim Lake	4 536	4.0	181
Hudson Bay Mining and Smelting Co., Limited	Tom	8 000	8.6	688
Abermin Corp. and Ogilvie Joint Venture	Jason	14 062	7.09	997
Placer Development Limited and United States Steel Corporation	Howard's Pass	120 000	2.1	2 500
Sulpetro Minerals Limited and Sovereign Metals Corporation	MEL	5 000	2.0	100
		167 603	3.4	5 642
Northwest Territories				
Cadillac Explorations Limited	Prairie Creek	1 452	11.16	162
Cominco Ltd. and Bathurst Norsemines Ltd.	Seven deposits	19 100	0.75	143
Kidd Creek Mines Ltd.	Izok Lake	11 023	1.4	154
Westmin Resources Limited Du Pont Canada Inc.	seven zones	7 260	3.3[e]	240[e]
		38 835	1.80	699
Other, Canada		16 406	4.7	777
Canada		260 000	3.6	9 400

[e] Estimated by Mineral Policy Sector.

TABLE 6. NON-SOCIALIST WORLD REFINED LEAD CONSUMPTION[1]

	1983	1984	1985e
		(000 t)	
North America	1 231	1 214	1 130
Central and South America	217	260	267
Europe	1 558	1 638	1 600
Africa	97	99	108
Asia	626	677	674
Oceania	71	71	69
Total	3 800	3 959	3 848

Source: International Lead and Zinc Study Group, EMR estimates.
[1] Total consumption of refined pig lead, including the lead content of antimonial lead.
[e] Estimated.

TABLE 7. RELATIVE LEAD-IMPORTANCE OF PRINCIPAL USES, NON-SOCIALIST WORLD, 1985e

	Europe	United States	Japan
	(per cent of total demand)		
End Uses			
Batteries	45	70	60
Cable Sheathing	5	1	5
Pipe and Sheet	20	3	5
Chemicals[1]	20	10	20
Alloys	5	5	5
Other	5	10	5

[1] Including tetraethyl lead.
[e] Estimated, totals may not add to 100 per cent due to rounding.

TABLE 8. NON-SOCIALIST WORLD MINE PRODUCTION

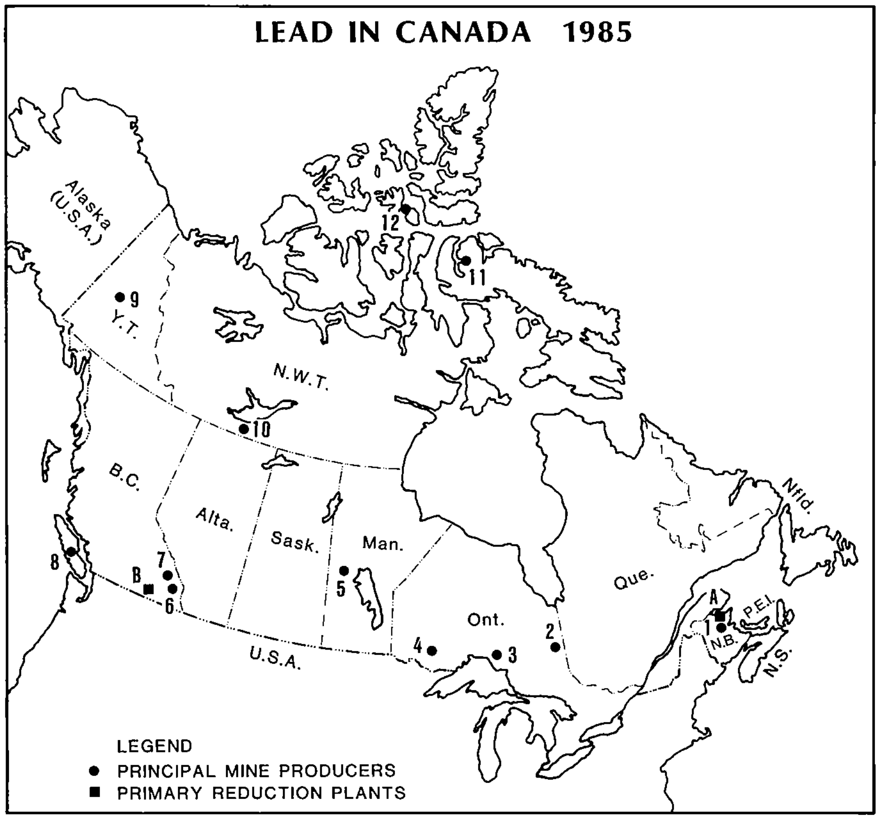
	1983	1984	1985e
		(000 t)	
North America	714	640	720
Central and South America	470	470	490
Europe	411	420	400
Africa	256	273	270
Asia	131	140	160
Oceania	466	418	480
Total	2 448	2 361	2 520

Source: International Lead and Zinc Study Group, EMR estimates.
[e] Estimated.

TABLE 9. MONTHLY AVERAGE LEAD PRICES

	United States Producer	Canadian Producer	LME Settlement
1984	(U.S. ¢ per lb)	(Cdn. ¢ per lb)	(£ per tonne)
January	25.1	31.2	282
February	24.1	30.0	280
March	25.0	31.1	316
April	26.4	33.0	339
May	25.4	33.0	326
June	28.2	34.8	352
July	30.5	41.5	374
August	28.2	38.0	356
September	24.2	33.4	320
October	22.3	31.5	339
November	25.2	33.4	356
December	21.9	31.2	350
Year Average	25.5	33.5	332
1985			
January	19.1	26.5	373
February	18.8	25.4	337
March	17.7	24.2	313
April	19.9	27.2	315
May	20.1	27.5	301
June	19.0	26.4	304
July	18.9	26.0	292
August	19.1	26.2	299
September	19.2	26.8	294
October	18.9	26.0	277
November	19.0	26.0	274
December	19.0	26.0	270
Year Average	19.0	26.2	304

Source: Metals Week, Northern Miner.



Princial mine producers
(numbers refer to locations on map above)

1. Brunswick Mining and Smelting Corporation Limited
2. Kidd Creek Mines Ltd.
3. Noranda Inc. (Geco Division)
4. Mattabi Mines Limited
   Noranda Inc. (Lyon Lake, "F" Group)
5. Hudson Bay Mining and Smelting Co., Limited
6. Cominco Ltd. (Sullivan mine)
   Teck Corporation (Beaverdell mine)
7. Dickenson Mines Limited (Silmonac mine)
8. Westmin Resources Limited (Lynx and Myra, H.W.)
9. United Keno Hill Mines Limited (Elsa)
10. Pine Point Mines Limited
11. Nanisivik Mines Ltd.
12. Cominco Ltd. (Polaris mine)

Metallurgical Plants

A. Brunswick Mining and Smelting Corporation Limited, Smelting Division, Belledune

B. Cominco Ltd., Trail

Lime

D.H. STONEHOUSE

SUMMARY 1985

The principal markets for lime in Canada continue to be in the steel industry, the pulp and paper industry and the mining industry. Slight recovery in the steel industry sector offset continued depression in the nonferrous mining sector during 1985, keeping demand for lime close to the levels of the last three years. Significant markets for lime have yet to develop in the environmental control field in Canada, although the possibility of use in water and sewage treatment and in the removal of sulphur dioxide from smelter gases and from thermal power plant emissions is becoming more likely.

During 1985, Dickenson Mines Limited and the Havelock Lime Group of Companies continued to operate the lime and limestone products facility at Havelock, New Brunswick as a joint venture. Dickenson completed the purchase of a 60 per cent interest in the assets of the Havelock Lime Group, January 1, 1984 and will pick up the remaining 40 per cent on January 1, 1987. High operating levels at mining and pulp and paper operations in the Maritime Provinces have resulted in record activity at Havelock Lime in both the calcined lime sector and the agricultural limestone area. Domtar Inc. effected its withdrawal from the lime business in Canada with the sale of its Beachville, Ontario quarry and calcining plant to BeachviLime Limited in 1984. There were no published plant takeovers or property sales within the Canadian lime sector during 1985.

In July 1985, Reiss Lime Company of Canada, Limited announced plans for a $13-million project in northern Ontario to manufacture a cement substitute using blast-furnace slag from the steel industry. Contracts for two facilities were issued - a slag granulation plant at The Algoma Steel Corporation Limited, Sault Ste. Marie steel works, and a grinding plant for the granulated slag at the Reiss lime plant at Spragg, Ontario. The company plans to produce about 200 000 tpy of slag cement to be used mainly by the mining industry in mine backfilling projects.

Canadian lime production in 1985 was increased in only two of the six producing provinces from a total production capacity of approximately 12 000 tpd. Capacity is large enough and is well distributed to meet foreseeable demand.

Dolomitic limestone and magnesite deposits have been investigated as sources of magnesia. The most recent development in this area is that of Baymag Mines Co. Limited which has quarried a high-grade magnesite at Eon Mountain in British Columbia since 1982. The ore is calcined in a refurbished kiln at Canada Cement Lafarge Ltd.'s Exshaw, Alberta plant to produce caustic magnesia and refractory grade MgO. The Canadian Refractories Division of Dresser Canada Inc. has produced refractory products for many years from a magnesitic dolomite at Kilmar, Quebec.

CANADIAN DEVELOPMENTS

Lime is a high-bulk, comparatively 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 preferred location for a lime plant is obviously near the principal lime markets, adjacent to a source of high-quality raw material and close to a supply of energy. The more heavily populated and industrialized provinces of Ontario and Quebec together produce over 80 per cent of Canada's total lime output, with Ontario contributing about two-thirds of Canada's total. Production figures do not include some captive production such as that from pulp and paper plants that burn sludge to recover lime for reuse in the causticization process.

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Exports of lime from Canada have continued to decline since 1979 when over 490 000 t was exported, principally to the United States. In 1984, about 186 000 t, mainly from Ontario producers, was exported.

Freight costs can represent a large part of the consumer's cost. Production costs have increased significantly as a result of higher energy costs. The industry, on average, uses about 6.4 gigajoules per t of production. New plants have incorporated preheater systems, and the need to replace some of the older less-efficient production capacity with fuel-conserving equipment is well recognized. A new-design, short-rotary kiln (65 metres) and preheater system can reduce energy consumption to about 5.1 gigajoules per t of product. The manufacturer of the new lime kiln for Domlim Inc. at St. Adolphe de Dudswell, Quebec states that with an on-line computerized process control system the "multi-column, parallel-flow, regenerative, vertical kiln" at 360 tpd rated capacity would consume less than 4.2 gigajoules per t.

Average Canadian prices for high calcium quicklime and for high calcium hydrated lime, fob plant, in bulk, were $66.14 a t and $69.06 a t respectively at the end of 1983. At mid-1984 these prices had risen to $70.11 and $73.19 a t but at the end of 1984 were down to $63.60 and $66.40 reflecting a highly competitive market.

USES

Carbonate rocks are basic to industry. They form about 15 per cent of the earth's crust and fortunately are widely distributed and easily exploitable. The principal carbonate rocks utilized by industry are limestones - sedimentary rocks composed mainly of the mineral calcite ($CaCO_3$) - and dolomites - sedimentary rocks composed mainly of the mineral dolomite ($CaCO_3 \cdot MgCO_3$). Commonly termed limestones, they can be classified according to their content of calcite and dolomite. Their importance to the construction industry is not only as building stone and aggregate but as the primary material in the manufacture of portland cement and lime. Limestones are also used as flux material, in glass manufac-ture, in refractories, as fillers, abrasives, soil conditioners and in the manufacture of a host of chemicals.

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. Slaked lime is the product of mixing quicklime and water, hydrated lime is slaked lime dried and, possibly, reground.

Calcining is done in kilns of various types, but essentially those of vertical or rotary design are used. 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, and environmental regulations have necessitated the incorporation of dust collection equipment.

The metallurgical industry provides the largest single market for lime. With 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. An increase in the demand for steel will result in the need for more fluxing lime and will encourage the development of captive sources by steel producers. The pulp and paper industry is currently the second-largest consumer of lime, most of which is used in the preparation of digesting liquor and in pulp bleaching. Any reduction of activity in either of these two industry sectors, brought on by strikes or lack of product demand, can have an immediate and serious effect on the lime industry, at least regionally. Developments in mechanical fiberizing in the pulp industry could reduce the current lime requirements of this industry significantly.

The uranium industry uses lime to control hydrogen-ion concentrations 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 cynamide, calcium chloride, fertilizers, insecticides, fungicides, pigments, glue, acetylene, precipitated calcium carbonate, calcium hydroxide, calcium sulphate, magnesia and magnesium metal.

The rapidly-growing concern for the safeguarding and treatment of water supplies and the appeal for enforced anti-pollution measures should result in greater use of lime for water and sewage treatment. The removal of sulphur dioxide (SO_2) from hydrocarbon fuels, either during the burning procedure, or from stack gases by either wet or dry scrubbing, could necessitate the use of lime. This may become a major market for this commodity as SO_2 emission regulations are developed. Lime is effective for this purpose, inexpensive, and can be regenerated in systems where the economics would so dictate. The creation of large amounts of gypsum waste sludge during SO_2 removal will present a disposal problem. Paradoxically, the lime industry is itself caught up in the clean-up campaigns sponsored by various levels of government, particularly efforts directed at dust removal.

Soil stabilization, especially for highways, offers a potential market for lime. However, not all soils have the physical and chemical characteristics to 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 masonry forms have many features attractive to the building construction industry.

OUTLOOK

The short-term outlook for the lime industry in Canada is directly related to economic recovery in general which will benefit the steel, pulp and paper and mining industries, the principal consumers of lime. Developments in the Hemlo gold mining district have created new demand for lime in the past two years, but this has been offset by reduced activity in the uranium industry. In the longer term environmental legislation to control acid rain and other pollutants could have a revitalizing influence on lime production.

PRICES

Canada lime prices quoted in Corpus Chemical Report

	December 1984
Lime carloads and truckload lots fob plant	
High calcium quicklime - bulk	$63.60 per tonne
High calcium hydrated - bulk	$66.40 per tonne

fob - Free on board.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
CANADA					
29010-1	Lime	free	free	25%	free
UNITED STATES (MFN)					
512.11	Lime hydrated		free		
512.14	Lime other		free		

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610.

TABLE 1. CANADA, LIME PRODUCTION AND TRADE, 1983-85

	1983		1984		1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production[1]						
By type						
Quicklime	2 066 000	142,285	2 075 000	142,659	1 858 000	..
Hydrated Lime	166 000	14,392	174 000	14,986	152 000	..
Total	2 232 000	156,677	2 249 114	157,645	2 010 000	137,043
By province						
Ontario	1 539 636	106,540	1 536 668	101,940	1 355 100	90,115
Quebec	323 453	23,012	316 700	24,122	265 000	18,258
Alberta	145 907	10,300	159 703	13,677	146 700	10,305
British Columbia	104 096	7,846	97 290	6,560	108 100	7,300
Manitoba	..	4,899	..	6,194	..	5,725
New Brunswick	..	4,080	..	5,154	..	5,340
Total	2 231 685	156,677	2 249 114	157,645	2 010 000	137,043
					(Jan.-Sept.)	
Imports						
Quick and hydrated						
United States	22 822	2,232	23 323	2,321	15 938	1,501
Belgium-Luxembourg	-	-	1 473	286	-	-
France	22	41	52	14	-	-
Total	22 844	2,273	24 848	2,621	15 938	1,501
Exports						
Quick and hydrated						
United States	215 520	14,279	186 139	13,857	143 455	12,064
Other countries	421	87	609	133	187	47
Total	215 941	14,366	186 748	13,990	143 642	12,111

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments and quantities used by producers.
P Preliminary; .. Not available; - Nil.

TABLE 2. CANADA, LIME PRODUCTION, TRADE AND APPARENT CONSUMPTION, 1970, 1975, 1978-85

	Production[1]			Imports	Exports	Apparent Consumption[2]
	Quick	Hydrated	Total			
	(tonnes)					
1970	1 296 590	224 026	1 520 616	30 649	181 994	1 369 271
1975	1 533 944	199 195	1 733 139	30 099	234 034	1 529 204
1978	1 857 580	176 631	2 034 211	31 130	478 552	1 586 789
1979	1 662 405	196 920	1 859 325	41 480	490 863	1 409 942
1980	2 364 000	190 000	2 554 000	40 901	403 166	2 191 735
1981	2 359 000	196 000	2 555 000	23 144	432 845	2 145 299
1982	2 017 000	180 000	2 197 000	15 963	281 247	1 931 716
1983	2 060 000	166 000	2 232 000	22 844	215 942	2 038 902
1984	2 075 000	174 000	2 249 000	24 848	186 748	2 087 100
1985P	1 858 000	152 000	2 010 000	24 800e	192 000e	1 842 800e

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments and quantities used by producers. [2] Production, plus imports, less exports.
P Preliminary; e Estimated.

TABLE 3. CANADIAN LIME INDUSTRY, 1985

Company	Plant Location	Type of Quicklime
New Brunswick		
Havelock Processing Ltd.	Havelock	High-calcium[2]
Quebec		
Domlim Inc.	Lime Ridge	High-calcium[2]
	St. Adolphe de Dudswell	High-calcium
Jolichaux Inc.	Joliette	High-calcium[2]
Quebec Sugar Refinery[1]	St.-Hilaire	High-calcium
Ontario		
The Algoma Steel Corporation, Limited[1]	Sault Ste. Marie	High-calcium and dolomitic
Allied Chemical Canada, Ltd.[1]	Amherstburg	High-calcium
BeachviLime Limited	Beachville	High-calcium
Guelph DoLime Limited	Guelph	Dolomitic[2]
Timminco Limited[1]	Haley	Dolomitic
Reiss Lime Company of Canada, Limited	Spragge	High-calcium
Stelco Inc.	Ingersoll	High-calcium
Steetley Industries Limited	Dundas	Dolomitic
Manitoba		
Alberta Sugar Company[1]	Fort Garry	High-calcium
Steel Brothers Canada Ltd.	Faulkner	High-calcium
Alberta		
Canadian Sugar Factories Limited[1]	Taber	High-calcium
	Picture Butte	High-calcium
Steel Brothers Canada Ltd.	Kananaskis	High-calcium[2]
Summit Lime Works Limited	Hazell	High-calcium and dolomitic[2]
British Columbia		
Steel Brothers Canada Ltd.	Kamloops	High-calcium
BP Resources Canada Limited	Fort Langley	High-calcium

[1] Production for captive use. [2] Hydrated lime produced also.

TABLE 4. CANADA, CONSUMPTION OF LIME, QUICK AND HYDRATED, 1982 AND 1983 (PRODUCERS' SHIPMENTS AND QUANTITIES USED BY PRODUCERS, BY USE)

	1982		1983P	
	(tonnes)	($000)	(tonnes)	($000)
Chemical and metallurgical				
Iron and steel plants	940 204[2]	60,803	1 030 727[2]	72,357
Pulp and paper mills	248 298	16,058	253 902	17,823
Water and sewage treatment	85 313	5,517	73 480	5,157
Nonferrous smelters	126 597[2]	8,187	67 661[2]	4,749
Cyanide and flotation mills	41 412[2]	2,678	48 370[2]	3,394
Sugar refineries	34 729	2,246	27 735	1,946
Other industrial[1]	617 300	39,921	601 131	42,198
Agricultural	20 752[3]	1,342	16 610	1,165
Road stabilization	(4)	(4)	(4)	(4)
Other uses	82 395	5,329	112 384	7,888
Total	2 197 000	142,081	2 232 000	156,677

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Includes glassworks, fertilizer plants, tanneries, uranium plants and other miscellaneous industrial uses. [2] Figures represent quicklime only. Figures for hydrated lime are included in "other industrial" to avoid disclosing confidential company information. [3] Figures represent hydrated lime only. Figures for quicklime are included in "other uses". ([4]) Confidential figures are included in "other industrial works".
P Preliminary.

TABLE 5. WORLD PRODUCTION OF QUICKLIME AND HYDRATED LIME INCLUDING DEAD-BURNED DOLOMITE SOLD AND USED, 1983 AND 1984

	1983P	1984e
	(000 tonnes)	
U.S.S.R.	25 492	26 308
United States	13 519	14 606
Japan	7 436	7 711
West Germany	7 003	7 257
Brazil	4 990	5 171
Poland	4 000	4 082
Romania	3 728	3 901
Mexico	3 629	3 810
East Germany	3 502	3 629
Czechoslovakia	3 103	3 175
United Kingdom	3 003	3 084
France	2 993	3 084
Yugoslavia	2 921	2 994
Canada	2 232	2 280
Italy	2 204	2 268
Belgium	1 996	2 087
Other countries	16 444	17 055
Total	108 195	112 502

Sources: Energy, Mines and Resources Canada; Statistics Canada; U.S. Bureau of Mines, Mineral Commodity Summaries, 1985.
P Preliminary; e Estimated.

Magnesium

G. BOKOVAY

Western world consumption of magnesium metal is estimated to be 225 000 t in 1985, a 4 per cent increase over the 1984 level. With economic growth in the major economies expected to be relatively strong in 1986, consumption is likely to rise by a level similar to 1985.

Although magnesium demand has increased in 1985, production has outpaced demand. This has resulted in a steady buildup of magnesium inventories over the past year; a situation which producers will be forced to address in 1986. During 1985, western world producers operated at about 80 per cent of capacity.

While the demand for magnesium in aluminum based alloys, which currently constitutes the largest single use for the metal, is expected to remain constant or grow marginally, magnesium demand in other sectors will more than compensate for this declining market over the next decade. In particular, magnesium will find greater application in diecast products for the automotive industry.

With the planned construction of a new low cost primary magnesium plant in Quebec by the Norwegian producer, Norsk Hydro AS, it is expected that competition in the important North American market will intensify. While some price competition will undoubtedly strengthen the competitive position of magnesium against other materials, particularly aluminum, certain producers could face serious financial difficulties.

CANADIAN DEVELOPMENTS

The Chromasco Division of Timminco Limited is currently Canada's only producer of primary magnesium. The company operates a plant at Haley, Ontario which is located about 110 km west of Ottawa.

Chromasco uses the Pigeon magnesium process in which calcined dolomite is reduced by ferrosilicon in a vacuum retort. The ferrosilicon used in the process is produced by Chromasco at a plant located at Beauharnois, Quebec, while the dolomite is mined at the plant site.

Although the capacity of the individual vacuum retorts is quite low and the cost of their maintenance is quite high, the process is energy efficient and the output is of extremely high purity. Chromasco currently markets four grades of primary magnesium ranging from 99.8 to 99.98 per cent purity as well as a wide range of magnesium alloys.

In addition to magnesium, calcium and strontium are also produced at Chromasco's Haley plant. Magnesium capacity at the plant is about 10 000 tpy. At the end of 1985, the facility was operating at or near full capacity.

At the end of August 1985, Norsk Hydro AS, the Norwegian state-controlled metals and petrochemicals group, announced that it would conduct a feasibility study for a 50 000 tpy magnesium plant at Bécancour, Quebec. The study is expected to be completed in mid-1986. It is reported that a final decision on the $300 million project will be made before the end of 1986, with a possible production start-up in 1989. The facility would create about 400 permanent jobs.

According to Norsk Hydro AS, the new plant would be based on its own low cost proprietary process technology, currently in use by the company in Norway. Although no decision has been made as to the source of feedstock for the Bécancour facility, the company is reported to be examining several alternatives including a seawater process that would utilize locally available dolomite. In this regard, the most likely source for

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dolomite would be from a major high-grade deposit near Havre St. Pierre, 1 200 km northeast of Montreal.

Metamag-SNA Inc., which is 90 per cent owned by Société nationale de l'amiante, concluded its research project in 1985 on a process to extract magnesium metal from asbestos tailings. Although favourable initial test results were achieved, it is reported that the process is still not commercially viable.

WORLD DEVELOPMENTS

The International Magnesium Association (IMA) reported that for the first nine months of 1985, shipments of primary magnesium in the western world were 168 000 t compared to 162 300 t during the same period in 1984. The IMA also reported that western world production for the first nine months of 1985 totalled 173 300 t compared to 172 000 t for the similar period in 1984. On September 30, magnesium inventories were reported to be 43 000 t, compared to 32 900 t a year earlier.

The United States, which is the largest magnesium producer in the world, has three primary magnesium producers. During the first nine months of 1985, production in United States was reported to be about 100 000 t compared to about 107 000 t during the same period in 1984. Dow Chemical Company, the largest U.S. producer, operates a 115 000 tpy electrolytic primary magnesium plant at Freeport, Texas. The magnesium chloride feedstock for the plant is derived from a seawater/dolomite process. This plant has operated since July 1984, at about 75 per cent of capacity.

In 1984, Dow completed the first phase of a modernization program which included the installation of more energy efficient electrolytic cells. In August 1985, Dow announced that it would proceed with additional modernization at the Freeport site over the next three years. This is expected to result in improved: energy efficiency, labour productivity, raw materials yields and magnesium product quality.

The second largest U.S. producer, Amax Magnesium Corporation, operates a primary magnesium plant at Rowley, Utah. An electrolytic process is used to extract magnesium from magnesium chloride derived from the natural brines of the Great Salt Lake. During 1985, this was supplemented with magnesium brine purchased from Kaiser Chemicals.

The third U.S. producer, Northwest Alloys, a subsidiary of the Aluminum Company of America (Alcoa), operates a plant at Addy, Washington that uses the Magnatherm process in which magnesium is produced by reducing dolomite with ferrosilicon. The capacity of the plant is about 22 500 tpy. Although the capacity was scheduled to have increased to 25 000 tpy in 1985 with the addition of a tenth furnace, this expansion was delayed due to inventory buildup.

Norsk Hydro, the second largest non-socialist magnesium producer operates a primary magnesium plant at Porsgrunn, Norway. The plant produces magnesium by the electrolysis of magnesium chloride derived from both a seawater/dolomite process and magnesium chloride brines imported from West Germany.

With the completion of a modernization program at the Porsgrunn plant in 1984, magnesium metal capacity is now about 60 000 tpy and may be expanded to 85 000 tpy within the next decade. During 1985, Norsk Hydro was reportedly operating at 55 000 tpy. While most of Norsk's production is consumed in Europe, it was reported that the company planned to increase sales to the large U.S. market, over the next several years.

In Brazil, Companhia Brasileira de Magnesio (Brasmag), which produced about 2 000 t of magnesium during 1985, commenced an expansion of its plant in Minas Gerais state to 4 000 tpy. The facility which began production in 1981, uses a silicothermic reduction process.

In India, a new 600 tpy magnesium plant is being constructed by Tamil Nadu Chemical Products. The project which is expected to be completed in 1986 will utilize sea bittern as a source of magnesium chloride feedstock.

The U.S.S.R. is the second largest magnesium producer in the world, with a total capacity estimated at 90 000 tpy. The known production facilities are at Zaporozh'ye in the Ukraine, Bereznike and Solikomsk in the Urals, Usf'Kamenogorsk in Kazakhstan, and Leningrad in Ust. The U.S.S.R. is reported to have developed a new type of diaphramless magnesium electrolytic cell that significantly reduces energy requirements.

PRICES

For most of 1985, the price for 99.8 per cent purity magnesium ingot was steady at $US 1.48/lb. At the end of the year, Dow and Amax raised their prices to $US 1.53/lb. Meanwhile, the price of the diecasting alloy AZ81B was reported to be between $1.26 and $1.30/lb in 1985.

Since on a volume basis magnesium is only two thirds the weight of aluminum, magnesium remains competitive as long as its price does not exceed 150 per cent of the price of aluminum. However, with the price of secondary "380" aluminum diecasting alloy reported to be less than 60 cents (U.S.) per lb during 1985, magnesium was much more expensive.

USES

The largest single application for magnesium, accounting for over 55 per cent of non-socialist magnesium consumption in 1984, is as an alloying agent with aluminum. Aluminum/magnesium alloys have greater tensile strength, increased hardness, better welding properties and superior corrosion resistance than unalloyed aluminum. One of the most important applications for aluminum alloys containing magnesium has been in beverage cans, with each can containing about 1.9 per cent magnesium. With greater recycling of can scrap in recent years, the demand for magnesium in this application has decreased somewhat. In the future, this trend is expected to continue particularly if the new plastic beverage can establishes itself in the market.

One of the potential new uses for aluminum/magnesium alloys is in the aluminum foil industry. The addition of magnesium increases the strength of the foil and thereby permits a thinner product.

The second largest use for magnesium is for structural applications, of which pressure diecast products constitute the most important component. After increasing from 21 000 t in 1982 to 30 400 t in 1984, the International Magnesium Association estimates than magnesium consumption in pressure diecastings was 36 000 t in 1985 and is expected to be about 45 000 t in 1989.

As automobile manufacturers increase the fuel efficiency of their products, the use of lightweight parts including those of diecast magnesium is growing. Among some new or likely automotive applications for magnesium, are transmission and transfer cases, clutch and axle housings, wheelrims, and covers for grills, air cleaners and valves.

Experimental applications include engine blocks for the Chevrolet "350" prototype V-8. A new experimental car, manufactured by Volvo, utilizes 50 kilograms of magnesium in various applications (7 per cent of gross weight).

While the greater use of magnesium by the automobile industry is no doubt the result of more rigorous fuel economy requirements that have been adopted in the United States, high-purity magnesium alloys can be used in applications that were once considered too corrosive for the metal. In response to concern about corrosion, producers have announced the development of new higher purity diecasting alloys or are placing more emphasis on existing high-purity products. An example of this type of high-purity alloy would be Chromasco's AZ91X diecasting alloy which contains a maximum of 0.004 per cent iron, 0.001 per cent nickel, 0.001 per cent copper and 0.01 per cent silicon.

Aside from automotive applications, diecast magnesium products are widely used in the manufacture of portable tools and sports equipment. Magnesium usage in electronic equipment, particularly computers, has grown substantially and this trend is expected to continue.

The growing emphasis on higher purity alloys is not restricted to diecasting applications. Dow Chemical recently announced the introduction of a new sanding-casting alloy AZ91C. The company states that the new alloy will be particularly useful for aerospace applications especially where a corrosive salt water environment may be encountered.

Magnesium is also used as a deoxidizing and desulphurizing agent in the ferrous industry. Magnesium demand in this application, which has grown from about 8 400 t in 1982 to 17 400 t in 1984, is expected to expand to 32 000 tpy by 1989. The metal is also used to produce ductile or nodular iron and as a reducing agent in the production of titanium, zirconium and other reactive metals. Pure magnesium metal is used frequently for cathodic corrosion protection of steel structures, especially underground pipes and tanks. There are many uses for magnesium in the chemical industry including the making of Grignard reagents used in the production of tetraethyl lead for gasoline, although this use has declined in recent years as governments move to cut the use of these additives. Magnesium is also used in the fuel cladding material in Magnox-type nuclear reactors.

The use of magnesium in dry cell type batteries is a fairly new application but one which has the potential for future growth in view of several recent design improvements. Unlike zinc-carbon or alkaline batteries, magnesium batteries have extremely long-shelf lives even at extremely high temperatures. This is due to a protective film of magnesium hydroxide which forms on the surface of the metal during storage periods. However, at the same time, this protective film can cause a delay in the flow of full current when the battery is turned on, making the magnesium battery unsuitable for certain applications.

Potential new applications for magnesium which are currently being investigated, include magnesium/aluminum composite castings, hydrogen storage systems utilizing magnesium hydride, and a magnesium-sulphuric automobile battery.

To support research designed to improve magnesium processing and applications technology, the International Magnesium Development Corp. has been established. In particular, the Corporation will be looking at new magnesium alloys and corrosion prevention, and rapid solidification technology.

OUTLOOK

While there are good prospects for significant growth in magnesium usage in diecasting and desulphurizing applications, the anticipated decline in some other applications, such as aluminum alloying, will moderate growth in demand. Overall, magnesium consumption is expected to grow at an average annual rate of about 3.0 to 3.5 per cent to 1990.

Magnesium's price is currently at a level that makes it much more expensive for diecasting applications than aluminum. Although the aluminum market prices are expected to recover somewhat in the next year, it is expected that aluminum prices will not exceed 60 to 65 cents (U.S.) per pound (constant 1985 U.S. cents) for the foreseeable future.

In the longer term, it is expected that increased competition within the North American market will result in some reduction in magnesium prices and thereby hasten the switch from aluminum to magnesium in diecasting applications. However, to some extent this growth will be partially offset by the expected slowing of demand for magnesium in desulphurization applications that is envisaged for the early-1990s since most steel producers will have already switched to magnesium by that time.

The magnesium industry is energy intensive and is expected to increasingly view the availability of low-cost energy as the major factor in any new production decision. With a large low-cost hydroelectric potential, Canada is expected to become a much larger force in world magnesium production before the end of the century.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
35105-1	Magnesium metal, not including alloys, in lumps, powders, ingots or blocks	4.3	4.3	25	2.5
34910-1	Alloys of magnesium; ingots, pigs, sheets, plates, strips, bars, rods and tubes	4.3	4.3	25	free
34911-1	Magnesium alloy ingots, for use in the production of magnesium castings (expires 30/6/86)	free	free	25	free
34912-1	Hardener alloys for use in the manufacture of magnesium castings (expires 30/6/86)	free	free	25	free
34915-1	Magnesium scrap	free	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 30/6/86)	free	free	25	free
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 30/6/86)	free	free	25	free

MFN Reductions under GATT (effective January 1 of year given)		1985	1986	1987
			(%)	
35105-1	Magnesium metal, not including alloys, in lumps, powders, ingots or blocks	4.3	4.2	4.0
34910-1	Alloys of magnesium; ingots, pigs, sheets, plates, strips, bars, rods and tubes	4.3	4.1	4.0
UNITED STATES				
628.55	Magnesium, unwrought, other than alloys and waste and scrap	12	10	8
628.57	Magnesium, unwrought, alloys, per pound on magnesium content	6.7	6.6	6.5
		¢ per lb of magnesium content + % ad valorem		
628.59	Magnesium metal, wrought, per pound on magnesium content	5.0¢ 2.8%	4.7¢ 2.6%	4.5¢ 2.5%

Sources: Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241.

TABLE 1. CANADA, CONSUMPTION OF MAGNESIUM, 1977-84

	1977	1978	1979	1980	1981	1982	1983	1984p
				(tonnes)				
Castings and wrought products[1]	879	952	1 447	1 412	619	574	490	535
Aluminum alloys and other uses[2]	5 343	3 001	3 003	4 000	5 768	4 431	5 078	6 295
Total	6 222	3 953	4 450	5 412	6 387	5 005	5 568	6 830

[1] Die, permanent mould and sand castings, structural shapes, tubing, forgings, sheet and plate. [2] Cathodic protection, reducing agents, deoxidizers and other alloys.
p Preliminary.

TABLE 2. CANADIAN IMPORTS/EXPORTS OF MAGNESIUM METAL

	Imports	Exports
	(tonnes)	
1980	3 419	5 316
1981	3 249	6 221
1982	1 972	4 501
1983	3 714	2 500
1984	4 287	4 022
1985 (first nine months)	3 076	3 703

Source: Statistics Canada.

TABLE 3. WORLD PRIMARY MAGNESIUM PRODUCTION, 1980-84

	1980	1981	1982	1983	1984
			(000 tonnes)		
Canada	9.3	8.8	7.9	6.0	8.0
United States	154.1	129.9	89.9	104.7	144.4
U.S.S.R.e	75.0	76.0	77.0	80.0	85.0
Norway	44.4	47.6	35.9	29.9	48.3
France	9.3	7.3	9.6	10.9	12.8
Italy	9.7	10.8	9.9	9.8	8.2
China, People's Republic	7.0	7.0	7.5	8.5	8.5
Japan	9.3	5.7	5.6	6.0	7.1
Yugoslavia	0.5	3.9	4.2	4.7	5.1
Poland	0.5	0.5	0.5	-	-
Brazil	-	-	0.3	0.5	1.2
India	0.1	0.1	0.1	0.1	0.1
Total	319.2	297.6	248.4	261.1	328.7

Source: Metallgesellschaft AG.
e Estimated; - Nil.

TABLE 4. PRIMARY MAGNESIUM PRODUCTION BY WORLD ZONE

Period	Area 1 United States & Canada	Area 2 Latin America	Area 3 Western Europe	Area 4 Africa & Middle East	Area 5 Asia & Oceania	Total
			(tonnes)			
1978	143 900	-	54 700	-	11 300	209 200
1979	156 400	-	58 700	-	11 400	226 500
1980	163 000	-	64 400	-	9 200	236 600
1981	138 400	-	64 400	-	5 700	208 500
1982	97 800	-	52 800	-	5 800	156 400
1983	109 000	-	51 000	-	6 000	166 000
1984	152 800	1 000	71 600	-	6 700	232 100
1985 (first nine months)	105 200	1 400	60 600	-	6 100	173 300

Source: International Magnesium Association.
- Nil.

TABLE 5. PRIMARY PRODUCERS SHIPMENTS BY WORLD ZONE

Period	Area 1 United States & Canada	Area 2 Latin America	Area 3 Western Europe	Area 4 Africa & Middle East	Area 5 Asia & Oceania	Total
			(tonnes)			
1982	85 761	8 347	60 591	1 278	17 731	173 708
1983	98 600	9 600	60 400	2 400	33 400	204 400
1984	110 100	8 000	66 800	1 600	29 500	216 000
1985 (first nine months)	76 700	7 100	52 900	1 900	29 600	168 200

Source: International Magnesium Association.

TABLE 6. WESTERN WORLD PRIMARY MAGNESIUM CONSUMPTION PATTERN, 1984

Use	North America	Latin America	Western Europe	Africa/ M. East	Asia/ Oceania	Total 1984
				(000 t)		
Aluminium alloying	56.2	2.3	35.4	1.6	22.7	118.2
Nodular iron	4.3	-	3.7	-	1.8	9.8
Desulphurization	14.1	-	2.9	-	0.4	17.4
Chemical/reduction	20.9	0.3	5.1	-	1.4	27.7
Pressure diecasting	5.7	5.4	18.3	-	1	30.4
Other structural	5.6	-	0.7	-	0.3	6.6
Other	3.3	-	0.7	-	1.9	5.9
Total	110.1	8.0	66.8	1.6	29.5	216.0

Source: International Magnesium Association.
- Nil.

Manganese

D.R. PHILLIPS

Manganese is essential in the production of nearly all types of steel, and approximately 90 per cent of all manganese produced is consumed by the iron and steel industry. Accordingly, the demand for manganese ores is directly proportional to world production of iron and steel. Manganese is considered to be a strategic commodity because of its critical role in iron and steel making, for which there are no acceptable substitutes.

Canadian ferroalloy companies have remained competitive due to low energy costs, modern plants and technological know-how. About 80 per cent of Canada's ferromanganese production was consumed domestically in 1985 compared to approximately 95 per cent in 1984.

CANADIAN DEVELOPMENTS

Canada has no domestic producers of manganese ore although several low-grade deposits have been identified in Nova Scotia, New Brunswick and British Columbia. The largest of these deposits, located near Woodstock, N.B. is reported to contain about 45 million t of mineralization grading 11 per cent manganese and 14 per cent iron. Although processes have been developed to utilize such low-grade deposits, commercial production has not been feasible to date due to market conditions and, in particular, because of the low price for manganese.

The federal and New Brunswick governments have jointly initiated studies under a Federal/Provincial Mineral Development Agreement to assess the feasibility of developing the Woodstock deposit.

The two ferromanganese producers in Canada, Elkem Metal Canada Inc., (previously Union Carbide Canada Limited) and Chromasco, division of Timminco Limited use imported metallurgical-grade manganese ore as feed material. These companies have plants at Beauharnois, Quebec and both sell their production mainly to domestic steel producers. Their major sources of manganese ore in 1985, in declining order of magnitude, were Gabon, Brazil and South Africa.

Chromasco, division of Timminco Limited, which had shut down three of its four furnaces in Beauharnois in 1982 and returned to near capacity in 1984, operated at approximately 80 per cent of capacity in 1985.

Following Elkem's acquisition of Union Carbide Corporation ferroalloy facilities in 1984, the company established new warehousing facilities in Hamilton. Hamilton was selected because of its close proximity to Elkem's major customers. The new facility, known as the Ontario Distribution Center (ODC), was opened in September 1985.

The centrepiece of the Elkem Beauharnois plant is a 30 megawatt (MW) electric arc furnace, the largest in the western world. This furnace has a nominal capacity of 120 000 tpy of standard grade ferromanganese. However, actual production of ferromanganese is considerably less as the furnace is also used to produce silicomanganese. In 1983, the furnace was operated well below capacity but, as a result of the increased demand for steel, production was expanded in 1984 to nearly full capacity. The plant operated at full capacity in 1985.

Canada also imports manganese metal, an important additive in specialty steels and aluminium alloys. The main consumers of manganese metal are Atlas Steels division of Rio Algom Limited, Aluminium Company of Canada Limited (Alcan) and Reynolds Aluminum Company of Canada Ltd.

High-purity manganese dioxide (MnO_2) and battery grade manganese ores are imported into Canada by various companies including Duracell Inc., Gould Manufacturing

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of Canada Ltd. (Industrial Battery Division), Cominco Ltd., and Canadian Electrolytic Zinc Limited (CEZ).

WORLD DEVELOPMENTS

World manganese ore production increased in 1984 by about 5 per cent compared to 1983, to an estimated 25.3 million t. Ore production in 1985 was estimated to be about equal to that in 1984.

In the United States, Bills related to fair trade in ferroalloys were introduced in the first quarter of 1985 by Senator R. Byrd (S262) and Republican C. Miller (HR976). These Bills were intended to impede the importation of unfairly priced imported ferroalloys. The Senate Bill was referred to the Finance Committee and the House Bill to the Ways and Means International Trade Committee.

South Africa's production of metallurgical grade ore accounts for about 95 per cent of its total mine output. The remaining production is of chemical grade MnO_2, most of which is consumed domestically.

General Mining Union Corporation Limited (Gencor), a South African company, acquired a 51 per cent interest in a new company called Manganese Metal Co. The remaining 49 per cent was held by Delta Group p.l.c. of London, England, through its South African subsidiary Delta Manganese (Pty.) Ltd. It was estimated that the new company would control about 55 per cent of the world's electrolytic manganese capacity.

The recent acquisitions of Union Carbide Corporation's ferroalloy facilities in the United States and Canada by Elkem A/S made it the world's largest independent ferroalloy producer. In the context of the original purchase agreements, Elkem exercised its rights in 1985 to acquire the remaining outstanding shares of the Canadian and U.S. ferralloy facilities.

Australian production of manganese ore in 1985, estimated at 1.9 million t, increased by approximately 1.4 per cent over 1984. Australia is a major exporter of manganese ore and ranks in fifth place as a producer. The Australian ferromanganese industry operated at approximately 80 per cent of capacity in 1985. Mine capacity is equivalent to approximately 2.4 million tpy of saleable ore.

Groote Eylandt Mining Company Proprietary Ltd. (GEMCO) which is a wholly owned subsidiary of The Broken Hill Proprietary Company Limited (B.H.P.) accounts for over 90 per cent of Australian manganese ore production. The company operated at about 83 per cent of its production capacity in 1985.

Australia exports approximately 75 per cent of its manganese ore production to Europe, Japan and the Republic of Korea. These countries normally account for approximately 90 per cent of Australian exports.

The development of the Carajas manganese deposit in Brazil was reported on schedule. Trial shipments were started in late-1984 and a pier for handling the ore at Itaqui was under construction. Ore reserves at Carajas are reported to be some 60 million t grading more than 40 per cent manganese. It was reported that the Igarape Azul Mine, also in the Carajas district, was producing sufficient manganese ore to supply the Brazilian battery industry. This mine has an annual production capacity of approximately 1 million t of manganese ore.

Companhia Paulista de Ferro-Ligas, a major Brazilian producer of ferroalloys, planned to install a ferromanganese plant near the Carajas railway at Maraba in Para State. This plant was being designed for capacity to produce some 36 000 tpy of ferromanganese and/or silico-manganese, depending on market requirements. It was scheduled to come on stream in 1986 at a cost of $US 40 million.

The new plant is to include facilities for the production of electrolytic manganese. Electrolytic manganese which is used in the production of specialty steels, is presently not produced in Brazil. The company expects to produce some 3 000 tpy of manganese metal initially, most of which will be consumed domestically; the balance will be available for export sales.

India, with an estimated mine capacity of 1.8 million tpy of manganese ore, operated at approximately 80 per cent of capacity in 1985. India also has a ferromanganese capacity of approximately 750 000 tpy manganese content.

Mexico's principal producer of metallurgical manganese ore, Cia Minera

Autlan SA de CV, is also a major producer of battery grade ore. Mexican mines operated close to capacity in 1984 and produced an estimated 570 000 t of commercial ore. The United States is a major consumer of Mexico's battery grade ore.

USES

The excellence of manganese as a desulphurizer has made this metal an irreplaceable input in the steel industry. Sulphur in steel tends to migrate to the grain boundaries and causes steel to crack and tear during hot rolling and forming. Manganese combines with the sulphur to produce manganese sulphide inclusions, which do not migrate to the grain boundaries. The metal also acts as a deoxidizer during the steelmaking process.

Manganese is usually added to steel in the form of a ferroalloy such as ferromanganese or silicomanganese. Steel mills in Canada use about 5.8 kilograms (kg) of manganese per t of crude steel produced.

Specialty steels frequently contain manganese to increase strength and hardness. Manganese metal is normally used in preference to ferromanganese for making these specialty steels because it provides better control of the manganese and impurities content.

Hadfield steels, a type of specialty steel, contains between 10 and 14 per cent manganese. These steels are extremely hard and tough, and are particularly suited for applications such as rock crusher parts and teeth in earth-moving machinery.

Iron used for castings is desulphurized with manganese. Otherwise, the sulphur causes surface imperfections and makes precision casting difficult.

Also, manganese is used to form alloys with nonferrous metals: aluminum-manganese alloys are noted for their strength, hardness and stiffness; manganese-magnesium alloys are hard, stiff and corrosion resistant; and manganese bronzes have properties desirable in specific applications such as ship propellers.

Manganese has many nonmetallurgical applications including its use in dry-cell batteries. In this role, manganese dioxide provides oxygen to combine with hydrogen, which permits the battery to operate at maximum efficiency. Manganese ores used for batteries must grade above 85 per cent manganese dioxide and have a low iron content. Very few natural manganese ores can meet these specifications and, as a result, most batteries contain a blend of natural ore and synthetic manganese dioxide.

A common classification of manganese ores gives rise to the following ore types: (1) Manganese ores containing more than 35 per cent manganese: these are used in the manufacture of both low- and high-grade ferromanganese. Although battery-grade ores are included in this class, these ores must contain no less than 85 per cent manganese dioxide. (2) Ferruginous manganese ores containing 10 to 35 per cent manganese and used in the manufacture of spiegeleisen. (3) Manganiferous iron ores containing 5 to 10 per cent manganese and used to produce manganiferous pig iron.

All types of manganese ores can be employed in the production of manganese chemicals such as: potassium permanganate, a powerful oxidant used in the purification of public water supplies; manganese oxide, an important addition to welding rods and fluxes; and an organometallic form of manganese, which inhibits smoke formation and improves the combustion of fuel oil. Various manganese chemicals are employed to produce colour effects in face bricks and, to a lesser extent, to colour or decolour glass and ceramics.

PRICES

Annual price negotiations for metallurgical grade manganese ore are normally concluded from April to June of each year. Prices are determined mainly on the basis of manganese content. However, several other factors including quantity, delivery schedules, tariffs and other related supply aspects of the ore are taken into account, including the physical character of the ore.

OUTLOOK

The demand for ferromanganese is forecasted to increase in 1986 in parallel with a projected rise in the world consumption of iron and steel, including in particular specialty steels.

It is anticipated that Canada could increase its exports of ferromanganese during the next decade, mainly to Europe and Asia where Canadian producers are becoming more competitive due to their lower energy costs. However, Canadian producers would eventually have to compete with new producers in developing countries for these markets.

Several developing countries that presently export their manganese in the form of ore are expected to become increasingly involved in secondary processing. This is particularly the case for countries such as Brazil, which has an abundant supply of good quality ore and low-cost hydro electric power. Such new producers could displace a major part of world capacity that currently exists in the developed market economy countries.

The shift in ferromanganese production to the developing countries is expected to accelerate as manufacturing facilities in the developed market economy countries become too obsolete to remain competitive and as their energy costs increase. For this reason it is projected that Japan, which was a net exporter of ferroalloy a decade ago, will be dependent on imports for its total ferroalloy consumption by the year 2000.

In the long term it is likely that the U.S.S.R. and the Republic of South Africa will continue to be the major suppliers of manganese ore. However, Brazil, India, Gabon, Australia and Mexico are expected to increase their share of the market. Those LDC's which have manganese reserves and low-cost energy are expected to increase their ore and secondary manganese production in response to a growth in their steel industries.

In view of the large world reserves of high-quality manganese ore, the potential for mining manganese modules from seabed deposits, and a reduction of the amount of manganese required to produce a t of steel due to technological developments, supply shortages of manganese ore and ferro-manganese are not likely to develop in the foreseeable future. However, manganese has no economical substitute in its main use and, accordingly, ferro-manganese production is projected to increase at the rate of 1.2 per cent per year up to 1990, in parallel with the growth in steel production.

Factors which have contributed to the decrease in the world consumption of manganese have been closely associated with technological developments in the iron and steel industry. The production of cast and forged products to near net shape, and the 25 per cent decrease in manganese requirement in steelmaking due to increased use of argon oxygen decarburization (AOD) furnaces will continue to reduce the demand for manganese in the next decade.

PRICES

United States prices in U.S. currency, as published by **Metals Week**,

	December 1983	December 1984	December 1985
		$	
Manganese ore, per long ton unit (22.4 lb) cif U.S. ports, Mn content			
Min. 48% Mn (low impurities)	1.44-1.47	1.44-1.47	1.40-1.45
Ferromanganese, fob shipping point, carload lots, lump, bulk			
Standard 78% Mn, per long ton	490.00	- LPS -	- LPS -
		(cents)	
Medium-carbon, 80-85% Mn, per lb Mn	41.00-46.00	41.00	41.00
Silicomanganese, per lb of alloy, fob shipping point, 65-68% Mn, 16-18.5% Si, 0.2% P, 2% C	21.00	23.50	23.50
Manganese metal, per lb of product, fob shipping point			
Regular, minimum 99.5% Mn	70.00	80.00	80.00
6% N, minimum 93.7% Mn	80.00	86.00	86.00

fob Free on board; cif Cost, insurance and freight; LPS - List Price Suspended.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
CANADA					
32900-1	Manganese ore	free	free	free	free
33504-1	Manganese oxide	free	free	free	free
35104-1	Electrolytic manganese metal	free	free	20%	free
37501-1	Ferromanganese, spiegeleisen and other alloys of manganese and iron, not more than 1% Si, on the Mn content, per lb.	free	0.4¢	1.25¢	free
37502-1	Silicomanganese, silicospiegel and other alloys of manganese and iron, more than 1% Si, on the Mn content, per lb.	free	0.72¢	1.75¢	free

MFN Reductions under GATT (effective January 1 of year given)	1985	1986	1987
		(cents)	
37502-1	0.72	0.71	0.70

UNITED STATES (MFN)

601.27	Manganese ore, including ferruginous manganese ore and manganiferous iron ore, all the foregoing containing over 10% Mn	free
632.30	Manganese metal, unwrought	14.0%

		1985	1986	1987
			(%)	
606.26	Ferromanganese, not containing over 1% C, per lb Mn content	2.4	2.4	2.3
606.28	Ferromanganese containing 1 to 4% C, per lb Mn content	1.4	1.4	1.4
606.30	Ferromanganese containing over 4% C, per lb Mn content	1.5	1.5	1.5
632.28	Manganese metal waste and scrap	7.7	6.7	5.6

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated 1985, USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241.

TABLE 1. CANADA, MANGANESE, TRADE AND CONSUMPTION, 1983-85

	1983		1984p		1985e	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Imports						
Manganese in ores and concentrates[1]						
Mexico	-	-	-	-	5 100	482
France	-	-	8 757	1,413	-	-
South Africa	8 037	1,112	20 227	2,539	7 726	1,112
Brazil	9 976	1,853	-	-	10 825	2,083
United States	3 316	1,166	3 169	1,206	3 895	1,661
Gabon	20 931	2,848	45 392	6,472	74 502	10,871
Total	42 260	6,978	77 545	11,630	102 048	16,209
Manganese metal						
South Africa	2 051	2,961	2 757	5,311	2 572	5,412
People's Republic of China	300	380	-	-	200	353
United States	265	374	237	493	367	1,212
Other countries	36	68	17	34	101	277
Total	2 652	3,782	3 011	5,838	3 240	7,254
Ferromanganese, including spiegeleisen[2]						
United States	8 498	8,229	10 824	7,819	10 124	7,833
West Germany	2 300	836	10 699	7,033	5 213	3,590
South Africa	2 031	1,223	3 676	1,735	8 002	3,373
Mexico	3 640	2,364	2 247	1,499	-	-
France	1 301	1,462	1 959	2,208	2 059	2,392
Norway	489	227	400	222	-	-
Total	18 259	14,342	29 805	20,615	25 398	17,188
Silicomanganese, including silicospiegeleisen[2]						
South Africa	-	-	6 077	2,636	2 720	1,167
Brazil	7	3	2	3	1 425	655
Norway	-	-	100	59	257	157
United States	453	329	651	372	2 577	1,957
Total	460	332	6 083	2,890	6 979	3,936
Exports						
Ferromanganese[2]						
United States	2 631	902	9 197	3,085	22 408	8,732
Puerto Rico	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-
Total	2 631	902	9 197	3,085	22 408	8,732
Consumption						
Manganese ore						
Metallurgical grade	93 946	..	105 607	..	..	..
Battery and chemical grade	3 228	..	3 306	..	..	..
Total	96 697	..	108 913	..	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Mn content; [2] Gross weight.
p Preliminary; e Estimated; - Nil; .. Not available.
Note: Components may not add due to rounding.

TABLE 2. CANADA, MANGANESE IMPORTS, EXPORTS AND CONSUMPTION, 1970, 1975, 1979-85

	Imports			Exports	Consumption	
	Manganese Ore[1]	Ferro-Manganese	Silico-Manganese	Ferro-Manganese	Ore	Ferromanganese and Silicomanganese
			(gross weight, tonnes)			
1970	115 052	17 891	975	510	153 846	97 952
1975	69 773	35 701	5 732	1 168	160 976	95 869
1979	45 150	83 700	21 876	12 043	64 699	89 429
1980	95 161	26 704	20 901	11 278	157 680	95 796
1981	119 746	36 656	12 669	57 040	288 908	83 886[r]
1982	71 655	25 088	2 877	11 738	130 826	69 166
1983	42 260	18 259	460	2 631	99 697	86 111
1984[p]	77 545	29 805	6 083	1 592	108 913	95 049
1985[e]	102 048	25 398	6 979	22 408	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Mn content.
[p] Preliminary; [e] Estimated; .. Not available.

TABLE 3. WORLD PRODUCTION OF MANGANESE ORES, 1982-84

	Mn	1982	1983[r]	1984[e]
	(%)		(000 tonnes)	
U.S.S.R.	30-33	9 824	10 890	11 110
Republic of South Africa	30-48+	5 216	3 181	3 361
Brazil	38-50	1 300	2 306	2 425
Gabon	50-53	1 512	2 059	2 336
Australia	37-53	1 132	1 492	1 874
People's Republic of China[e]	20+	1 597	1 760	1 760
India	10-54	1 448	1 455	1 433
Mexico	27+	509	386	571
Ghana	30-50	132	191	132
Japan	24-28	82	85	86
Hungary	30-33	93	65	66
Morocco	50-53	94	67	63
Bulgaria	30-	50	50	50
Yugoslavia	30+	31	29	30
Other countries[1]	..	61	54	59
Total	..	23 081	24 093	25 341

Source: U.S. Bureau of Mines, "Mineral Yearbook", 1984.
[1] Includes 19 countries, each producing less than 24 000 tpy.
[e] Estimated; [r] Revised; .. Not available.

Mercury

J. BIGAUSKAS

Mercury (chemical symbol, Hg) is principally recovered from sulphide ores and recycled materials. The principal sulphide in ores is cinnabar (HgS), a bright red, soft mineral. Mercury produced from ore is called prime virgin mercury and usually exceeds 99.9 per cent purity. Recovery from ore generally approaches 95 per cent. Ore is heated in retorts or furnaces to volatilize the mercury and release sulphur as sulphur dioxide. A condenser collects the mercury as a liquid. Further purification is done by filtration, multiple distillation, chemical or air oxidation or electrolytic refining. Mercury-bearing scrap, dusts and residues are also treated by recyclers, particularly during periods of high mercury prices and high feed availability.

CANADIAN DEVELOPMENTS

There has been no mine output of mercury in Canada since July 1975, when the Pinchi Lake mine of Cominco Ltd., 48 km north of Fort St. James, British Columbia, suspended operations indefinitely. Cominco Ltd., however, has recovered mercury as mercuric chloride from SO_2 gas at its zinc-lead metallurgical plant at Trail, British Columbia since 1982-83.

Canadian imports of mercury metal totalled 33 t in the first nine months of 1985. Consumption rose by an estimated 13 per cent in 1984. Consumption statistics are not available for 1985.

WORLD DEVELOPMENTS

Non-socialist world production of mercury in 1985 is estimated at 3 000 t (87,000 flasks[1]) while production in the socialist world is about 2 500 - 3 000 t. Major producers in the non-socialist world are Spain, the United States, Mexico and Algeria. Major producers in the socialist world are the U.S.S.R., the People's Republic of China and Czechoslovakia.

Minas de Almadēn of Spain is the largest producer of mercury in the non-socialist world and also has one of the oldest operating mines. The Almaden mine has been in nearly continuous operation for more than 2,000 years. However, most ore presently comes from a new open-pit mine at El Entredicho. Italy has not mined mercury since 1982 when it shutdown the Monte Amiata mine of SAMIM S.p.A.

Although, presently a smaller producer, Yugoslavia, has slated a Dinar 133 m expansion at its Idrija mercury mine which will raise capacity to 155 tpy. Output in 1985 was about 100 t. About half of this is exported. The mine was closed in 1977 because of low prices and low grades, but was reopened in 1983.

In September 1985, Placer U.S. Inc. of San Francisco announced a cut in production at its 51 per cent-owned McDermitt mine - the only United States primary producer of mercury. The move was attributed to a soft mercury market. Production at the McDermitt mine was about 16,000 flasks in 1985, down from 19,000 flasks (660 t) in 1984 and 25,000 flasks (860 t) in 1983. Placer U.S. Inc. is a wholly-owned subsidiary of Placer Development Limited of Vancouver, British Columbia. Sterling Mineral Ventures of New York owns the remaining 49 per cent in the mine.

STOCKS

During fiscal year 1985, the U.S. General Services Administration sold 5,000 flasks (172 t) of mercury from the National Defense Stockpile. In September the GSA announced it would begin to sell surplus Department of Energy (DOE) mercury in fiscal year 1986. Monthly tenders of 1,500 flasks (52 t) were offered with the first bid opening on October 15, 1985. GSA planned to dispose of 18,000 flasks of DOE mercury during fiscal year 1986. The DOE stockpile contained about 34,700 flasks (1 200 t) of mercury at year-end.

[1] One flask of mercury weighs 34.473 kg.

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The U.S. President proposed new stockpile objectives in July which, if approved, would make surplus total holdings of some 170,000 flasks (5 900 t).

PROPERTIES AND USES

Mercury's liquid state at room temperature and high electrical conductivity makes it useful in various electrical controls. Mercury batteries, invented in 1944, are used in a variety of applications. Energy-efficient mercury lamps, with their familiar orange glow, light streets and large buildings. Mercury is also used as a flowing cathode in preparation of chlorine and caustic soda, and as a catalyst for the production of vinyl chloride monomers.

PRICES

The average price for 1985 was $US 311, slightly less than the $314 average in 1984.

OUTLOOK

Relatively high levels of mercury supplies will likely put downward pressure on prices in 1986. In the longer term, mercury prices will be adversely affected by increased substitution in certain markets and by increased recycling of mercury which will likely be encouraged, if only for environmental reasons. As well, the high level of inventories and idle capacity will take many years to work off, particularly if growth in non-socialist world consumption is slow and net imports from the socialist world continue to be significant.

AVERAGE MERCURY PRICES

	1983	1984	1985
	($US per flask, 99.99% purity)		
January	376	304	318
February	347	288	314
March	342	304	310
April	332	326	300
May	310	330	294
June	292	319	310
July	276	308	321
August	282	296	323
September	305	318	323
October	341	329	323
November	342	327	313
December	326	322	283
Average	322	314	311

TABLE 1. CANADA, MERCURY IMPORTS 1983-85 AND CONSUMPTION, 1983-84

	1983		1984		Jan.-Sept. 1985	
	(t)	($000)	(t)	($000)	(t)	($000)
Imports[1]						
Spain	5	185	20	183	-	-
United Kingdom	1	10	-	-	-	15
Algeria	-	-	-	-	17	209
United States	56	642	55	655	16	187
Total	74	837	75	839	33	411

	1983	1984
	(kilograms)	
Consumption[2] (metal)		
Chlorine and caustic soda production catalysts	8 864	8 459
Electrical apparatus and industrial controls	7 869	5 129
Miscellaneous	20 389	28 425
Total	37 122	42 013

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Numbers may not add due to rounding. [2] As reported by consumers.
- Insignificant or none.

Mica

M. PRUD'HOMME

SUMMARY

Canada is the world's leading producer of ground and flake phlogopite. Production is from only one mine and mill acquired wholly by Marietta Resources International Ltd. The mine is situated near Parent, Quebec, and the processing plant is near Montreal. Phlogopite mica is used mainly as a filler in gypsum products, paints and plastics. In late-1985, Lacana Petroleum Inc. of Toronto purchased the Marietta Suzorite operation in Quebec.

Domestic production rose 13.2 per cent and the average unit value increased 2 per cent in 1985. Almost 50 per cent of mica shipments are exported to the United States, Japan and Europe. The total value of imports in 1984 was about $4 million. During the first nine months in 1985, the value of imports reached $3.1 million. Imports have been declining continuously since 1981, with a decline of 13 per cent in ground mica during 1984. Almost all imports are from the United States with Ontario accounting for 43 per cent; Alberta, 30 per cent; British Columbia, 16 per cent and Quebec, 6 per cent. The average unit value of imported ground mica increased 21 per cent from $272 a t in 1984 to $330 a t in 1985.

Canadian mica prices rose an average of only 4 per cent with prices ranging between $113 and $740 per t.

World demand for ground mica is forecast at an average annual growth rate of 0.7 per cent for the period 1983-2000. Development of synthetic mica and solid-state technology will continue to reduce the demand for sheet mica in electronics. The main area of growth for ground mica is in the plastics industry. There is a continuing growing interest in using mica in plastics for automobile parts, in paint and in insulating products as a substitute for asbestos.

THE MICA GROUP

The micas comprise a series of phyllosilicates with a variable chemical composition, but distinct physical properties, such as basal cleavage. The term "mica" primarily refers to muscovite $K\,Al_2\,(Al\,Si_3O_{10})\,(OH)_2$, biotite $K\,(Mg,Fe)_3\,(Al\,Si_3O_{10})\,(OH)_2$ and phlogopite $K\,Mg_3\,(Al\,Si_3O_{10})\,(OH)_2$. The micas are complex hydrated aluminous silicates that crystallize in the monoclinic system.

Colour varies from black to virtually colourless. Hardness is approximately 2 to 3 on Mohs' Scale, and density ranges from 2.7 to 3.1.

Essentially, only the muscovite and phlogopite varieties are of economic importance. Muscovite is a common constituent of acid igneous rock, such as granites, pegmatites and aplites. Phlogopite is particularly common in ferromagnesian basic rock, such as the pyroxenites, metasedimentary crystalline limestones, peridotites and dunites.

The micas are marketed in various forms, ranging from blocks and splittings to scrap, flake, ground and micronized.

Sheet mica is extracted from enormous crystals and worked by hand to obtain blocks, sheets and splittings. These grades are classified according to the size, thickness and colour of the sheets. Mica sheets are valued by the electrical and electronics industries for their dielectric, optical and mechanical properties.

Scrap mica is obtained from sheet mica waste. It is generally reduced to a powder or flakes for the manufacture of mica paper and micanite or filler. These micas are classified according to particle size and are wet-ground or dry-ground. Flake mica is extracted as a coproduct of feldspar, kaolin and lithium; certain types are found in schist deposits with a high mica content.

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SITUATION IN CANADA

Production and deposits

Canada produced mica continuously from 1886 until 1966 when the last shipment of phlogopite was made from the Blackburn mine in Cantley, Quebec. The Lacey mine near Sideham, Ontario, was a major phlogopite-producing site until 1948. From 1941 to 1953 Canada was one of the largest producers of sheet muscovite, which was extracted from the Purdy mine near Mattawa, Ontario. In 1977, mica production resumed in Canada following development of a large deposit of phlogopite in Suzor township, near Parent, Quebec. Canadian production has since relied on this single producer. However, several exploration and development projects have been undertaken since 1982, in both Ontario and Quebec.

Marietta Resources International Ltd. began development of the phlogopite deposit in Suzor township, Laviolette County, in 1974. This unique assemblage of schistose rock contains approximately 80-90 per cent phlogopite mica, 4-8 per cent pyroxene, 2-6 per cent perthite and traces of apatite, calcite and chlorite. Phlogopite reserves are estimated at more than 27 million t of homogenous ore to a depth of 60 m.

The ore is open-pit mined on an intermittent basis every two years. A Kennedy Jaw Crusher breaks the ore to smaller than 20 cm prior to shipment by rail twice each year to the Boucherville processing plant near Montreal. The ore is then dry ground, concentrated in a pneumatic separator, and classified according to four sizes: -10+20 mesh, -20+40 mesh, -40+100 mesh, and over 100 mesh.

Production capacity varies from 25 000 to 35 000 tpy as determined by the qualities required. Tailings of feldspathic materials are distributed as waste material. Flake mica, registered under the name of Suzorite, is used as a reinforcing agent in plastics and in composites. The ground varieties of phlogopite act as a filler in asphalt products, in gypsum caulking products, and in oil well drilling muds.

In late 1984, Marietta Resources International Ltd. acquired 100 per cent interest in the mica operations when it bought the option shares from its former joint-venture partner: La Société Minéralurgique Laviolette, Inc. In December 1985, Lacana Petroleum Inc., a division of Lacana Mining Corporation, completed the acquisition of the Suzorite Mica operations for about $8.8 million.

During 1985, shipments in the plastic industry increased significantly, especially in the United States. Phlogopite mica is also being exported in Japan and Europe. In-house research has developed a new grade of commerciable mica: EC Mica for electric and magnetic shielding. EC Mica will be a lower-priced substitute for use in specialty paints and fillers which are used to prevent interference in electronics apparatus such as aircraft instruments and computers.

Traces of mica have been discovered at several sites in Canada. Muscovite is particularly common in pegmatite intrusions. Interesting occurrences were located in the following Ontario townships: Addington, Calvin, Canney, Chapman, Chisholm, Christie, Clarendon, Davis, Deacon, Hungerford, Kaladar, Lennox, Mattawa, McKonkey, Olrig and Sheffield; in Quebec, muscovite is found in the counties of Abitibi-Temiscamingue, Charlevoix, Dubuc and Saguenay; in British Columbia, near Yellowhead Pass, the Big Ben district of the Columbia River, and in the Fort Grahame district.

In Canada, phlogopite is virtually confined to the northeastern belt of the Grenville series. The major occurrences of phlogopite are found in Quebec in the counties of Argenteuil, Gatineau, Hull, Labelle, Laviolette, Montcalm and Papineau, and in Ontario in the counties of Frontenac and Lanark.

Exploration and research

During 1983-84, the National Research Council of Canada conducted research on related mica materials at its Industrial Materials Research Institute at Boucherville, Quebec. Studies were carried out on textural factors in extruded mica-polypropylene composites and on mechanical degradation of mica-reinforced polymers such as polyethylene and polypropylene.

USES AND SPECIFICATIONS

Sheet mica is used for its electrical and insulating properties, principally in electronic markets. Ground mica is used mainly as a filler in building products and in paints, as a reinforcement in plastics, and as a component in oil well drilling muds.

Sheet mica is graded according to thickness: blocks must be thicker than 0.007 in. (0.18 mm), films between 0.0008 and 0.004 in. (0.0206-0.1028 mm), and splittings approximately 0.0011 in. (0.0028 mm). Sheet mica is used mainly in the electrical and electronics industries, and in small quantities for thermal insulation. Sheet muscovite is used to manufacture micanite, mica-paper and fabricated products, such as capacitors and commutator segments. Since the dielectric properties of muscovite are better than those of phlogopite, transparent mica is the most common variety used in those sectors. The specifications for sheet mica comply with the standards of the American Society for Testing and Materials (ASTM). Designation ASTM-D351-62 specifies quality according to stain, inclusions and imperfections. Designation ASTM-D2131-65 specifies the required characteristics for mica product manufacture. Designation ASTM-D748-59 defines the requirements for the electrical, physical and visual properties of the mica sheets used in capacitors.

Mica-paper, glass-bounded mica, and phosphate-bonded mica are substitutes for build-up mica made of splitting. Ceramics, bentonite, glass, nylon, plastics, fused quartz, silicones, talc and teflon are substitutes for sheet micas.

Ground and micronized micas are used as reinforcing agents or fillers. The major uses are in gypsum caulking products, asphalt roofing products, paints, rubber products, plastics, and oil well drilling muds.

Drywall products and joint cement compounds constitute the major use for mica. Mica prevents cracking and provides good workability due to its structural quality. Product size should be less than 150 microns and it should be free of abrasive grits. Muscovite is occasionally preferred over phlogopite as it is virtually colourless. In this use, the principal substitutes for mica are talc, clay and asbestos.

Mica is used in asphalt roofing products as a dusting agent. It is also used as a filler in asphalt mixtures to improve their resistance to weathering. Dry-ground mica varies in size from 850 to 75 microns (20 to 200 mesh).

Paints require fillers to improve surface qualities. Mica reduces shrinkage, prevents cracking and improves resistance to weathering. It is used in exterior paints, anti-corrosive emulsions and oil-based metal primers. Wet-ground or micronized mica should be transparent and have particle sizes in the order of 100, 160 and 325 mesh, and over than 30 microns.

Producers of rubber materials use mica as a dusting and releasing agent. It is also used as a filler to reduce gas penetration and shrinkage during moulding. The mica is generally in 850 to 150 micron flakes.

Plastics are a recent application for micas. Flakes are used as a reinforcing agent along with other fibrous minerals, such as wollastonite and asbestos. Micas with a high diameter to thickness ratio (High Aspect Ratio, HAR) are used in polypropylenes, polyethylenes and phenolic plastics. The resulting plastics have high flexural and tensile strength, low permeability and good resistance to weathering. Delaminated micas are treated with coupling agents to improve their cohesion with resins. Treated micas are chemically surface treated to be used in resins systems such as polypropylene and high-density polypropylene. These grades are the most expensive and they are substitutes for higher cost fiberglass. Loading levels range from 20 to 50 per cent by weight. These ground micas have a particle size ranging from 425 to 45 microns.

Other principal uses of the mica varieties include: mica splittings for build-up mica products such as molding plates, segment plates, heater plates and tapes through the use of binders, adhesives, and backing materials; dry-ground mica for insulation boards, oil well drilling muds, welding electrodes, acoustical products, adhesives, fire extinguishers, foundry coatings, lubricants, and composite cement materials; wet-ground mica for wallpaper and lubricants.

CONSUMPTION AND TRADE IN CANADA

In Canada, mica is primarily consumed by the construction industry. More than 90 per cent of the mica is used in gypsum caulking products and paints. The rubber, plastics and drilling mud industries share the remaining 10 per cent.

Canada imports ground muscovite from the United States for asphalt roofing products and gypsum products.

The trend since 1981 to declining imports of mica has continued during 1984 and 1985. In 1984, imports of ground mica were down by 13 per cent to 2 287 t. Almost all imports of ground mica are from the United States into Ontario (43 per cent), Alberta (30 per cent), British Columbia (16 per cent), and Quebec (6 per cent). Average unit value increased by 21 per cent from $272 per tonne in 1984.

Imports of fabricated mica products show a decrease of 4 per cent in 1985, compared to 1984. The United States accounts for 81 per cent of total imports of fabricated mica, which are shipped mainly into Ontario (74 per cent) and Quebec (24 per cent).

Canadian exports are primarily to the United States, essentially for use in the plastics industry. Exports increased by 22 per cent from 4 700 t in 1983 to 5 750 t in 1984. Canadian mica is also exported to Japan, Europe and South America.

WORLD PRODUCTION AND REVIEW

World production of mica can be broken down according to mica type. India is the most important source of muscovite sheet mica, followed by Brazil, Argentina and Madagascar. The United States, the largest producer and consumer of ground and flake mica, produces muscovite by wet and dry methods, generally as a coproduct of kaolin, lithium or feldspar. Canada dominates the world market in the production of flake, ground and micronized phlogopite; Argentina produces a small amount of sheet phlogopite.

In 1984, the world production of mica rose 8.3 per cent, to 260 930 t. India accounts for about 60 per cent of the world trade in sheet mica although its output has dropped from about 30 000 t in 1960 to 8 000 t in 1983.

In India, the Mica Trading Corporation of India Ltd. (MITCO) set export target of 17 000 t for the 1984-85 period, a 62 per cent increase over export orders concluded in 1983-84. Importing countries are the U.S.S.R., Poland, the United States, Japan, South Korea and Singapore. MITCO is continuing its search for alternative markets for exports of Indian mica, especially in countries with advanced manufacturing in electronics and electrical goods.

In Japan, Kuraroy Co. Ltd. is studying the use of electroplated mica flakes as an electromagnetic interference shielding materials which will be a substitute to aluminium film. Kuraroy Co. imports its raw material mica flakes from Marietta Resources International Ltd.

In Spain, Cia Minera Santa Comba SA ceased its production of mica which was exploited as a coproduct with kaolin at Santa Comba in La Coruna.

In the United Kingdom, Wood Treatment has doubled its mica dry grinding capacity to 10 000 tpa. Almost all imports of crude mica are from China and Brazil.

In the United States, Hercules Incorporated of Wilmington, Delaware, has purchased Mica Corp. which is a leading supplier of specialty electronic laminates for printed circuits.

PRICE

Prices for mica are based on type, grade and quality. Sheet mica grades are 10 times more valuable than ground mica grades. Sheet mica prices vary over a wide range from less than $2 a kg to $2 600 a kg. Prices of crude flake mica range from about $30 to $60 a t.

Since the 1980s, prices for ground mica have tended to increase reflecting the increasing demand for higher grades and the more sophisticated processing such as required for the chemically treated micas.

Prices for ground mica may vary depending on its colour, fineness, quality and the method of processing. Canadian prices for mica have risen slightly in 1985, with an average increase of 4 per cent in 1985; phlogopite mica prices ranged between $113 and $740 per t.

OUTLOOK

The sheet mica producers' strategy is to develop more the production of fabricated mica; although these high-value-added products still require extensive manual labour.

In North America, the production capacity of ground mica exceeds demand; however, optimistic forecasts of increased demand in the 1980s have resulted in work being started on several expansion projects. The economic performances of the ground and flake mica industry are linked to those of the construction, plastics, drilling mud and insulation industries.

In the construction sector, manufacturers of paints, asphalt roofing products and gypsum caulking products consume more than 90 per cent of all mica used in Canada. World demand for mica, currently estimated at 220 400 t in 1983, is expected to be 249 400 t in 2000, an average annual growth rate of 0.7 per cent by the U.S. Bureau of Mines. Sheet mica demand will decline because of changing industrial technologies and because of greater use of substitute materials. Demand for ground mica is likely to continue to grow at an average annual rate of 0.7 per cent.

The main area of growth in the use of ground mica will be in the plastics industry, especially in the production of parts for automobile and domestic appliances. Production of plastics is dominated by the industrialized countries, mainly the United States with 26 per cent of world total production of plastics, forecast to increase by 7 per cent in the period 1983-2000. Two factors should ensure rising demand in the plastics industry: higher consumption of polypropylene in the automobile industry, and the increasing use of mineral fillers to reduce production costs of plastics. In the United States, consumption of polypropylene is expected to increase by 5.4 per cent annually from 1981 to 1991.

In the gypsum plasterboard and caulking compounds industries, which is the largest end-use for ground mica, the increase in demand is linked to activity of new construction. In paints, demand is quite stable and is also linked to construction activity. The improved quality of paint imparted by the use of mica will lead to increased use in this field and will provide steady growth.

In oil well drilling muds, a modest growth is anticipated because of mica substitutes and in insulation industry mica consumption will be steady because of satisfactory performance.

Opportunities for a new supplier in North America are quite limited. Established producers and exporters of sheet mica such as India, Brazil and China, can adequately meet any cumulative world demand. Moreover, India is looking forward to manufacturing fabricated mica products instead of exporting crude raw materials. World reserves of scrap mica are large and adequate to meet ground mica demand to 2000. Current suppliers of surface-treated mica aresufficiently adequate to meet the requirements of plastics compounders, in particular because this small market is already saturated.

PRICES

Average price[1] for wet-ground and dry-ground mica in the United States.

	$US per short ton
Wet-ground mica:	392
Dry-ground mica:	123
By uses:	
drill muds	107
paints	170
joint cement	149

Prices for mica in the United States, according to the Chemical Marketing Reporter[2].

	$US per lb
Dry-ground mica: Joint cement, plastics, 50-pound bags, carload, works	.07½
Dry-ground mica: Roofing products, 20 to 80 mesh sieves, point of shipping	.07
Wet-ground mica: Paints, per carload, 325 mesh sieve, fob, works	.16¾
By uses; carload, fob, works	
rubber products	.16¾
wallpaper	.22

Prices for phlogopite[3], fob, works, carload

	$Cdn per short ton
Micronized mica	248-443
Surface-treated mica	680-740
Flake or ground mica	113-410

[1] U.S. Bureau of Mines, 1984, Mica. [2] CMR, December, 1985. [3] Marietta Resources International Ltd., June 1, 1985.
fob Free on board.

TARIFFS

Item No.		British Preferential	Most Favoured Nation (MFN)	General	General Preferential
			(%)		
CANADA					
29600-1	Mica schist	free	free	free	free
29650-1	Mica, phlogopite and muscovite, unmanufactured, in blocks, sheets, splittings, films, waste and scrap	free	free	25	free
44550-1	Raw low-loss mica, sheets and punchings of low-loss mica	free	free	25	free

Item No.				
UNITED STATES (MFN)				
516.11	Untrimmed phlogopite	free		
516.31	Split block mica	free		
516.41	Other	free		
516.51	Mica splittings	free		
516.61	Mica, not over 0.006" in thickness, not cut or stamped to dimensions, shape or form	free		
		1985	1986	1987
			(%)	
516.21	Phlogopite, waste and scrap	4.7	4.4	4.2
516.24	Other mica, waste and scrap	2.4	2.4	2.4
516.81	Ground or pulverized mica	3.3	2.9	2.4

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated 1985, USITC Publication 1610; U.S. Federal Register, Vol. 44, No. 241.

Note: Various other tariffs are in effect on cut and stamped mica and on mica manufacturing.

TABLE 1. CANADA, MICA IMPORTS, 1982-85

	1982		1983		1984		1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
							(Jan.-Sept.)	
Rough, scrap and schist mica								
United States	..	24	..	52	..	53	..	18
India	..	134	..	0	..	0	..	0
Subtotal	..	158	..	52	..	53	..	18
Ground mica								
United States	2 378	590	2 632	680	2 287	622	1 670	555
Subtotal	2 378	590	2 632	680	2 287	622	1 670	555
Mica in blocks, films and sheets								
United States	481	250	157	191	84	128	53	170
India	1	2	1	6	24	18	35	47
Subtotal	482	252	158	197	108	146	88	217
Fabricated mica, nes								
United states	..	2,230	..	1,385	..	2,236	..	1,870
France	..	420	..	1,118	..	575	..	271
India	..	18	..	54	..	43	..	88
United Kingdom	..	88	..	115	..	173	..	77
Switzerland	..	7	..	2	..	0	..	7
West Germany	..	0	..	0	..	2	..	0
Hong Kong	..	3	..	0	..	0	..	0
Subtotal	..	2,766	..	2,674	..	3,119	..	2,313
Total rough, sheet, ground and fabricated mica	..	3,766	..	3,603	..	3,940	..	3,103

Sources: Energy, Mines and Resources Canada; Statistics Canada.
Note: As figures have been rounded, sums may not correspond to the totals indicated.
P Preliminary; nes Not elsewhere specified; .. Not available.

TABLE 2. MICA CONSUMPTION IN CANADA, 1980-84

	1980	1981	1982	1983	1984
			(tonnes)		
Gypsum products	790	545	1 204	1 722	1 415
Paint and varnish	1 678	1 483	1 402	948	611
Rubber	24	54	30	52	41
Other products[1]	84	177	109	280	418
Total	2 576	2 259	2 745	3 002	2 485

[1] Includes electrical apparatus, foundries, paper and paper products, floor coverings, plastics and other miscellaneous products.

TABLE 3. WORLD PRODUCTION OF MICA, ALL VARIETIES, 1981-84

	1981	1982	1983	1984[e]	Remarks
		(tonnes)			
United States[1]	120 630	96 140	126 980	146 030	Muscovite, flake and scrap
U.S.S.R.[e]	47 160	48 070	48 980	48 980	All varieties
India[e]	29 010	21 540	19 050	19 050	Muscovite, exports and local consumption, sheet and flake.
Korean Republic	9 980	20 350	14 400	14 970	Muscovite, coproduct of kaolin and feldspath, scrap.
Canada[2]	12 000	11 000	12 000	12 500	Phlogopite, flake and ground
France[e]	6 800	6 480	5 990	6 490	Muscovite, coproduct of kaolin
South Africa	2 390	1 760	2 670	4 671	Muscovite, flake
Brazil	1 950	1 080	3 460	3 540	Muscovite, sheet
Spain	3 520	3 430	3 400	1 360	Muscovite, coproduct of kaolin
Madagascar	380	1 300	1 084	1 000	Phlogopite, sheet and scrap
Argentina	500	280	330	300	Muscovite, sheet and scrap
Other countries	5 300	2 430	2 540	5 350	
World total[3]	240 620	212 930	240 874	260 930	

Source: U.S. Bureau of Mines, Mica, 1984.
[1] Excluding the production of sericite, estimated at 35 370 tonnes in 1983. [2] Shipments estimate. [3] In addition to these countries, Morocco, Taiwan and Zimbabwe produced almost 3 280 tonnes in 1981; Romania, the People's Republic of China and Pakistan are other mica producers.
[e] Estimated.

TABLE 4. MICA[1] TRADE AND CONSUMPTION IN CANADA 1970, 1975 AND 1980-84

	Imports	Consumption
	(tonnes)	
1970	3 422	2 611
1975	5 111	3 718
1980	2 597	2 576
1981	3 133	2 259
1982	2 860	2 745
1983	2 790	3 002
1984	2 395	2 485

Sources: Energy, Mines and Resources, Canada; Statistics Canada.
[1] Sheet and ground mica.

Mineral Aggregates

D.H. STONEHOUSE

SUMMARY 1985

During 1985 both residential and non-residential construction in Canada continued the modest upward trend begun in the latter part of 1984. Although business investment leading to construction activity is being encouraged, no major contracts of the mega project variety have been announced in recent years. Except for activity in British Columbia surrounding Expo 86, most new construction projects are confined to eastern Canada. Demand for mineral aggregates generally reflects the up and down trends in construction but the timing of that demand and the type of construction for which expenditures are made make direct relation between construction expenditures and production of mineral aggregate materials rather difficult. Total aggregate production over the past three years has been slightly in excess of 300 million tonnes a year. Average unit prices have not changed greatly and continue to fluctuate widely from province to province depending upon the proximity of the resource base to the consuming centre. Housing starts, a fair indicator of construction materials demand, were only 134,900 in 1984, the second lowest level since 1966 but will be in the 150,000 range for 1985, while total construction expenditures are expected to approach $60 billion.

Many provinces continued programs both to identify and to assess their aggregate resource base and to project future market requirements. In some instances these programs have been undertaken as part of Mineral Development Agreements under the Economic and Regional Development Agreements (ERDA's) arranged between the federal and provincial governments. The constraints to development of aggregate properties have not lessened. Property owners do not want quarries or gravel pits nearby nor would they like to see the prices increase to compensate for greater hauling distances.

An awareness of the importance of mineral aggregates to the construction industry has been heightened by an appreciation of the extent and rate of urban expansion and the realization that already large deposits of aggregate material have been made inaccessible by the growth of towns and cities or by legislation.

Of particular note is the development of the Ontario Government's new Planning Act and the importance given to mineral aggregates policy within the Act. Municipal plans will be required not only to protect existing pits and quarries but to identify and preserve presently untapped aggregate reserves for future development. Concern has been registered from agricultural and environmental interests that aggregates have been given greater priority than they deserve and that touted future shortages are both exaggerated and unfounded. The fact remains that sand, gravel and stone are non-renewable resources which continue to be vital to the economy.

Until recently none of the principal lightweight aggregates (vermiculite, pumice and perlite) was mined in Canada. Imports, mainly from the United States, supplied the requirements for use in both lightweight concrete and gypsum products, for loose insulation applications and for horticultural uses. During 1983 Aurun Mines Ltd. developed a perlite property near Empire Valley, British Columbia. In each of the next two years about 1 000 t was produced for processing at a plant near Surrey, British Columbia. Towards the end of 1985, Aurun Mines had arranged financing for the construction and installation of new equipment at the Surrey plant.

Total imports of crude lightweight aggregate materials were valued at $5.6 million in 1984 up about 7 per cent while the volume was decreased by 10 per cent to 42 232 t. To October 1985, imports and the value of imports were increased over the same period of 1984 by 9 per cent.

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CANADIAN DEVELOPMENTS

Sand and Gravel

During 1983-85 production of sand and gravel averaged 225 million tpy increasing per capita consumption to over 9 tpy. Average unit values were slightly increased as well to about $2.68/t.

Sand and gravel deposits are widespread throughout Canada, and large producers have established "permanent" plants as close to major consuming centres as possible. 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 small producers serving 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 provide 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 data concerning both production and consumption of sand, gravel and stone.

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 to the continued operation of the Canadian construction industry in certain areas. Predicted shortages could encourage exploitation of underwater deposits and could make underground mining of crushed stone attractive.

Crushed 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. 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 costs 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.

Quarrying operations that can supply high quality construction aggregates or high chemical quality stone for specified uses have been successful on both the east and west coasts where ocean-going barges or other large volume ocean transportation facilities have been used to reduce the unit transportation costs. Producers of high calcium limestone on Texada Island in British Columbia have supplied Vancouver and Washington state cement and lime producers with raw material for many years. Construction aggregate from the Strait of Canso area in Nova Scotia has been barged to many Atlantic Canada areas and during the last two years has been shipped as far as Houston, Texas in 50 000 to 60 000 t shiploads. Marketing techniques concentrate on aggregate-poor areas where demand is growing and alternate supplies are more expensive. Production and processing costs are kept low, by the fact that deposits being exploited are adjacent to deep water, and on-land trucking and conveying are kept to minimum.

Detailed information about the aggregates industries 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.

Lightweight Aggregates

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.

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 (760°C to 980°C) it expands to between 4 and 20 times its original volume. Expanded material can be manufactured to weigh as little as 30 to 60 kg/m^3, with attention being given to preblending of feed to the kiln and retention time in the kiln.

In Canada, imported perlite is expanded and used mainly by gypsum products manufacturers in plaster products such as wallboard or drywall, and in fibre-perlite roof insulation board, 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 soil conditioners and fertilizer carriers.

Imports of crude perlite for consumption in Canada are from New Mexico and Colorado deposits, worked by such companies as Manville Corporation, United States Gypsum Company, United Perlite Corp. and Grefco, Inc.

Aurun Mines Ltd. has begun to produce perlite from a deposit near Empire Valley in British Columbia. During 1984 the company constructed a processing plant near Vancouver. Export markets are being investigated.

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 the 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 British Columbia.

Vermiculite: The term vermiculite refers to a group of micaceous minerals, hydrous magnesium-aluminum silicates, that exhibit a characteristic lamellar structure and 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. Required temperatures can vary from 1 100° C to 1 650°C depending on the type of furnace in use. A controlled time and temperature relation is critical in order to produce a product of minimum bulk density and good quality.

The expansion process has been improved technologically to enable 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 the manufacture of insulating plaster and concrete. The energy situation will undoubtedly result in greater use of insulation in both new construction and older buildings.

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 and from the Enoree region of South Carolina. Canada also imports crude vermiculite from the Republic of South Africa, where Palabora Mining Co. Ltd. is the major producer. Minor amounts of vermiculite are produced in Argentina, Brazil, India, Kenya and Tanzania.

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

Clay, shale and slag: 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. Clays receive little beneficiation other than drying before being introduced to the kiln in which they are heated. Shales are crushed and screened before burning.

In steelmaking, 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.

In July, 1985 Reiss Lime Company of Canada, Limited announced plans for a $13 million slag cement project in northern Ontario. A slag granulation unit will be located at The Algoma Steel Corporation Limited, Sault Ste-Marie steel works and a plant to grind slag granules for use as cement will be constructed at the Reiss Lime property at Spragg, Ontario, together with storage and handling facilities. Initial sales of slag cement will be directed at the northern Ontario mining industry where it will be used in mine backfill. The Spragg plant will have a capacity of 200 000 tpy.

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, in which application its pozzolanic qualities are utilized. Use of fly ash as a lightweight aggregate could become increasingly important. Ontario Hydro produces over 400 000 tpy of fly ash from three coal-fired stations. Experimentation continues toward successful utilization of this material.

PRICES

There are no standard prices for sand, gravel and crushed stone. In addition to supply-demand factors, 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.

Prices for graded, washed and crushed sand, gravel and stone will show a slow but steady increase, based on greater property costs, more sophisticated operating techniques and equipment, pollution and environmental considerations, and higher labour and transportation costs.

USES

The principal uses for sand and gravel are in highway construction and as concrete aggregate. Individual home construction triggers the need for about 300 t of aggregate per unit while apartment construction requires only about 50 t per unit, according to an Ontario Ministry of Natural Resources study.

The construction industry utilizes 95 per cent of total stone output as crushed stone mainly as an aggregate in concrete and asphalt, in highway and railway construction and as heavy riprap for facing wharves and breakwaters. 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.

The use of lightweight concrete in commercial and institutional projects has facilitated the construction of taller buildings and the use of longer clear spans in bridges and buildings. Additional advantages from the use of lightweight aggregates lie in the fact that they supply thermal and acoustical insulation, fire resistance, good freeze-thaw resistance, low water absorption and a degree of toughness to the concrete product. Disadvantages stem from the fact that in production of both manufactured and ultra-lightweight aggregates heat processing is required. As the cost of fuel increases, the competitiveness of these types will be reduced unless the insulation values more than offset the heat units consumed in processing.

Any lightweight material with acceptable physical and chemical characteristics could substitute for the mineral commodities generally used. The most significant substitute for vermiculite, for instance, is styrofoam or polyurethane, which offers insulating value and comparable strength. However, these materials are petroleum-based and higher fuel prices could limit their use. Mineral wool is a competitive insulation material but its manufacture requires a pyroprocessing stage, as does the production of perlite and vermiculite. Transportation costs for high-bulk, lightweight materials are high; those materials, such as perlite and vermiculite, that can be transported to a consuming centre prior to expansion, have obvious advantages.

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 332-66 - Lightweight Aggregates for Insulating Concrete; C 330-75a - Lightweight Aggregates for Structural Concrete; and C331-69 - Lightweight Aggregates for Concrete Masonry Units.

OUTLOOK

At the end of 1985 a few indicators provide a positive outlook for building construction in Canada: housing starts are increasing, inflation is relatively low, interest rates have steadied and unemployment is decreasing. On a regional basis the construction outlook is fairly good in eastern Canada but less encouraging in the west where the effects of depressed world oil prices will likely mean less investment. The Canadian Construction Association predicts increases of 4.5 per cent in constant dollars through 1995 in the non-residential contract construction sector.

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 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 resources utilization. Industry must locate its plants so as to minimize any adverse effects on the environment from their 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. Inventories indicating the potential available reserves of sand, gravel and stone should be prerequisite to legislation regulating land use. Surveys to locate such resources are being carried out in many provinces in order to optimize their use and to choose the best possible distribution routes to consuming centres. It should be observed that controls and zoning can reduce reserves of these resources significantly.

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 reserves must be located, assessed and made part of any community development planning or regional zoning, with optimum land and resource utilization in mind.

TABLE 1. CANADA, TOTAL PRODUCTION OF STONE, 1983-85

	1983		1984		1985P	
	(000 t)	($ 000)	(000 t)	($ 000)	(000 t)	($ 000)
By province						
Newfoundland	279	1,431	558	3,328	575	3,335
Nova Scotia	1 296	7,784	4 377	21,529	4 400	21,250
New Brunswick	2 087	11,310	2 036	10,341	2 060	11,120
Quebec	27 303	121,154	30 946	139,247	31 173	142,574
Ontario	27 939	127,192	33 992	160,847	31 393	151,887
Manitoba	1 137	5,452	2 120	11,927	1 922	8,635
Alberta	286	3,457	258	3,416	180	2,324
British Columbia	4 915	27,084	6 738	38,181	6 100	36,235
Northwest Territories	2 409	14,601	729	4,617	127	795
Canada	67 651	319,465	81 754	393,432	77 930	378,115
By use[1]						
Building stone						
Rough	205	7,359	..	..	..	..
Monumental and ornamental stone	39	4,012	..	..	..	..
Other (flagstone, curbstone, paving blocks, etc.)	19	900	..	..	..	..
Chemical and metallurgical						
Cement plants, foreign	594	1,523	..	..	..	..
Lining, open-hearth furnaces	19	100	..	..	..	..
Flux in iron and steel furnaces	980	4,160	..	..	..	..
Flux in nonferrous smelters	129	1,727	..	..	..	..
Glass factories	571	4,348	..	..	..	..
Lime kilns, foreign	289	1,402	..	..	..	..
Pulp and paper mills	272	2,835	..	..	..	..
Sugar refineries	47	250	..	..	..	..
Other chemical uses	70	2,307	..	..	..	..
Pulverized stone						
Whiting (substitute)	101	5,936	..	..	..	..
Asphalt filler	45	258	..	..	..	..
Dusting, coal mines	81	1,180	..	..	..	..
Agricultural purposes and fertilizer plants	1 109	10,464	..	..	..	..
Other uses	609	4,162	..	..	..	..
Crushed stone for						
Manufacture of artificial stone	12	207	..	..	..	..
Roofing granules	326	21,523	..	..	..	..
Poultry grit	26	518	..	..	..	..
Stucco dash	12	428	..	..	..	..
Terrazzo chips	7	279	..	..	..	..
Rock wool	-	-	..	..	..	..
Rubble and riprap	4 610	22,394	..	..	..	..
Concrete aggregate	5 587	21,743	..	..	..	..
Asphalt aggregate	4 930	20,768	..	..	..	..
Road metal	20 404	73,790	..	..	..	..
Railroad ballast	3 810	20,959	..	..	..	..
Other uses	22 728	77,530	..	..	..	..
Total	67 651	313,065	..	..	..	..

[1] The 1983 value of production includes companies transportation costs not applicable in the by use category.
P Preliminary; .. Not available; - Nil.

TABLE 2. CANADA, PRODUCTION OF SAND AND GRAVEL BY PROVINCE, 1983-85

	1983		1984		1985P	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
Newfoundland	4 057	18,389	3 123	11,637	3 025	11,350
Prince Edward Island	1 174	726	271	805	400	1,550
Nova Scotia	8 136	23,076	8 180	20,925	7 475	21,300
New Brunswick	5 668	10,830	7 401	8,803	7 600	9,700
Quebec	37 006	71,168	35 189	66,353	29 564	60,019
Ontario	68 316	174,933	67 245	151,380	69 250	167,400
Manitoba	9 909	26,537	11 693	31,952	12 410	33,150
Saskatchewan	7 999	21,014	9 737	22,070	10 200	26,375
Alberta	43 789	126,354	45 494	105,001	44 600	109,000
British Columbia	40 969	112,456	35 103	85,973	31 750	76,835
Yukon and Northwest Territories	6 385	33,917	10 323	41,428	7 450	34,575
Canada	233 408	619,400	233 759	546,328	223 724	551,254

P Preliminary.
Figures may not add due to rounding.

TABLE 3. AVAILABLE DATA ON CONSUMPTION OF SAND AND GRAVEL, BY PROVINCE, 1982 AND 1983

		Atlantic Provinces	Quebec	Ontario	Western Provinces[1]	Canada
				(000 tonnes)		
Roads	1982	11 525	26 430	36 292	62 441	136 688
	1983	14 455	25 955	42 300	74 818	157 528
Concrete aggregate	1982	1 029	3 037	9 265	9 106	22 437
	1983	1 366	3 173	10 655	9 021	24 215
Asphalt aggregate	1982	1 479	3 462	4 016	6 560	15 517
	1983	1 846	2 793	3 837	7 662	16 138
Railroad ballast	1982	168	152	777	1 699	2 796
	1983	147	153	75	2 248	2 623
Mortar sand	1982	37	307	865	354	1 563
	1983	97	342	1 086	1 699	3 224
Backfill for mines	1982	1	601	557	23	1 182
	1983	1	189	767	14	971
Other fill	1982	931	7 719	7 289	13 388	29 327
	1983	795	4 058	8 197	7 307	20 357
Other uses	1982	294	224	1 312	993	2 823
	1983	328	343	1 399	6 282	8 352
Total sand and gravel	1982	15 464	41 932	60 373	94 564	212 333
	1983	19 035	37 006	68 316	109 051	233 408

[1] As of 1982 the western provinces include the Yukon and Northwest Territories.

TABLE 4. CANADA, EXPORTS AND IMPORTS OF SAND AND GRAVEL AND CRUSHED STONE, 1982-85

	1982		1983		1984		Jan.-Sept. 1985	
	(tonnes)	($)	(tonnes)	($)	(tonnes)	($)	(tonnes)	($)
Exports								
Sand and gravel								
United States	168 178r	624,000	83 931	328,000	108 928	551,000	218 860	853,000
South Africa	34	9,000	34	9,000	122	32,000	1 854	14,000
Algeria	-	-	103	10,000	146	14,000		
France	335	34,000	49	4,000	591	12,000	33	5,000
St. Pierre and Miquelon	-	-	19	2,000	19	2,000		
Other countries	143	18,000	11 497	79,000	6	2,000	4 988	33,000
Total	168 690	685,000	95 633	432,000	109 812	613,000	225 735	906,000
Crushed limestone								
United States	1 516 889	8,475,000	1 390 795	8,375,000	1 216 631	6,811,000	932 303	5,067
Other countries	602	8,000	-	-	46	4,000	-	-
Total	1 517 491	8,483,000	1 390 795	8,375,000	1 216 677	6,815,000	932 303	5,067
Imports								
Sand and gravel, nes								
United States	1 172 701r	5,248,000	878 545	4,362,000	1 266 255	6,113,000	882 983	4,370,000
West Germany	2 219	5,000	36	6,000	715	3,000	846	3,000
Other countries	4 359	13,000	33	4,000	13	2,000	1 531	24,000
Total	1 179 279r	5,266,000	878 614	4,372,000	1 266 983	6,118,000	885 360	4,397,000
Crushed limestone								
United States	1 485 420r	9,003,000	1 799 861	8,447,000	1 944 046	9,666,000	1 279 509	6,994,000
Total	1 485 420	9,003,000	1 799 861	8,447,000	1 944 046	9,666,000	1 279 509	6,994,000
Crushed stone, nes								
United States	71 313	1,239,000	43 889	1,092,000	44 108	1,377,000	59 419	1,388,000
Italy	41	3,000	63	3,000	230	28,000	43	6,000
Other countries	25	2,000	34	10,000	75	2,000	195	37,000
Total	71 379	1,244,000	43 986	1,105,000	44 413	1,408,000	59 657	1,432,000

Source: Statistics Canada.
r Revised; - Nil; nes Not elsewhere specified.

TABLE 5. LIGHTWEIGHT AGGREGATE PLANTS IN CANADA 1984

Company	Location	Commodity	Remarks
Atlantic Provinces			
Annapolis Valley Peat Moss Company Limited	Berwick, N.S.	Perlite, Vermiculite	Processed mainly for use in horticulture.
Avon Aggregates Ltd.	Minto, N.B.	Expanded Shale	Processed for concrete products industry.
Quebec			
Canexel Inc.	Gatineau	Perlite	Processed for use in ceiling tile manufacture.
Domtar Inc.	Montreal	Perlite, Vermiculite	Processed material purchased for use in gypsum plaster and wallboard at all company plants.
F. Hyde & Company, Limited	Montreal	Vermiculite	Processed for use in horticulture and as loose insulation.
Miron Inc.	Montreal	Pumice	Purchased for concrete block manufacture.
Perlite Industries Inc.	Ville St. Pierre	Perlite	Processed for use in horticulture and as industrial filler.
V.I.L. Vermiculite Inc.	Lachine	Vermiculite	Processed for use in horticulture and as loose insulation.
Ontario			
Canadian Gypsum Company, Limited	Hagersville	Perlite	Processed for use in gypsum plaster.
National Slag Limited	Hamilton	Slag	Used in concrete blocks and as slag cement.
V.I.L. Vermiculite Inc.	Rexdale	Vermiculite	Processed for use in horticulture and as loose insulation.
W.R. Grace & Co. of Canada Ltd.	St. Thomas	Vermiculite	Vermiculite processed for use in horticulture and as loose insulation.
	Ajax	Vermiculite, Perlite	Perlite processed for use in gypsum plaster and in horticulture.
Prairie Provinces			
Apex Aggregate	Saskatoon, Sask.	Expanded clay	Processed for concrete block manufacture.
Cindercrete Products Limited	Regina, Sask.	Expanded clay	Processed for concrete products industry.
Consolidated Concrete Limited	Calgary, Alta.	Expanded shale	Processed for concrete products industry.
	Edmonton, Alta.	Expanded clay	Processed for concrete products industry.
Genstar Corporation, Edcon Block Division	Edmonton, Alta.	Expanded clay	Processed for concrete block manufacture.
Kildonan Concrete Products Ltd.	Winnipeg, Man.	Expanded clay	Processed for concrete products industry.
W.R. Grace & Co. of Canada, Ltd.	Winnipeg, Man.	Vermiculite, Perlite	Perlite processed for use in gypsum plaster and in horticulture.
	Edmonton, Alta.	Vermiculite, Perlite	Vermiculite processed for use in horticulture and as loose insulation.
British Columbia			
Ocean Construction Supplies Limited	Vancouver	Pumice	Purchased for concrete block manufacture.

TABLE 6. CANADA, IMPORTED RAW MATERIALS PURCHASED, 1983 AND 1984

	1983		1984	
	(tonnes)	($)	(tonnes)	($)
Pumice, perlite and vermiculite[1]	47 160	5,267,013	42 232	5,617,752

Source: Company data.
[1] Combined to avoid disclosing confidential company data.

TABLE 7. CANADA, PRODUCTION OF LIGHTWEIGHT AGGREGATES, 1983 AND 1984

	1983		1984	
	(m^3)	($)	(m^3)	($)
From domestic raw materials				
Expanded clay, shale and slag	204 264	5,049,810	149 524	3,560,468
From imported crude materials				
Expanded perlite and exfoliated vermiculite[1]	370 636[r]	10,796,688	398 462	15,659,737
Total	574 900[r]	15,846,498	547 986	19,220,205

Source: Company data.
[1] Combined to avoid disclosing confidential company data.
[r] Revised.

TABLE 8. CANADA, CONSUMPTION OF SLAG, PERCENTAGE BY USE, 1982-84

Use	1982	1983	1984
Concrete block manufacture	38.0	27.0	28.0
Ready-mix concrete	4.0	2.0	1.0
Loose insulation	1.0	1.0	1.0
Slag cement	57.0	70.0	70.0

Source: Company data.

TABLE 9. CANADA, CONSUMPTION OF EXPANDED CLAY AND SHALE, PERCENTAGE BY USE, 1982-84

Use	1982	1983	1984
Concrete block manufacture	78.7	80.6	74.8
Precast concrete manufacture	11.5	7.8	13.0
Ready-mix concrete	4.3	6.5	11.2
Horticulture and miscellaneous uses	5.5	5.1	1.0

Source: Company data.

TABLE 10. CANADA, CONSUMPTION OF EXPANDED PERLITE, PERCENTAGE BY USE 1982-84

Use	1982	1983	1984
Insulation			
in gypsum products	20.6	21.9	26.7
in other construction materials	34.9	28.0	27.1
Horticulture and agriculture	33.7	34.6	38.4
Loose insulation and miscellaneous uses	10.8	15.5	7.8

Source: Company data.

TABLE 11. CANADA, CONSUMPTION OF EXFOLIATED VERMICULITE, PERCENTAGE BY USE 1982-84

Use	1982	1983	1984
Insulation			
loose	45.8	30.2	24.5
in concrete and concrete products	0.5	0.4	1.2
in gypsum products	1.7	0.5	0.7
Horticulture	48.2	46.3	56.7
Miscellaneous uses	3.8	22.6	16.9

Source: Company data.

TABLE 12. CANADA, VALUE OF CONSTRUCTION[1] BY TYPE, 1983-85

	1983	1984	1985
		($ millions)	
Building Construction			
Residential	16,851	16,497	16,912
Industrial	2,450	2,707	2,967
Commercial	6,482	7,034	7,374
Institutional	3,065	3,028	3,186
Other building	1,905	2,068	2,143
Total	30,753	31,334	32,582
Engineering Construction			
Marine	426	459	500
Highways, airport runways	4,326	4,345	4,873
Waterworks, sewage systems	2,229	2,222	2,292
Dams, irrigation	291	294	288
Electric power	4,397	3,691	3,483
Railway, telephones	2,469	2,552	2,732
Gas and oil facilities	8,128	8,339	8,879
Other engineering	2,929	2,894	3,333
Total	25,195	24,796	26,380
Total construction	55,948	56,130	58,962

Source: Statistics Canada.
[1] Actual expenditures 1983, preliminary actual 1984, intentions 1985.

TABLE 13. CANADA, VALUE OF CONSTRUCTION[1] BY PROVINCE, 1983-85

	1983			1984			1985		
	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total
	($000)								
Newfoundland	500,406	966,856	1,467,262	499,344	955,432	1,454,776	545,809	937,967	1,483,776
Nova Scotia	862,518	1,243,189	2,105,707	947,772	1,230,719	2,178,491	1,040,607	1,244,812	2,285,419
New Brunswick	724,935	429,475	1,154,410	714,228	493,606	1,207,834	707,603	475,935	1,183,538
Prince Edward Island	112,102	69,861	181,963	119,655	66,139	185,794	124,646	68,880	193,526
Quebec	6,798,160	4,194,350	10,992,510	7,689,032	3,978,144	11,667,176	7,922,247	4,050,275	11,972,522
Ontario	10,114,265	4,856,478	14,970,743	11,323,048	5,287,148	16,610,196	12,130,421	5,428,646	17,559,067
Manitoba	1,025,322	620,076	1,645,398	1,082,729	712,903	1,795,632	1,178,621	803,656	1,982,277
Saskatchewan	1,383,238	1,333,645	2,716,883	1,293,247	1,492,889	2,786,136	1,345,724	1,771,544	3,117,268
Alberta	4,640,878	6,441,239	11,082,117	3,416,105	6,257,861	9,673,966	3,436,296	7,398,700	10,834,996
British Columbia, Yukon and Northwest Territories	4,590,837	5,039,937	9,630,774	4,249,136	4,320,995	8,570,131	4,150,391	4,199,396	8,349,787
Canada	30,752,661	25,195,106	55,947,767	31,334,296	24,795,836	56,130,132	32,582,365	26,379,811	58,962,176

Source: Statistics Canada.
[1] Actual expenditures 1983, preliminary actual 1984, intentions 1985.

TABLE 14. CANADA ROCK- MINERAL- AND GLASS-WOOL PRODUCERS, 1984

Company	Location	Remarks
Quebec		
Fiberglas Canada Inc.	Candiac	Expanded in 1977.
Manville Canada Inc.	Brossard	15 000 tpy capacity.
Ontario		
Fiberglas Canada Inc.	Sarnia	Expanded in 1978. New electric furnace is largest of kind.
	Toronto	New plant in 1979.
Canadian Gypsum Company, Limited	Mount Dennis (Toronto)	Using slag from Hamilton.
Holmes Insulations Inc.	Sarnia	Slag - Detroit.
Bishop Fibretech Inc.	Toronto	Slag - Hamilton.
Graham Fiber Glass Limited	Erin	New by 1979. Capacity 10 000 tpy.
Roxul Company	Milton	A division of Standard Industries Ltd.
Ottawa Fibre Industries Ltd.	Ottawa	
Prairie Provinces		
Fiberglas Canada Inc.	Clover Bar, Alta. (Edmonton)	Expanded in 1977.
Manville Canada Inc.	Innisfail, Alta.	New in 1978. Capacity 6 000 tpm. New energy-efficient mechanical fiberizing technology in use.
Alberta Rockwool Corporation	Calgary, Alta.	
British Columbia		
Fiberglas Canada Inc.	Mission	New in 1980. Capacity 45 000 tpy.
Pacific Enercon Inc.	Grand Forks	

Molybdenum

D.G. FONG

Western world molybdenum demand in 1985 increased slightly to about 7 700 tonnes (t) while production dropped marginally to about 7 890 t. The molybdenum market showed signs of firming during the first quarter of 1985, a direct reaction to reports of stronger demand, mine closures in the United States, and an earthquake in Chile that might have disrupted supplies from that source. However, prices fell once again, starting in the second quarter, as a result of the continuing overhang of large inventories on the market, weaker demand and intense market competition.

Canadian molybdenum production in 1985 was at its lowest point in many years. The industry operated at 30 per cent of its capacity in 1985, largely a result of the continuing closure of all primary molybdenum mines and several byproduct producers. Canadian production is expected to improve in 1986 when a Hemlo area gold mine places its molybdenum circuit into operation. It is also anticipated that Placer Development Limited might decide to bring its Endako Mine back in operation during 1986.

CANADIAN DEVELOPMENTS

Brenda Mines Ltd., a subsidiary of Noranda Inc., restarted production on September 15, 1985 following an agreement reached with the Commission of Critical Industries of British Columbia. The agreement provided special concessions on power rates and taxes over a three-year period. This Peachland, British Columbia, copper-molybdenum mine had been closed since December 14, 1984. Prior to the reopening, the union ratified an extension of its labour agreement to mid-1987, which provides mine employees with a profit-sharing plan in lieu of wage increases.

The Endako Mine of Placer Development Limited, located at Fraser Lake, British Columbia, remained closed in 1985 because of low demand and poor market prices. The mine has been maintained on standby since its closure in June 1982. Inventories from Endako have been depleted; the company has been selling molybdenum from its subsidiary, Gibraltar Mines Limited and, in some cases, purchases from other producers. In May, Equity Silver Mines Limited commenced production of ammonium dimolybdate (ADM) and high-purity oxide on a toll basis. Placer owns 70 per cent of Equity Silver.

In August, Noranda Inc. announced the sale of its 30 per cent interest in Placer in order to reduce its debt and bring down its debt-to-equity ratio. The sale of Placer represents the first stage of a program to reduce the company's debt by about $1 billion. However, no specific time limit was stated for the planned debt-reduction program. During 1985, Noranda brought on-stream its Golden Giant gold-molybdenum mine in Hemlo, Ontario. The production of gold commenced in March, but no production of molybdenum was reported although the installation of a molybdenum recovery circuit had been completed. The average molybdenum grade in the Noranda mine is 0.16 per cent molybdenite (MoS_2).

At Gibraltar, molybdenum output during the first three quarters of 1985 increased by 88 per cent over the corresponding period in 1984 as a result of higher ore grades. The company continued to look for ways to reduce costs and improve efficiency. Tests on column flotation cells were continued with a view to using these as a means of reducing expenditures and improving metal recoveries. Gibraltar has also reduced costs through cutbacks on manpower, which has been trimmed to about half of the 1980 level.

Operations at Lornex Mining Corporation Ltd.'s copper-molybdenum mine returned to profitability after a year of operating losses. Output of molybdenum at this Highland Valley, British Columbia mine increased by 14 per cent during the first half of 1985; higher molybdenum prices during the first quarter motivated the company to increase its tonnage throughput

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while improved ore recovery and the application of computer technology also helped to increase the output. The newly installed computer assisted truck dispatch system, better mine planning and fuel conversion in light vehicles to compressed natural gas have all helped to improve productivity and reduce operating costs.

Lornex was the first mining company to benefit from British Columbia's Industrial Electricity Discount Act which gave the company a 25 per cent discount on the purchase of 16.2 MW of surplus electricity from British Columbia Hydro and Power Authority (B.C. Hydro). The company planned to utilize the power to pump additional water which would improve mineral recoveries at its mine-mill complex. Lower grade copper and molybdenum ore which would have been otherwise dumped as waste, was to be reprocessed, thereby extending the life of the mining operation.

The Mount Pleasant Tungsten mine in New Brunswick, which commenced production in 1983, was placed on an indefinite closure at the end of July 1985 due to depressed markets for tungsten and molybdenum. The tungsten-molybdenum mine had an annual output capacity of 1 000 t of tungsten trioxide and 600 t of molybdenum but the operation did not report production of molybdenum during its brief period of operation.

Moli Energy Limited of Vancouver planned to spend $42.6 million to build a production plant outside Vancouver to produce lithium-molybdenum rechargeable batteries. Production is to start with an initial output rate of 3.7 million AA cells a year, rising to 34 million cells annually by 1990. The company was operating a pilot plant at Burnaby, British Columbia which produced 200 to 300 AA batteries a day. Moli Energy was also carrying out research on a 'BC' size cell, the type of battery that can be used to power electrical vehicles.

Because of the large amount of unutilized capacity, slow recovery in demand and high inventories, developments at a number of promising molybdenum deposits in Canada have been placed on hold for an indefinite period. These include the Red Mountain property in the Yukon Territory, and the Ruby Creek and Trout Lake deposits in British Columbia. It is unlikely that development at these deposits will resume within this decade.

WORLD DEVELOPMENTS

In the United States, AMAX Inc. reopened the Climax and Henderson mines on September 3 following a 9-week shutdown. The summer closure at the two Colorado molybdenum mines was to bring production in line with demand. Following the opening, the mines continued to operate at about one-half of capacity or about 22 680 tpy of molybdenum. However, greater emphasis was placed on the output of higher grade ores from the Henderson mine.

AMAX continued to pare production costs in order to make its product more competitive in the molybdenum market. In addition to using a higher proportion of ore from the lower cost Henderson mine, the company trimmed its workforce and streamlined its operations.

Duval Corporation was operating at capacity at its Sierrita mine during 1985 while its parent company, Pennzoil Company was seeking a buyer for the copper-molybdenum operation. Production at the Arizona mine was increased to about 100 000 tpd of ore from 82 500 tpd following the recent installation of the in-pit crusher. The output of molybdenum was at its capacity rate of 9 070 tpy despite the depressed market and high inventories. It was reported that the mine was operated at capacity to demonstrate its low unit operating costs in an effort to make the mine more attractive to potential buyers.

Anaconda Minerals Company, a subsidiary of Atlantic Richfield Company (Arco), decided in late-January to close its Tonopah molybdenum mine in Nevada. This 20 000 tpd mine was brought on-stream in 1982 at a time of low demand and poor metal prices. Since the mine start-up, Anaconda has been experiencing operating losses. The closure of the Tonopah mine resulted in a reduction of 4 536 t of annual supply in the molybdenum concentrate market.

Kennecott Minerals Company suspended production at its Bingham Canyon copper-molybdenum mine in April and thereby reduced the supply by a further 1 630 t of molybdenum concentrate to the market. The closure placed additional pressure on the already tight supply of concentrates, in contrast to the oxide market which remained in oversupply with high inventories.

Amoco Minerals Company officially became Cyprus Minerals Company in July. The change followed Amoco Corporation's decision to spin off its mineral assets which include the Thompson Creek molybdenum mine at Chalis, Idaho, the Bagdad copper-molybdenum mine in Arizona, and other coal and industrial mineral operations. Cyprus Minerals was created as a separate company and independent of the oil giant. However, shares were offered to the stockholders of Amoco Minerals Company.

Thompson Creek mine has an annual output capacity of 9 070 tpy of contained molybdenum. During 1985, the mine was operating near capacity despite the weak market. To further reduce production costs, Cyprus Minerals was planning to mine in a deeper area where there is higher grade ore.

A major earthquake in Chile helped to generate a short-term rally in the molybdenum market. Although production of molybdenum in Chile continued nearly as normal, some shipments were delayed because of damage to some of the Chilean ports. The Chuquicamata mine, which accounts for about 70 per cent of the annual molybdenum output of Corporacion Nacional del Cobre de Chile (Codelco-Chile), and Port Antofagasta, through which the Chuquicamata materials are handled, were unaffected. The 1985 molybdenum output from Chile, estimated at 15 870 t, was down 910 t from 1984; however, the lower output was largely due to lower ore grades.

Codelco terminated its arrangements with U.S. sales agents and started dealing directly with its clients through its subsidiary, Corporacion del Cobre USA Inc.

USES

Molybdenum is used in a wide range of products as an alloy additive, a chemical compound, a pure metal and as lubricants. Approximately 90 per cent of all molybdenum consumed in the western world is used in metallurgical applications including steel, ferrous castings, special alloys, and pure molybdenum metal. The remaining 10 per cent is used in non-metallurgical applications such as chemicals, catalysts and lubricants.

As an alloying additive in steel, molybdenum imparts hardenability, strength, toughness and resistance to corrosion and abrasion. Tool steels, stainless steels, high-strength steels, heat resisting steels and a wide range of alloy steels are important consumers of molybdenum. Depending on type and specification, molybdenum is added in amounts ranging from less than 0.1 per cent to nearly 10 per cent. Molybdenum can be added as a sole agent but, more often, it is used in combination with other additive metals.

Molybdenum is an important alloying element in most types of tool steels. Among the tool steel additives, molybdenum and tungsten both promote red hardness and increase wear resistance in high speed steels. The performance of these steels is proportional to the percentage of the elements. However, molybdenum produces more carbide than tungsten per unit weight added, and thus can replace tungsten at a rate of almost one to two. For some hot work tool steels and high speed steels, the molybdenum content can be as high as 9 to 10 per cent.

Additions of molybdenum to austenitic and ferritic stainless steels enhance the resistance to corrosive acids and brines. These steels are finding increasing use in heat exchangers for severe chemical environments, seawater condenser tubings, caustic evaporators, and heat resisting steels operating under stress and high temperatures.

In high-strength, low-alloy steels, the addition of molybdenum increases the yield and tensile strength, and improves toughness and weldability. Steels with these properties are especially useful in structural applications and in Arctic-grade large-diameter pipelines. The consumption intensity of molybdenum in pipeline steels has declined, especially in Japan and western Europe where pipeline manufacturers have switched to non-molybdenum steels, even for the Arctic-grade pipelines. This increase in substitution to other ferroalloy additives was brought about mainly by the high prices and short supply of molybdenum in the late-1970s.

Molybdenum is an important constituent of many high performance alloys that are extremely resistant to heat, corrosion and wear. These alloys are used extensively in aerospace components, chemical processing plants, and high temperature furnace and foundry parts.

Molybdenum compounds are used as catalysts in the petroleum refining and chemical processing industries. Molybdenum orange, an important molybdenum pigment, is used in printing inks, dyes and corrosion resistant primer. Pure molybdenum disulphide is an excellent dry lubricant and is used as an oil additive. The lamellar structure of the molybdenum disulphide helps to reduce friction and thus prolongs engine life. In recent years, non-metallurgical applications have been experiencing a faster growth rate than other uses.

New uses have recently been developed for molybdenum in a new generation of batteries. This new line of products, being developed in Canada, uses pure molybdenum disulphide (as cathode) and lithium (as anode) to make rechargeable batteries. The lithium-molybdenum battery is found to have more energy and power per cell volume than the conventional nickel-cadmium or alkaline units. It is also superior in terms of rechargeability, charge retention and storage temperature range. Because of the relatively high price, its main market is expected to be original equipment manufacturers which install batteries in such items as cameras, photoflashes, portable televisions and computers, military communications equipment and any other applications where light weight, charge retention and power density are important factors.

PRICES

Prices of molybdenum fluctuated widely during the year, rising from a low of $US 6.06 per kg for technical oxide at the beginning of the year to a high of $US 9.92 a kg in March. The ferromolybdenum price rose from $US 7.71 to $US 10.80 a kg of contained molybdenum, and on the European market, the oxide price went as high as $US 10.47. The price improvement was primarily due to announcements of mine closures, rumours of further mine shutdowns in the United States and the major earthquake in Chile.

Prices started to fall in April, dropping to a low of $US 5.73 per kg of oxide by the end of the year in recognition of the market reality - continuing high producer inventories, a softening in demand and liquidation of stocks by merchants. Despite the summer shutdown at AMAX's Colorado mines, an increase in inventories as a result of stepped-up production at a number of U.S. major producers created a further negative impact on the molybdenum market.

OUTLOOK

The demand for molybdenum will continue to parallel activity in the specialty steel sector, which together accounts for about 75 per cent of total molybdenum consumption. Although consumption in the western world has improved substantially as a result of the economic recovery, it is unlikely that it will return to the 1979 peak level of 84 000 t before the first half of the 1990s.

During the next three years, the molybdenum market is expected to make modest gains. The growth rate for molybdenum consumption during this period is forecasted to be 2 to 3 per cent per annum, largely in parallel with the projected economic growth in the western World. Market prices will continue to be weak and production capacity is expected to exceed consumption by a wide margin, in spite of the forecasted growth in demand.

Current high world inventories, estimated at about eight months' consumption, are also a constraint on any expectations for a turnaround in the molybdenum market.

In contrast to the weak molybdenum market of recent years, the average growth rate for consumption during the next decade is expected to be 4 to 5 per cent per year, derived in large part from the rising trend in the use of molybdenum in low-alloy steels. A stable and dependable supply of molybdenum at relatively low prices will favor the expanding use of molybdenum as compared with many of its substitutes.

Among the end uses, molybdenum consumption is expected to grow at a faster rate in applications that use pure metal and chemicals, particularly in relation to relatively young industries where fast growth is associated with technological advances. For example, high purity molybdenum is increasingly being used in electronics. Ultrapure molybdenum is required for metal oxide semi-conductor gates in large-scale circuits. Because of its high thermal conductivity, molybdenum is expected to become a widely used material for the mounting of silicon chips to other semi-conductor devices.

A major shift of molybdenum consumption to the developing countries is not expected to take place in the next decade, in spite of the rapid growth of steel production in the developing countries and a static level of steel output forecasted for the advanced industrial nations. This is because the specialized technology for making alloy steel is concentrated in the advanced industrial countries; most of the steel production in developing countries will continue to be carbon steels.

World mine capacity for molybdenum is more than adequate to satisfy the projected demand increase well into the next decade. There are also a number of well defined molybdenum deposits, especially in North America, which could be developed when world supply and demand approach a reasonable balance. Indeed, production restraint will be an ongoing industry challenge if market stability is to be achieved.

Canadian production and exports could rise considerably during the next few years. The reopening of Brenda Mines has been a major step in reversing the recent production trend. The start-up of the molybdenum recovery circuit at Noranda's Hemlo gold mine and the anticipated resumption of operations at the Endako mine will enhance Canada's supply capability further. These mines, being the average to low-cost producers, are well positioned to take advantage of the forecasted market growth.

PRICES

Prices in $US per kilogram of contained molybdenum, fob shipping point unless indicated otherwise, December 31.

	1984	1985
	($)	
Byproduct concentrates (MoS_2)	5.95-6.39	5.07
Export oxide (MoO_3) in cans	8.65-13.23	7.45
Dealer oxide (MoO_3) in cans; min. 57% Mo	6.06-6.61	5.62-5.84
Ferromolybdenum[1] Dealer export (fas port)	7.83-8.05	7.14-7.28

Source: Metals Week.
[1] Price based on molybdenum content.
fob Free on board; fas Free alongside ship.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
32900-1	Molybdenum ores and concentrates	free	free	free	free
33505-1	Molybdenum oxides	10.0	13.1	25.0	8.5
37506-1	Ferromolybdenum	free	4.3	5.0	free
35120-1	Molybdenum metal in powder, pellets, scrap, ingots, sheets, strips, plates, bars, rods, tubing or wire, for use in Canadian manufactures	free	free	25.0	free
92847-1	Molybdates	10.0	10.7	25.0	7
	Temporary reduction, June 3, 1980 to June 30, 1987	free			free
92856-1	Molybdenum carbides	3.8	3.8	25.0	2.5
	Temporary reduction, June 3, 1980 to December 31, 1986	free			free

TARIFFS (cont'd)

MFN Reductions under GATT (effective January 1 of year given)		1985	1986	1987
			(%)	
33505-1		13.1	12.8	12.5
37506-1		4.3	4.2	4.0
92847-1		10.7	9.9	9.2
92856-1		3.8	1.9	free
UNITED STATES				
601.33	Molybdenum ore (per lb on Mo content)	9.8¢	9.4¢	9.0¢
419.60	Molybdenum compounds	3.4	3.3	3.2
606.31	Ferromolybdenum	5.2	4.9	4.5
628.70	Molybdenum metal, waste and scrap	7.1	6.6	6.0
628.72	Molybdenum metal, unwrought	7.2¢/ lb on Mo content +2.2	6.7¢/ lb on Mo content +2.0	6.3¢/ lb on Mo content +1.9
628.74	Molybdenum metal, wrought	8.1	7.3	6.6
417.28	Ammonium molybdate	4.8	4.5	4.3
418.26	Calcium molybdate	4.8	4.7	4.7
421.10	Sodium molybdate	4.1	3.9	3.7
423.88	Molybdenum carbide	3.0	2.9	2.8

EUROPEAN ECONOMIC COMMUNITY (MFN)		1985	Base Rate	Concession Rate
			(%)	
26.01	Molybdenum ores and conc	free		
28.28	Molybdenum oxides and hydroxides	6	8.0	5.3
73.02	Ferromolybdenum	5.3	7.0	4.9
81.02	Molybdenum metal			
	A. Unwrought: powder	6		
	other	5		
	B. Wrought: bars, angles, plates, sheets, strip, wire	8		
	C. Other	10		
28.47	Molybdates	7.8	11.2	6.6
28.56	Molybdenum carbides	8	9.6	8.0
JAPAN (MFN)				
26.01	Molybdenum ores and conc			
	A. Quota	free		
	B. Other	1.9	7.5	free
28.28	Molybdenum trioxide	3.7	5.0	3.7
73.02	Ferromolybdenum	4.9	7.5	4.9
81.02	Molybdenum metal			
	A. Unwrought, powders and flakes	3.7	5.0	3.7
	B. Waste and scrap	3.7	5.0	3.7
	C. Other	4.9	7.5	4.9
28.47	Molybdates	4.9	7.5	4.9
28.56	Molybdenum carbides	3.7	5.0	3.7

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated 1985, USITC publication 1610; U.S. Federal Register, Vol. 44, No. 241; Official Journal of the European Communities, Vol. 27, No. L320, 1985; Customs Tariff Schedules of Japan, 1985.

TABLE 1. CANADA, MOLYBDENUM PRODUCTION AND TRADE, 1983-85, AND CONSUMPTION, 1983

	1983		1984		1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production (shipments)[1]						
British Columbia	10 179	87,564	11 420	104,774	7 333	73,089,000
Quebec	15	146	136	1,384	235	2,301,000
Total	10 194	87,710	11 556	106,158	7 568	75,390,000
Exports					(Jan.-Sept.)	
Molybdenum in ores, concentrates and scrap[2]						
United Kingdom	2 452	24,374	963	8,821	373	3,711
Belgium-Luxembourg	1 969	22,216	1 859	16,251	445	3,477
Netherlands	2 097	19,511	1 167	10,671	490	4,695
West Germany	2 006	16,404	1 429	11,933	549	4,159
Japan	1 274	14,940	2 280	26,809	895	9,829
United States	437	3,584	406	3,491	429	4,025
Austria	404	2,900	59	721	..	..
Chile	517	2,422	701	6,576	405	4,425
Other countries	128	1,426	32	460	50	663
Total	11 284	107,777	8 896	85,724	3 636	34,984
Imports						
Molybdic oxide (containing less than 1 per cent impurities)	141	1,486	238	2,428	181	1,840
Molybdenum in ores and concentrates (Mo content)	233	1,833	329	2,782	203	1,858
Ferromolybdenum alloys	34	323	186	2,081	219	2,301

	1983	
	(kilograms)	($)
Consumption (Mo content)		
Addition agents	387 874	..
Electrical and electronics	2 009	..
Other uses[3]	100 234	..
Total	490 117	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments (Mo content of molybdenum concentrates, molybdic oxide and ferromolybdenum). [2] Includes molybdenite and molybdic oxide in ores and concentrates. [3] Alloy, pigment and ceramics.
P Preliminary; .. Not available.

TABLE 2. CANADA, MOLYBDENUM PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975 AND 1977-85

	Production[1]	Exports[2]	Imports		Consumption[5]
			Molybdic oxide[3]	Ferro-molybdenum[4]	
	(kilograms)				
1970	15 318 593	13 763 800	33 500	29 619	1 036 940
1975	13 323 144	15 710 300	56 400	269 281	1 436 883
1977	16 567 555	15 326 100	192 100	74 330	1 149 736
1978	13 943 405	13 421 000	329 500	55 294	1 268 640
1979	11 174 586	11 481 900	335 900	153 945	1 249 944
1980	11 889 000	14 584 500	361 700	53 618	1 055 107
1981	12 850 000	13 664 000	423 000	36 069	1 311 863
1982	13 961 000	17 444 000	193 000	6 840	671 368
1983	10 194 000	11 284 000	141 000	34 000	490 117
1984	11 556 777	8 896 000	238 000	186 000	..
1985P	7 569 000	7 539 000e	181 000e	219 000e	..

Sources: Energy, Mines and Resources Canada; Statistics Canada; except where noted.
[1] Producers' shipments (Mo content of molybdenum concentrates, oxide and ferromolybdenum). [2] Mo content, ores and concentrates. [3] Gross weight. [4] United States exports to Canada, reported by the U.S. Bureau of Commerce, Exports of Domestic and Foreign Merchandise (Report 410), over 50 per cent molybdenum. [5] Mo content of molybdenum products reported by consumers.
P Preliminary; e Estimated; .. Not available.

TABLE 3. WORLD PRODUCTION OF MOLYBDENUM IN ORES AND CONCENTRATES, 1983-85

Country	1983	1984	1985e
	(tonnes Mo content)		
United States	15 238	47 021	48 500
Canada	9 155	8 473	6 800
Chile	15 420	16 780	15 870
U.S.S.R.e	11 000	11 200	11 200
People's Republic of Chinae	2 000	2 000	2 000
Peru	2 629	3 080	2 900
Republic of Korea	142	100	100
Bulgariae	330	330	330
Japane	97	120	100
Finland	218	200	200
Mexico	5 865	2 150	4 400
Mongolia	960	1 000	1 000
Total	63 054	92 454	93 400

Sources: Energy, Mines and Resources Canada; U.S. Bureau of Mines, Minerals Yearbook, Preprint, 1984; U.S. Bureau of Mines, Mineral Commodity Summaries, 1985; Intermet Third Quarterly Molybdenum Report, 1985, Santiago, Chile.
P Preliminary; e Estimated.

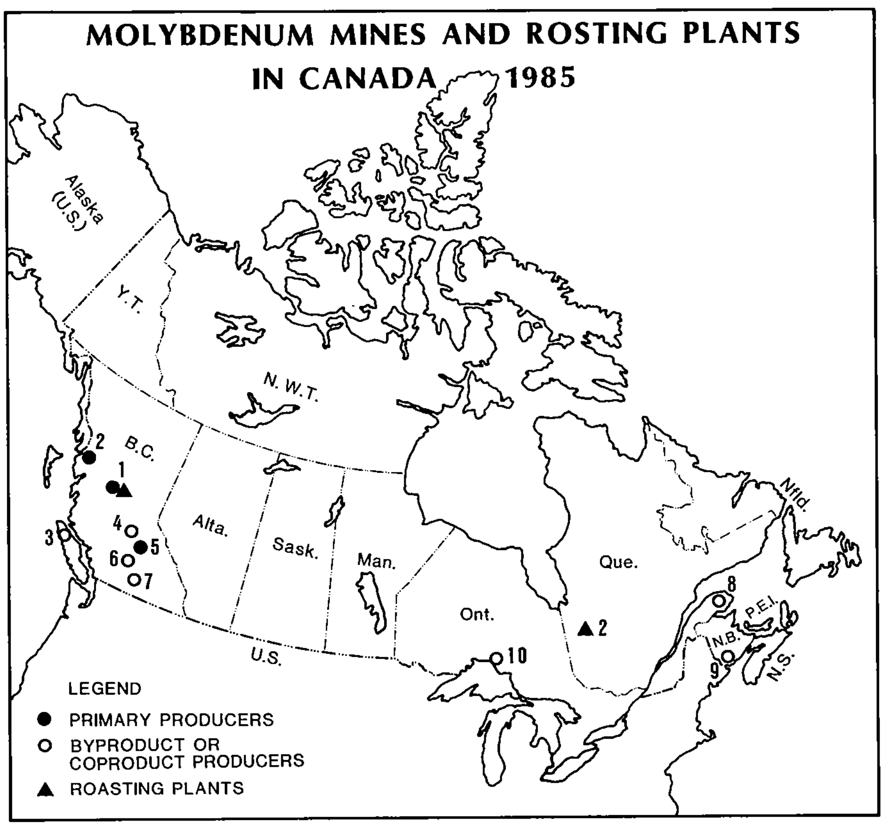
TABLE 4. PRINCIPAL MOLYBDENUM PRODUCERS IN THE WESTERN WORLD, 1985

Company	Country	Installed Capacity
		(000 tpy Mo)
AMAX Inc.	United States	45
Corporacion Nacional del Cobre de Chile (Codelco-Chile)	Chile	20
Duval Corporation	United States	10
Amoco Minerals Company	United States	9
Molycorp, Inc.	United States	9
Placer Development Limited	Canada	7.7
Anaconda Minerals Corporation	United States	6.8
Mexicana de Cobre S.A.	Mexico	5.4
Kennecott Minerals Company	United States	3.5
Noranda Inc.	Canada	4.5
Southern Peru Copper Corporation	Peru	3.1
Amax of Canada Limited	Canada	4
Lornex Mining Corporation Ltd.	Canada	3.4
Newmont Mining Corporation	United States	2.2
Teck Corporation	Canada	2.0
Utah Mines Ltd.	Canada	1.6
Others		4.5
Total		141.7

TABLE 5. CANADA, MINE PRODUCTION, 1984

Company and Mine Name	Location	Type of Producer	Mill Capacity (tpd)	Ore Milled Tonnes	Ore Milled Grade (% Mo)	Concentrates Produced Tonnes	Concentrates Produced Grade (% Mo)	Concentrates Produced Contained Mo (tonnes)
Amax of Canada Limited Kitsault Mine	Alice Arm B.C.	Primary	10 886	-	-	-	-	-
Brenda Mines Ltd.	Peachland, B.C.	Coproduct	27 200	6 109 067	0.039	3 593	55.98	2 012
Gibraltar Mines Limited	McLeese Lake, B.C.	Byproduct	37 195	13 142 200	0.010	726	50.70	361
Highmont Mining Corporation	Highland Valley, B.C.	Coproduct	22 680	6 049 857	0.025	1 984	53.13	1 054
Lornex Mining Corporation Ltd.,	Highland Valley, B.C.	Byproduct	72 575	28 163 000	0.017	6 402	53.84	3 447
Noranda Inc., Boss Mountain Division	Williams Lake, B.C.	Primary	2 631	-	-	-	-	-
Mines Gaspé Division Needle Mountain and Copper Mountain	Holland Twp. Gaspé, Que.	Byproduct	32 800	355 481	0.056	264	51.59	136
Placer Development Limited, Endako Mine	Endako, B.C.	Primary	29 937	-	-	-	-	-
Utah Mines Ltd., Island Copper mine	Port Hardy, B.C.	Byproduct	38 100	16 360 918	0.013	3 062	47.78	1 463
Total								8 473

Sources: Energy, Mines and Resources Canada; Company annual reports.
- Nil.



Mines

1. Placer Development Limited (Endako Mine)
2. Amax of Canada Limited (Kitsault Mine)
3. Utah Mines Ltd. (Island Copper Mine)
4. Gibraltar Mines Limited
5. Noranda Inc. (Boss Mountain Division)
6. Lornex Mining Corporation Ltd.
   Highmont Mining Corporation
7. Brenda Mines Ltd.
8. Noranda Inc. (Gaspé Division)
9. Mount Pleasant Resources Inc.
10. Noranda Inc. (Golden Giant Mine)

Roasting Plants

1. Placer Development Limited (Endako Mine)
2. Eldorado Gold Mines Inc. (Duparquet)

Nepheline Syenite and Feldspar

M.A. BOUCHER

SUMMARY

Nepheline syenite is produced commercially as an industrial raw material for the manufacture of glass and ceramics, mainly by Canada and Norway, and to a smaller extent by Brazil and the U.S.S.R.

Canadian production and exports of nepheline syenite continued to decrease in 1985 from the high level reached in 1979. The decline in production was due to a continuing lower demand for container glass, which must compete with plastics and aluminum, and to an increase in glass waste recycling. Lower exports were the result of the closing of more glass plants in the United States, and the acceptance of lower quality feldspathic material by United States manufacturers.

Published prices remained the same in 1985 as in 1984, although contract prices for fine-grained filler and glass materials were increased.

CANADIAN DEVELOPMENTS

Production

Nepheline syenite is produced in Ontario by Indusmin Limited, a subsidiary of Falconbridge Limited. The company operates two mines and two concentrating plants with an estimated combined production capacity of 800 000 tpy of finished products. Nepheline syenite is mined from two adjacent deposits located on Blue Mountain in Methuen Township, Peterborough County, 175 km northeast of Toronto. The two plants operated at a little over 60 per cent of capacity in 1985. The nepheline syenite is upgraded to low-iron and high-iron glass grades, and to ceramic grades by primary and secondary crushing, drying, screening, high-intensity magnetic separation, pebble milling, and for ultra-fine grades (for use as filler in paints, plastics, etc.) using air classification.

In view of declining markets for nepheline syenite in the United States and Canada, and in order to rationalize the operations, reduce unit costs of production and remain competitive with U.S. feldspathic producers, Indusmin purchased during the year the mining and concentrating operation of International Minerals & Chemical Corporation (IMC) located on Blue Mountain. Indusmin is now the only producer of nepheline syenite in North America: most of the production is exported to the United States.

Feldspar was not produced commercially in Canada in 1985. A potential producer is Bearcat Explorations Ltd. of Calgary. The company reported it was in the process of developing a pegmatite in southeastern British Columbia for the production of several industrial mineral commodities. The pegmatite is composed of approximately 65 per cent feldspar, 20-30 per cent quartz, 5-8 per cent muscovite and 1 per cent accessory minerals. The unit outcrops for about 4 km in length and 1.5 km in width.

The company's objective is to produce a feldspathic product suitable for the glass, fiberglass and ceramic industries. Mica could be used by the drywall cement, paint and drilling mud industry, and quartz could be used for glassmaking. Bench flotation tests are being conducted by B.C. Research in Vancouver and preliminary chemical analyses were reported to be very encouraging. Market studies have been conducted and a feasibility study is proposed for open-pit mining. To date, drilling has indicated sufficient reserves for 10 years production with extensive probable reserves.

CONSUMPTION

The glass and glass fibre industries account for some 60 per cent of nepheline syenite consumption in Canada while insulation and ceramic products account for about 17 per cent each.

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Consumption of nepheline syenite in Canada by glass producers continued to be negatively influenced by the use of plastics and aluminum, by increased recycling of glass waste, and by the development of thinner glass containers. Although growth in filler and extender pigment applications is expected to continue strong, tonnages will remain small for many years.

The major consumers of nepheline syenite in Canada are: Domglas Inc., Consumers Glass Company Limited, Fiberglas Canada Inc., American Standard Inc., and Crane Canada Inc.

TRADE

Canada has a large trade surplus in nepheline syenite and feldspar with the United States. While exports of nepheline syenite to the United States averaged 320 000-350 000 tpy in recent years, imports of feldspar from the United States averaged only about 3 000 tpy and are declining. Nearly all feldspar imported into Canada comes from North Carolina where both Indusmin and IMC have mining operations.

Market areas of North America's producers of feldspar, nepheline syenite and aplite

Market area	Material
Central and eastern Canada and north central United States	nepheline syenite
Northeast United States	feldspar
East central United States	aplite
Southeast and south central United States	feldspar
Southwest United States	feldspathic sand

PRICES

The value of production per t of nepheline syenite increased by 12 per cent in 1985 over 1984 and the value of exports per t to the United States increased by 9.5 per cent in 1985 (based on 9 month figures).

Listed prices for nepheline syenite in 1984 ranged from a low of $22 per t for sand, to a high of $93 per t for filler and extender grade. Listed prices for nepheline syenite products have remained the same since 1982.

USES

Nepheline syenite is preferred to feldspar as a source of alumina and alkalis for glass manufacture. Its use results in more rapid melting of the batch at lower temperatures than with feldspar thus reducing fuel consumption, lengthening the life of furnace refractories, and improving the yield and quality of glass. Other industrial uses for nepheline syenite include ceramic glazes, enamels, fiberglass and fillers 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. It is used in glassmaking as a source of alumina and alkalis, in 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. Potash feldspar is an essential ingredient in the manufacture of high voltage porcelain insulators. Dental spar, which is used in the manufacture of artificial teeth, is a pure white potash feldspar, free of iron and mica.

OUTLOOK

Only a modest increase in sales of nepheline syenite can be expected in 1986.

In the medium-term, if the U.S. economy does not improve, more rationalization in the industry can be expected.

In the longer-term, glass container producers will continue to compete with plastics and aluminum producers. Fiberglass is bulky and consequently expensive to transport and may over the years loose markets to more compact material. The use of nepheline syenite in ceramics and as a filler is expected to grow substantially, but consumption tonnages will remain small for several years.

There are opportunities for new feldspar or nepheline syenite development in western Canada as nearly all the production currently is concentrated in eastern Canada and eastern United States.

PRICES OF FELDSPAR AND NEPHELINE SYENITE IN U.S. CURRENCY

	1983	1984	1985
		($/tonne)	
FELDSPAR			
Ceramic grade, bulk			
FOB Spruce Pine, NC, 170-250 mesh	45.46	48.50	48.50
FOB Monticello, Ga, 200 mesh, high potash	76.31	81.00	81.00
FOB Middleton, Con, -200 mesh	55.65	58.68	58.68
Glass grade, bulk			
FOB Spruce Pine, NC, 97.8% + 200 mesh	30.30	32.34	32.34
FOB Middleton, Con, 96% + 200 mesh	41.05	42.98	42.98
FOB Monticello, Ga, 200 mesh, high potash	56.20	59.50	59.50
NEPHELINE SYENITE			
Canadian, CL-car lots TL-truck lots			
Glass gr., 30 mesh, bulk CL/TL, low iron	28.65-31.40	28.65-31.40	28.65-31.40
Glass gr., 30 mesh, bulk CL/TL, high iron	22.04-25.62	22.04-25.62	22.04-25.62
Ceramic gr., 200 mesh, bagged 10-ton lots	60.60-62.81	60.60-62.81	60.60-62.81
Filler/extender grade	73.83-93.67	73.83-93.67	73.83-93.67

Source: Industrial Minerals, December 1983, 1984, 1985.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
29600-1	Feldspar, crude	free	free	free	free
29625-1	Feldspar, ground but not further manufactured	free	6.0	30	free
29640-1	Ground feldspar for use in Canadian manufactures	free	free	30	free
	Nepheline syenite	free	free	free	free

MFN Reductions under GATT (effective January 1 of year given)		1985	1986	1987
			(%)	
29625-1		6.0	5.8	5.5
UNITED STATES (MFN)				
522.31	Crude feldspar	free		
522.41	Feldspar, crushed, ground or pulverized	3.0	2.9	2.8
522.33	Crude nepheline syenite	free		
522.43	Nepheline syenite, crushed, ground or pulverized	free		

Sources: The Customs Tariff, 1985 Revenue Canada, Customs and Excise; Tariff Schedules of the United States, Annotated 1985, USITC Publication 1610. U.S. Federal Register Vol. 44, No. 241.

TABLE 1. CANADA, NEPHELINE SYENITE PRODUCTION, EXPORTS AND CONSUMPTION, 1982-85

	1982		1983		1984		1985p	
	(tonnes)	($)	(tonnes)	($)	(tonnes)	($)	(tonnes)	($)
Production (shipments)	550 480	17,323,776	523 249	18,130,692	520 640	17,866,091	487 996	18,903,461
							(Jan.-Sept.)	
Exports								
United States	373 932	13,557,000	345 245	13,469,000	334 354	13,689	235 456	10,557
Netherlands	24 490	1,014,000	20 995	1,019,000	21 830	960	8 645	378
Italy	6 834	495,000	8 614	658,000	10 482	823	5 859	449
United Kingdom	4 751	256,000	8 926	472,000	5 425	322	560	71
Australia	1 537	121,000	8 943	294,000	9 933	358	873	66
Spain	269	18,000	1 927	105,000	896	63	1 818	72
Other countries	2 975	304,000	3 649	293,000	4 149	414	3 099	387
Total	414 788	15,765,000	398 299	16,310,000	387 069	16,629	256 310	11,980
Consumption[1]								
Glass and glass fibre	57 368r	..	54 127	..	55 218	..	..	..
Insulation	12 146r	..	16 471	..	15 895	..	..	..
Ceramic products	10 465	..	16 571	..	12 916	..	..	..
Paints	3 669	..	5 922	..	5 819	..	..	..
Others[2]	1 725	..	1 543	..	1 766	..	..	..
Total	85 373r	..	94 634	..	91 614	..	..	..

Sources: Statistics Canada; Energy, Mines and Resources, Canada.
[1] Available data, as reported by consumers. [2] Includes frits and enamel, foundry, plastics, rubber products, electrical apparatus and other minor uses.
p Preliminary; .. Not available; r Revised.

TABLE 2. CANADA, NEPHELINE SYENITE PRODUCTION AND EXPORTS, 1970, 1975 AND 1979-84

	Production[1]	Exports
	(tonnes)	
1970	454 110	351 940
1975	468 427	356 629
1979	605 699	471 056
1980	600 000	448 468
1981	588 000	476 281
1982	550 480	414 788
1983	523 249	398 299
1984	520 640	387 069

Sources: Energy, Mines and Resources, Canada; Statistics Canada.
[1] Producers' shipments.

TABLE 3. CANADA, FELDSPAR CONSUMPTION, 1981-84

	1981	1982	1983	1984
	(tonnes)			
Consumption				
Whiteware	4 410	2 655	2 065	1 924
Other products[1]	196	135	148	182
Total	4 606	2 790	2 213	2 106

[1] Includes porcelain enamel, artificial abrasives and other minor uses.

TABLE 4. CANADA, CONSUMPTION AND VALUE OF IMPORTS OF CRUDE OR GROUND FELDSPAR, 1975 AND 1979-84

	Imports	Consumption
	($)	(tonnes)
1975	..	5 630
1979	501,000	4 588
1980	385,000	4 051
1981	642,000	4 606
1982	251,000	2 790
1983	309,000	2 213
1984	..	2 106

Sources: Statistics Canada; Energy, Mines and Resources Canada.
.. Not available.

TABLE 5. WORLD MINE PRODUCTION OF FELDSPAR, 1983 AND 1984

	1983[e]	1984[e]
	(tonnes)	
United States	710	710
Brazil	110	110
France	190	200
Germany, Federal Republic of	370	370
Italy	880	880
Mexico	120	120
Spain	135	140
Other Market Economy Countries	454	460
U.S.S.R.	360	360
Other Centrally Planned Economies	153	150
Total	3 482	3 500

Source: United States Bureau of Mines Mineral Commodity Summaries, 1985.
[e] Estimated.

Nickel

R.G. TELEWIAK

Increased use of stainless scrap, reduced economic growth in some major markets and a slight decrease in stainless steel production, all contributed to western world nickel consumption declining by an estimated 4 per cent in 1985, compared with 1984. Preliminary data indicate consumption was 550 000 t, versus 575 000 t the previous year.

In the first half of the year there was a reduction in inventories and prices were generally relatively strong. Several producers, reacting to the higher prices and expectations of a stronger market than actually materialized, increased production. As a result, inventories increased during the second half and prices fell. On the London Metal Exchange (LME), prices declined from an average of $US 2.29 in the first quarter to $1.87 in the fourth.

Overcapacity is expected to continue to dominate the industry for the next few years and this will limit any major price increases. In 1986 we believe that prices will recover from fourth quarter 1985 levels but due to continuing relatively high production, particularly in the first half of the year, price increases will be modest.

CANADIAN DEVELOPMENTS

Cost-reduction programs continued to be a major priority of producers. Costs of production have decreased substantially in the past three years and this has resulted in an improvement in the financial performance of Inco Limited and Falconbridge Limited, despite nickel prices which are well below historical levels. Inco reported nine-month 1985 earnings of $US 44.6 million compared with a loss of $81.8 million for the same period in 1984. Falconbridge reported nine-month earnings of $C 30.9 million, compared with $19.7 a year earlier.

Cost cutting measures continued in all segments of the operations but were again particularly strong in mining. Greater use of bulk mining methods was the main reason. About 75 per cent of Inco's mining was accounted for by bulk mining in 1985, compared with a little over 30 per cent in 1981.

At Sudbury, Inco continued to make productivity gains in the smelter and other parts of the complex. Development proceeded on the high grade deep zone of the Creighton mine, which is expected to provide some of Inco's lowest cost ore.

Falconbridge, at Sudbury, commenced a three-year, $216 million program of preproduction, development and capital expenditures. A major part of the program is to deepen the Strathcona No. 1 shaft, and to develop the Craig and Onaping deposits. Falconbridge had fallen behind in mine development a few years ago, due to other priorities. While still a relatively small percentage of smelter production, an increased amount of scrap was processed in 1985.

The Ontario government, late in the year, announced new sulphur dioxide emission controls for Inco and Falconbridge at Sudbury. The limit for Inco was set at 265 000 tpy of sulphur dioxide in 1994, compared with 728 000 tpy in 1985. For Falconbridge, the limit in 1994 will be 100 000 tpy compared with 154 000 tpy in 1985. Both companies are expected to conduct further research and development before deciding which options will be technically viable and most cost-effective. The companies must report by December 1988 on how they will meet the new regulations.

At Thompson, Manitoba, Inco commenced preliminary production at its Thompson open pit. The mine is high grade, averaging 2.7 per cent nickel, and it is expected that this mine will be one of the lowest, if not the lowest, cost nickel mine in the world. The open pit will replace the Pipe open pit which was mined out in 1984 but from which stockpiled ore was taken in 1985. As a result of less complex metallurgy, the metal recoveries are expected to be higher than at

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Pipe. The ore grade is also three times higher than at Pipe.

Hudson Bay Mining and Smelting Co., Limited announced a major new mineral discovery, Namew Lake, 60 km south of Flin Flon, Manitoba. Drilling has outlined a deposit of 2.6 MT to the 365 m level grading 2.4 per cent nickel, 0.9 per cent copper,0.022 t platinum and the same for palladium. The deposit is open at depth but the grade of mineralization appears to decrease at depth. An exploration shaft was collared and more detailed exploration of the deposit is planned for 1986.

Sherritt Gordon Mines Limited operated the Fort Saskatchewan, Alberta refinery near its annual capacity of 21 000 t of nickel in briquettes and powder. The major source of feed continued to be Inco, with concentrates obtained from Thompson and Sudbury. In early 1986, Sherritt Gordon is also expected to start treating some nickel matte produced by Agnew Mining Co. Pty. Ltd. in Australia.

In response to the growing oversupply, Inco announced late in the year that it would lower its planned 1986 production. Inco will close its operations in Ontario from June 2 to August 10 and in Manitoba from July 7 to September 7. The Shebandowan mine in northwestern Ontario will be put on standby as will the Clarabelle open pit and No. 3 zone at the Creighton mine in Sudbury.

Canadian nickel consumption is expected to have increased slightly in 1985, primarily as a result of higher operating rates by the stainless producer, Atlas Steels division of Rio Algom Limited. Consumption at Canada's other major consumer, the Royal Canadian Mint, was similar to the 1985 level.

WORLD DEVELOPMENTS

Several producers increased their operating rates during the first half of the year but with nickel consumption declining in the second half, some producers by year-end had announced reductions in planned 1986 production levels. Technical difficulties and labour-management disputes resulted in production for some producers being lower than planned levels.

Société Métallurgique Le Nickel (SLN) in New Caledonia increased its production to 45 000 t of nickel in ferronickel and matte, compared to 34 800 t in 1984. This increase was despite a reduction in mine output, resulting from action caused by political unrest. This action, including destruction of equipment at both the Thio and Kaouaoua mines, resulted in SLN acquiring additional ore from small independent mines. Exports of ore to Japan were reduced from earlier planned levels. SLN announced that 1986 production would be 44 000 t compared with a previously planned level of 47 000 t, and could be lowered further depending upon market conditions.

In Australia, Queensland Nickel Pty Ltd. increased production in the second quarter, close to its 21 800 tpy capacity of nickel contained in ferronickel. The plant had been operating at 70 per cent of capacity. Production of Agnew Mining was lowered due to a major underground rockfall, and output of Western Mining Corporation Limited was affected by a labour-management dispute.

In Indonesia, P.T. International Nickel Indonesia increased its production from 50 million pounds per year to a targetted 65 million pounds. Difficulties with three converters and a spill of molten material from the No. 1 electric furnace, had affected 1984 production. Late in the year, the company announced that it will close one of its three furnaces in 1986, for at least six months.

Falconbridge Dominicana, C por A operated its ferronickel plant in the Dominican Republic at an annual rate of 27 000 t of nickel in ferronickel, using one of its two large furnaces. On December 20, the company stopped production for five weeks. Plant maintenance will occur during the shutdown and Falconbridge is expected to resume production from the other furnace, which has recently been further modified.

Production by Cerro Matoso S.A. in Colombia was lower than planned due to continuing difficulties with the furnace linings. The ore is acidic and this has caused problems with the furnace lining at the matte-slag interface. Production in 1985 is estimated at 11 400 t, compared with a capacity of 22 700 tpy. Cerro Matoso is planning to produce 20 000 t in 1986.

In Brazil, Cia Niquel Tocantins is proceeding with expansion of its Sao Miguel Paulista refinery to 10 000 tpy of electrolytic nickel by 1988. Production is expected to be about 5 000 t in 1986 compared to a scheduled 4 200 t in 1985.

Falconbridge started an expansion of its refinery at Kristiansand, Norway to 54 400 t of nickel annually from 38 600 t, with adjustments for the refining of copper, cobalt and precious metals. A long-term agreement was signed with BCL Ltd., which operates mines and a smelter at Selebi Pikwe, Botswana. BCL agreed to deliver 6 500 t of matte to the refinery in 1985, 21 000 t in 1986 and 41 000 tpy from 1987 to 1999.

Some BCL matte is also being sent for treatment to Rio Tinto Mining (Zimbabwe) Ltd., under a long-term agreement. The 5 000 tpy refinery in Zimbabwe was closed in 1983 due to exhaustion of the Empress mine and cessation of a temporary contract to refine some BCL matte. Under a shorter term agreement Bindura Nickel Corp. Ltd. in Zimbabwe will also process some of the matte.

AMAX Inc. in the United States, which had been treating the BCL matte, closed its Port Nickel, Louisiana refinery on November 30. The Botswana matte had been the major source of matte with the remainder coming from Agnew Mining in Australia. AMAX has a contract until 1989 with Agnew Mining for the matte and AMAX agreed to terms with Sherritt Gordon and Outokumpu Oy for sale of most of it.

Also in the United States, the M.A. Hanna Company closed its nickel mine and ferronickel smelter at Riddle, Oregon for four months starting mid-June, in order to install a wet screening process and a crushing plant. Operating costs are expected to be about 20 per cent lower due to the modifications. Hanna will still be operating the smelter on weekends and in the evenings to take advantage of off-peak electricity rates but the modifications will permit an increase in production to 10 700 tpy from 8 200 tpy.

The Japanese government approved a plan to offer financial assistance to domestic ferronickel, ferrochrome and ferrosilicon producers which agree to reduce plant capacity before March 31, 1987. The ferronickel producers reported to be interested in the plan are Sumitomo Metal Mining Co. Ltd., Hyuga Smelting Co., Ltd., Pacific Metals Co., Ltd. and Nippon Mining Co. Ltd. This MITI program continues efforts to reduce energy-intensive metal processing in Japan.

Cuba brought the first of its three line Punta Gorda complex into production on November 7. The plant will have a capacity of 30 000 tpy of contained nickel, when in full operation. Production had also been scheduled for the late 1980s, from Las Camariocas, a twin plant 20 km away, but this project has been delayed.

China continued with modernization and expansion of its nickel plant at Jinchuan in Gansa province. The plant has a capacity of 19 000 t of refined nickel. Plans are to double this capacity by 1990. China is expected to be a modest exporter in 1986, perhaps of about 2 000 t.

Net Comecon exports to the west were estimated to be about 25 000 t, the same as in 1984. Under an agreement signed with several Japanese trading companies, Raznoimport, the Soviet metal trading company, sold an estimated 4 000 t to 5 000 t of nickel. In 1984, these firms had obtained about one-half of this amount. The pricing arrangement was based upon the monthly average LME price.

INTERNATIONAL NICKEL STUDY GROUP (INSG)

An intergovernmental preparatory meeting on nickel was held in April involving 39 producing and consuming countries plus representatives from The General Agreement on Tariffs and Trade, International Monetary Fund, European Economic Community and the International Lead and Zinc Study Group. There was consensus that substantial scope exists for improving intergovernmental cooperation on issues concerning nickel, in particular by improving the information available on the international nickel economy and by providing a forum for international discussions on nickel.

As a result of this meeting, a United Nations Conference on Nickel was convened from October 28 to November 7, which involved similar participation. Terms of reference for an INSG were negotiated and adopted, with the exception of a paragraph on how the group would come into effect. As well, rules of procedure for the group were agreed to except for the form of the secretariat and the formula for calculating individual country contributions.

The United Nations was asked to reconvene the Conference, preferably from

April 28 to May 2, 1986, to resolve the remaining issues, to consider with industry advisors a statistical program and to prepare for an inaugural meeting which could be held in October 1986.

The elements of the terms of reference and rules of procedure adopted in November will not be reopened. It can therefore be concluded that the INSG will be modelled closely on the autonomous International Lead and Zinc Study Group (ILZSG) which is considered to have operated successfully since its formation in 1959.

PRICES

Nickel prices were stronger in the first half of the year than the second. A better balance of supply and demand existed in the first half and inventories rose in the second half, particularly the last quarter. For the year, nickel averaged $US 2.22 on the LME compared with $2.16 in 1984.

Stainless steel scrap was readily available due to record stainless steel production in 1984 and, with nickel prices being relatively high in the first part of the year, consumption of scrap increased and also consumers acquired more inventories of scrap. The increased use of scrap was a factor in declining prices of primary nickel in the second half. Markets for ferronickel, which are especially susceptible to substitution by scrap, were particularly hard hit.

The suspension of LME trading of tin, commencing on October 23, caused a temporary weakening in the price of nickel on the LME. However, before year-end nickel prices had rebounded to their pre-suspension levels.

A more important factor in some of the price volatility of nickel on the LME in 1985 was the relatively low level of LME stocks, which resulted in some short-term shortages. Stocks were about 5 000-6 000 t for most of the year, compared to an average 12 000 t in 1984. In the April-May period the unusual situation developed, whereby the realized producer price was actually several cents per pound below the LME price. Normally producer realized prices for Class I nickel are about 10-20 cents higher than the LME.

USES

Resistance to corrosion, high strength over a wide temperature range, pleasing appearance and suitability as an alloying agent are characteristics of nickel which make it useful in a wide range of applications. The major use is in stainless steels, which account for close to 50 per cent of consumption, followed by nickel-base alloys, electroplating, alloy steels, foundry products and copper-based alloys. Nickel is extensively used as an alloying agent and is a component in some 3,000 different alloys.

Close to two-thirds of nickel consumption is in capital goods with the remainder used in consumer products. Nickel is used in chemical and food processing, nuclear power plants, aerospace equipment, motor vehicles, oil and gas pipelines, electrical equipment, machinery, batteries, catalysts, and in many other applications.

Relatively new end-use markets that will contribute to nickel's consumption growth in the future are pollution abatement equipment, cryogenic containers, barnacle-resisting copper-nickel alloy plating for boat hulls, and nickel-cadmium batteries for standby power applications.

Some new alloys have been recently developed which could have an attractive future. One of these, a zinc-nickel alloy is reportedly being examined by Nissan in Japan for use in a galvanizing process for automobile applications. Tests have indicated that the product is five to seven times as corrosive resistant as regular galvanized steel. The enhanced appearance and low weight make this type of product potentially attractive for certain other uses, such as galvanized steel lamp posts.

Another nickel-based alloy, altraloy, has been developed which may displace gold in some electronic applications. Nickel is combined with iridium to make a low-cost connector or surface contact material.

OUTLOOK

Overcapacity has been an important influence on the market for several years and it is expected that this will continue to be the situation through the remainder of the 1980s. Some new capacity is being developed, including expansions in Cuba and China, and this in combination with expected slow growth in consumption, will result in continued overcapacity.

However, there are some encouraging developments which should affect the market over the medium-to-longer-term. Nickel producers have lowered their costs of production in recent years, primarily due to introduction of improved techniques and equipment, and it is expected that many of these cost-cutting measures will be permanent. As a result, nickel prices will not need to be as high as previously thought for producers to be profitable. Prices are likely to be considerably lower than many analysts were forecasting a few years ago and this will encourage increased consumption and reduce the threat of substitution by other metals, ceramics, plastics and other materials.

The recently established Nickel Development Institute is also likely to have an important impact on demand. The Institute, headquartered in Toronto and supported by most major western world producers, is encouraging the use of nickel through market promotion programs and research into new uses for nickel. At the end of 1985, the Institute was involved in over 40 projects - many cost-shared with other groups such as stainless steel associations - and it is estimated that conclusion of these projects could result in an annual increase in nickel consumption of about 20 000 t.

Given the expected relatively modest nickel prices and the high costs of establishing new capacity, return on investment is not likely to be sufficient to encourage installation of much new capacity. This should bring capacity and supply into better balance in the 1990s.

Consumption over the next decade is expected to grow at a higher rate than over the previous decade, which has been marked by very slow growth, but will still be far less than the 6 per cent which prevailed in the 1950s and 1960s. It is expected that nickel consumption will grow at an annual rate of about 1.7 per cent. While some more mature markets, like the United States and Japan, are expected to experience somewhat lower growth rates, this will be offset by higher rates in some relatively small but emerging markets such as China, Brazil and South Korea.

With the closer balance between capacity and demand in the 1990s, some real increase in prices can be expected. Prices in constant 1985 $US are likely to increase to about $2.75 per pound in the 1990s.

Nickel production in Canada is expected to increase slowly to the year 2000 (Table 6) but will unlikely reach the 1970 peak production of 277 000 t. Canada is expected to remain a highly cost-competitive producer, particularly given the cost reduction programs which are under way. An increasing amount of ore will be mined by low-cost bulk mining methods and this will be a significant factor in lowering costs, especially given that mining accounts for about 50 per cent of current operating costs. The Thompson open pit will also supply low cost ore. A constraint on production, particularly at Inco Sudbury, will be the limit on permissible sulphur dioxide emissions, from the smelter.

In the short term, we believe that consumption of primary nickel will be about 2-4 per cent higher in 1986, than in 1985. While overall nickel consumption is expected to be flat, less stainless scrap will be available and this will impact positively upon consumption of primary nickel. Nickel prices on the LME are expected to average about US$ 2.00 - 2.10.

TARIFFS

Item No.		General Preferential	British Preferential	Most Favoured Nation	General
			(%)		
CANADA					
32900-1	Nickel ores	free	free	free	free
33506-1	Nickelous oxide	10	8.5	13.1	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	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	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	free	20
35515-1	Nickel and alloys containing 60% by weight or more of nickel, in powder form	free	free	free	free
35520-1	Nickel or nickel alloys, namely: matte, sludges, spent catalysts and scrap and concentrates other than ores	free	free	free	free
35800-1	Anodes of nickel	free	free	free	10
37506-1	Ferronickel	free	free	4.3	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.	5	7.6	7.6	20

MFN Reductions under GATT (effective January 1 of year given)	1985	1986	1987
		(%)	
33506-1	13.1	12.8	12.5
37506-1	4.3	4.2	4.0
44643-1	7.6	7.2	6.8

TARIFFS (cont'd)

Item No.		General Preferential	British Preferential	Most Favoured Nation	General
			(%)		
UNITED STATES					
419.72	Nickel oxide		free		
423.90	Mixtures of two or more inorganic compounds in chief value of nickel oxide		free		
601.36	Nickel ore		free		
603.60	Nickel matte		free		
606.20	Ferronickel		free		
620.03	Unwrought nickel		free		
620.04	Nickel waste and scrap		free		
620.32	Nickel powders		free		
620.47	Pipe and tube fittings if Canadian article and original motor vehicle equipment		free		

Item No.		1985	1986	1987
			(%)	
419.70	Nickel chloride	4.0	3.9	3.7
419.74	Nickel sulfate	3.7	3.4	3.2
419.76	Other nickel compounds	4.0	3.9	3.7
426.58	Nickel salts: acetate	4.0	3.9	3.7
426.62	Nickel salts: formate	4.0	3.9	3.7
426.64	Nickel salts: other	4.0	3.9	3.7
620.08	Nickel plates and sheets, clad	7.5	6.8	6.0
620.10	Other wrought nickel, not cold worked	3.9	3.7	3.5
620.12	Other wrought nickel, cold worked	5.3	5.0	4.7
620.16	Nickel, cut, pressed or stamped to nonrectangular shapes	6.4	5.9	5.5
620.20	Nickel rods and wire, not cold worked	4.0	3.9	3.7
620.22	Nickel rods and wire, cold worked	5.3	5.0	4.7
620.26	Nickel angles, shapes and sections	6.4	5.9	5.5
620.30	Nickel flakes, per pound	1.2¢	0.6¢	free
620.40	Pipes, tubes and blanks, not cold worked	2.6	2.6	2.5
620.42	Pipes, tubes and blanks, cold worked	3.3	3.1	3.0
620.46	Pipe and tube fittings	5.0	4.3	3.6
620.50	Electroplating anodes, wrought or cast, of nickel	4.0	3.9	3.7
642.06	Nickel wire strand	5.3	5.0	4.7
657.50	Articles of nickel, not coated or plated with precious metal	6.4	5.9	5.5

Sources: The Customs Tariff, January 1985, Revenue Canada Customs and Excise; Tariff Schedules of the United States Annotated 1985, USITC Publication 1610; U.S. Federal Register, Vol. 44, No. 241.

TABLE 1. CANADA, NICKEL PRODUCTION, TRADE AND CONSUMPTION, 1983-85

	1983r		1984		1985p	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production[1]						
All forms						
Ontario	88 451	550,263	133 048	890,975	137 668	968,358
Manitoba	36 571	231,195	40 677	275,165	37 902	266,603
Total	125 022	781,458	173 725	1,166,140	175 570	1,234,961
Exports					(Jan. - Sept.)	
Nickel in ores, concentrates and matte[2]						
Norway	22 812	116,908	31 049	193,329	26 791	175,694
United Kingdom	17 271	116,654	27 421	191,049	19 280	136,768
Japan	.	-	821	3,981	-	-
United States	4	33	119	341	60	422
Other	-	-	-	-	12	96
Total	40 087	233,595	59 410	388,700	46 143	312,980
Nickel in oxides						
United States	5 501	44,631	8 874	..	6 344	..
EEC	2 237	18,149	2 455		1 390	..
Other countries	3 429	27,821	8 751	..	5 628	..
Total	11 167	90,601	20 080	144,020	13 362	95,487
Nickel and nickel alloy scrap						
United States	2 524	10,176	3 898	17,779	1 511	7,523
Netherlands	329	1,526	3 435	18,235	1 213	7,576
Austria	61	410	..	-	13	2
South Korea	19	79	222	1,360	229	1,593
Other countries	54	145	1 950	10,187	514	2,992
Total	2 987	12,336	9 505	47,561	3 480	19,688
Nickel anodes, cathodes, ingots, rods						
United States	37 370	232,424	45 729	..	33 852	..
EEC	17 364	107,996	14 133	..	15 258	..
Other countries	12 215	75,971	20 553	..	10 431	..
Total	66 949	416,391	80 415	479,995	59 541	367,038
Nickel and nickel alloy fabricated material, nes						
United States	7 745	62,465	8 888	69,870	7 147	56,786
South Africa	676	5,332	116	956	798	6 949
Belgium-Luxembourg	603	3,367	509	3,658	373	2,079
Hong Kong	540	3,015	34	266	58	372
United Kingdom	221	1,862	335	2,367	356	2,065
Japan	134	1,028	313	2,117	872	7,786
Other countries	447	3,165	614	4,544	415	3,245
Total	10 366	80,234	10 809	83,778	10 019	79,510
Imports						
Nickel in ores, concentrates and scrap						
Australia	6 721	23,375	4 019	17,421	4 102	21,167
United States	12 316	15,011	9 977	14,989	11 292	17,433
United Kingdom	2 106	3,676	6 303	11,014	4 621	5,445
Belgium-Luxembourg	3 650	3,173	2 486	2,365	1 858	1,496
Norway	2 731	2,245	1 488	1,112	46	337
Other countries	1 877	1,672	463	733	544	1,188
Total	29 401	49,451	24 736	47,634	22 463	47,066
Nickel anodes, cathodes, ingots, rods						
Norway	1 045	5,808	2 422	18,583	1 374	10,027
United States	654	4,185	972	6,494	666	5,239
United Kingdom	444	3,850	39	266	17	173
Netherlands	122	815	-	-	-	
Other countries	92	472	46	317	42	313
Total	2 357	15,130	3 479	25,661	2 099	15,752
Nickel alloy ingots, blocks, rods and wire bars						
United States	607	6,487	589	6,848	300	3,622
Dominican Republic	347	692	.	-	-	-
West Germany	42	269	34	239	142	968
Belgium-Luxembourg	2	13	-	-	-	-
Other	-	-	-	-	1	11
Total	998	7,461	623	7,087	443	4,601

TABLE 1. (cont'd.)

	1983r		1984		Jan.-Sept. 1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Nickel and alloy plates, sheet, strip						
United States	424	5,626	529	7,181	466	7,657
West Germany	508	3,078	470	3,171	467	2,908
Sweden	26	161	5	30	17	93
Other countries	1	10	8	57	25	167
Total	959	8,875	1 012	10,439	975	10,825
Nickel and nickel alloy pipe and tubing						
Sweden	325	4,518	365	3,453	172	1,437
United States	106	2,041	128	2,172	85	1,481
West Germany	70	958	62	953	27	251
Other countries	24	389	72	1,138	67	929
Total	525	7,906	627	7,715	351	4,098
Nickel and alloy fabricated material, nes						
United States	519	11,254	460	11,749	414	12,274
United Kingdom	125	1,050	37	580	15	176
West Germany	40	376	54	517	125	1,669
Japan	4	16	2	8	4	15
Other countries	1	26	10	102	21	282
Total	689	12,722	563	12,957	579	14,417
Consumption3	..	..	..	..	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
1 Refined nickel and nickel in oxides 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 oxides and salts) as reported by consumers.
P Preliminary; - Nil; .. Not available; nes Not elsewhere specified.

TABLE 2. CANADA, NICKEL PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975 AND 1980-84

		Exports					
	Production1	In Matte etc.	In Oxide Sinter	Refined Metal	Total	Imports2	Consumption3
				(tonnes)			
1970	277 490	88 805	39 821	138 983	267 609	10 728	10 699
1975	242 180	84 391	38 527	91 164	214 082	12 847	11 308
1980	184 802	42 647	16 989	88 125	147 761	4 344	9 676
1981	160 247	53 841	14 390	79 935	148 166	2 335	8 603r
1982	88 581	27 037	13 127	62 314	102 478	2 588	6 723r
1983r	125 022	40 087	11 167	66 949	118 203	2 357	5 010
1984P	173 725	59 410	20 080	80 415	159 905	3 479	9 100

Sources: Energy, Mines and Resources Canada; 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).
P Preliminary; r Revised.

TABLE 3. CANADIAN PROCESSING CAPACITY, 1985

	Inco			Falconbridge	Sherritt Gordon
	Port Colborne	Sudbury	Thompson	Sudbury	Fort Saskatchewan
	(tpy of contained nickel)				
Smelter	n.a.	127 000[1]	81 600	45 000	n.a.
Refinery	65 000[2]	56 700	55 000	n.a.	21 000

1 Reduced from 154 200 t due to a government regulation on SO_2 emissions imposed in 1980.
2 Electrolytic nickel portion of refinery closed in 1984, only utility nickel currently being produced.
n.a. Not applicable.

TABLE 4. WORLD MINE PRODUCTION OF NICKEL, 1983 AND 1984

	1983	1984
	(tonnes)	
U.S.S.R.	175 000	175 000
Canada[1]	125 000	173 700
Australia	78 700	76 900
New Caledonia	45 000	58 300
Cuba	39 200	38 000
Indonesia	41 200	47 800
South Africa	20 500	22 500
Dominican Republic	20 200	24 300
Botswana	18 200	18 600
People's Republic of China	15 000	17 500
Other	78 100	99 200
Total	649 900	751 800

Sources: Energy, Mines and Resources Canada; World Bureau of Metal Statistics.
[1] Refined nickel and nickel in oxide and salts produced, plus recoverable nickel in matte and concentrates produced.

TABLE 5. WORLD CONSUMPTION OF NICKEL, 1983 AND 1984

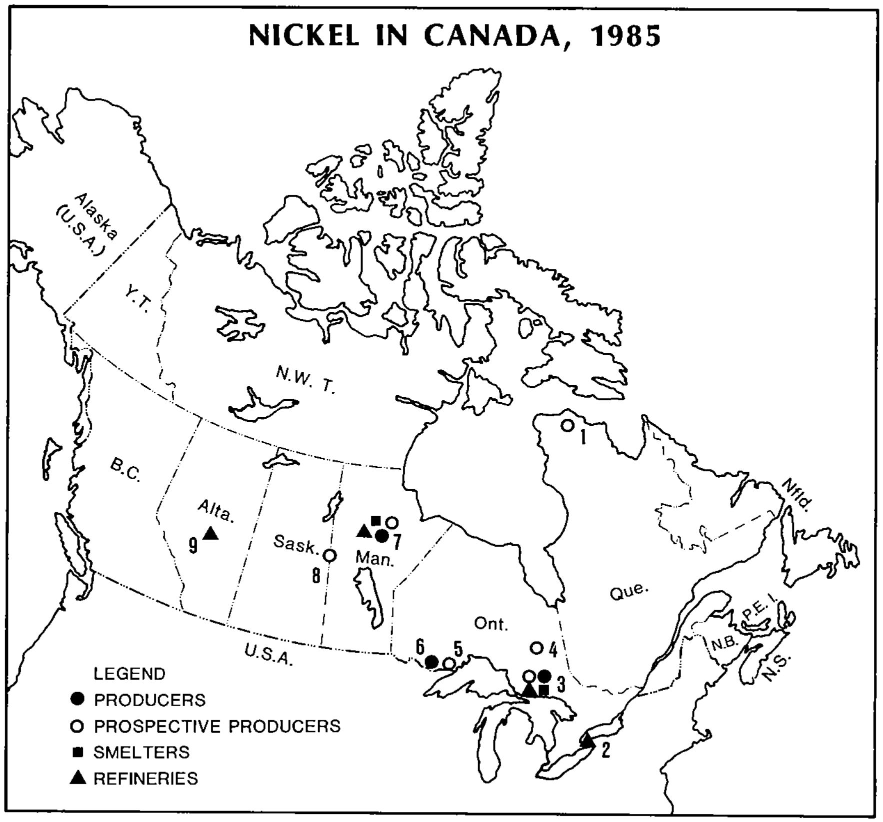
	1983	1984
	(tonnes)	
U.S.S.R.	140 000	140 000
United States	117 400	130 400
Japan	114 800	146 000
Germany, F.R.	63 000	78 000
France	32 500	38 900
Italy	22 500	28 000
United Kingdom	21 800	26 100
People's Republic of China	19 000	20 000
Sweden	16 400	20 400
India	13 000	15 200
Other	101 000	125 700
Total	671 300	768 700

Sources: World Bureau of Metal Statistics; Energy, Mines and Resources Canada; U.S. Department of the Interior.

TABLE 6. FORECAST OF CANADIAN MINE PRODUCTION[1]

	Inco		Falconbridge	
Year	Sudbury	Thompson	Sudbury	Total
		(tonnes)		
1986	90 000	35 000	33 500	158 500
1987	105 000	45 000	33 500	183 500
1988	108 000	49 000	34 000	191 000
1989	109 000	50 000	35 000	194 000
1990	110 000	50 000	35 500	195 500
2000	116 000	50 000	37 000	203 000

[1] From existing mining areas; does not include likely production from greenfield developments, such as Namew Lake.



Producers, prospective producers, smelters and refineries
(numbers refer to locations on map above)

Producers

3. Falconbridge Limited
   (East, Fraser, Lockerby, North, Strathcona
   Inco Limited
   Clarabelle, Copper Cliff North, Copper Cliff South, Creighton, Frood, Garson, Levack, Little Stobie, McCreedy West and Stobie)
6. Inco Limited (Shebandowan mine)
7. Inco Limited (Thompson and Thompson open pit)

Prospective Producers

1. New Quebec Raglan Mines Limited
3. Falconbridge Limited
   (Craig, Lindsley, Onaping, Onex, Thayer mines)
   Inco Limited (Coleman, Crean Hill, Murray, Totten)
4. Teck Corporation (Moncalm Township)
5. Great Lakes Nickel Limited (Pardee Township)
7. Inco Limited
   (Soab, North, Soab, South, Birchtree, Pipe No. 1)
8. Hudson Bay Mining and Smelting Co., Limited (Namew Lake)

Smelters

3. Falconbridge Limited (Falconbridge)
   Inco Limited (Sudbury)
7. Inco Limited (Thompson)

Refineries

2. Inco Limited (Port Colborne)
3. Inco Limited (Sudbury)
7. Inco Limited (Thompson)
9. Sherritt Gordon Mines Limited
   (Fort Saskatchewan)

Peat

M. PRUD'HOMME

Peat is an intermediary compound of the biochemical decomposition of plant matter. A raw material, it is ligneous, fibrous and elastic. It has a pH of 2.8 to 4.0 and an ash content of 0.5 to 2.5 per cent. Peat is found in peat-bogs, swamps and marshes. Its main properties are its high water-retaining capacity, low density, high resistance to decomposition, low heat conductivity and high porosity. It can hold up to twenty times its weight in liquids and gas. Peat is divided into two principal types according to its botanical composition and the degree of decomposition. Sphagnum peat is relatively undecomposed, with a von Post value of H1 to H5; it has a high fibre content, is light yellowish-brown in colour and contains few colloids. Fuel peat is highly decomposed, with a von Post value of H6 to H10; it is blackish in colour and contains colloid residues.

The total area of peatlands in Canada is estimated at 111 328 000 hectares, covering close to 12 per cent of the country's land surface. Approximately 60 per cent of all Canadian peatlands are perennially frozen. Indicated peat resources total approximately 3 004 996 million m^3, equivalent to 335 000 million t of dry peat. Measured resources are evaluated at 1 092 million t. In Canada, close to 280 000 hectares of peatland are currently used for agricultural purposes.

Peat production in Canada is limited to a short harvesting season - from June to September due to weather conditions, which hinder drainage and drying of the peat.

Canada produces mainly sphagnum peat, which is used in horticulture and agriculture. It is harvested primarily in eastern and southeastern Quebec, and in northeastern and eastern New Brunswick. A small amount of hypnum moss is also produced in Alberta and Ontario.

USES

Sphagnum peat is extracted from peatlands and dried. After the fibres are removed, it is pressed into bales. It is marketed in three forms. In its natural state, peat is sold in bulk form within a 100 km radius of the production centres. When packaged in bags or bales, peat is compressed using a ratio of 2:1. The most common bale sizes are 170 dm^3 (6 ft^3), 113 dm^3 (4 ft^3), and 56 dm^3 (2 ft^3). Peat is mixed with fertilizers and other products, such as vermiculite and perlite, to form a substrate, and with limestone, soil and fertilizers to form potting soil.

Because of the range of its physical and chemical properties, peat has many uses. It is used in its natural state in agriculture and horticulture to loosen up clay soils, to maintain moisture in sandy soils and to add organic matter and fertilizers to depleted soils. Peat is also used as a horse, cattle and poultry litter to absorb liquids and odours. Peat is used in the production of artificial mixtures such as potting soil, seed carriers, peat-perlite and peat-vermiculite mixes, fertilizers and composts.

Peat is used in the production of peat pots for sprouting plants. It also has industrial applications such as an oil absorbent, a binder in the production of iron pellets, a filtration agent and an insulating material as well as medical uses. It can be used in the production of paper towels, chemical products, metallurgical coke and activated carbon (charcoal).

Fuel peat is recognized as an alternate source of energy. This form of biomass is widely used as a fuel in several European countries, such as Ireland and Finland, and in the U.S.S.R. The calorific value of dry Canadian peat is approximately 4 700 to 5 100 kcal/kg, compared with oil at 9 900 to 10 000 kcal/kg and coal at 4 800 to 5 800 kcal/kg.

PRODUCTION AND TRADE IN CANADA

In 1985, there were 69 peat producers in Canada. Total production was 585 758 t, an increase of 8.3 per cent over 1984. Quebec

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is the largest producer, accounting for 37.5 per cent volume of Canadian shipments, followed by New Brunswick (34 per cent), Manitoba (14 per cent), Alberta (8.5 per cent) and the other provinces (6 per cent). In 1985, the unit price rose 4.3 per cent to $99.80 (current dollars) per t.

The use of peat on the domestic market is limited to horticulture, nurseries, landscaping, and potato and mushroom growing. Apparent Canadian consumption is approximately 15 per cent of the total volume of shipments, and the remaining production is exported.

In the first nine months of 1985, Canada exported approximately 358 818 t or $66.8 million worth of peat. In 1984, exports rose to 460 600 t, worth $82.2 million, a 16 per cent increase in value and volume over 1983.

The principal importers of Canadian peat are the United States (94.8 per cent) and Japan (4.8 per cent). In 1985, the unit price of exported peat was $186 a t, a 4 per cent increase over 1984.

WORLD PRODUCTION AND FOREIGN TRADE

In 1984, world peat production was estimated at 374 655 000 t, of which close to 304 930 000 t were used in agriculture. The U.S.S.R. is the largest producer of agricultural peat, accounting for 98.7 per cent of total world production. Canada ranks fourth, with a 0.18 per cent share.

In the United States, only 60 per cent of the peat demand is met by domestic production while the rest is imported. In 1984, the United States imported 439 960 t of peat, 99 per cent of which came from Canada. Quebec and New Brunswick exported approximately 7,676,710 bales, and Manitoba and Alberta exported 2,802,690 bales. The volume of Canadian exports increased 16 per cent over 1983. Since 1982, the increase in demand in the United States has been met predominantly by imports from Canada. The western and northeastern U.S. markets are dominated by Canadian producers, who offer a high quality product at competitive prices. Sphagnum peat is used in soil enrichment, mushroom growing, potting soil and by nurseries. Peat is sold to retailers in 2 ft^3 and 4 ft^3 bales, and to large volume users in 5 ft^3 and 6 ft^3 bales. In 1984, the consumer prices of imported sphagnum peat dropped 4 per cent from 1983, to $119.18 per t.

Japan is the second largest importer of Canadian peat. In 1984, shipments rose to 20 717 t, an increase of 19 per cent over 1983. Since 1981, exports of Canadian peat to Japan have grown at an average annual rate of 11.7 per cent. Canada is Japan's principal supplier of peat, accounting for 97 per cent of its total imports while the remainder comes from the Federal Republic of Germany and Finland. In Japan, peat is used in rice cultivation (30 per cent), horticulture (30 per cent) and landscaping (30 per cent). The price of Canadian peat to large volume users ranges from $27 to $30 for a 170 dm^3 bale.

OUTLOOK

Viewing the U.S. market as stable and relatively saturated, Canadian peat producers will focus their efforts on overseas markets and will maintain their market share in Japan. In the next few years, the reorganization of the Canadian peat industry will result in increased concentration of production centres. The major firms will increase their market share and increase their competitiveness on the domestic and international markets. Growth sectors for peat are added value goods, such as substrates and potting soils. In the long-term, the peat industry will benefit from technological developments that will increase the industrial applications of peat.

The U.S. Bureau of Mines has estimated that the American demand for peat could reach 1 270 000 t by 1990 and 1 814 000 t by the year 2000, an annual average increase of 3.4 per cent. In the year 2000, the world demand for peat, including fuel peat in the U.S.S.R., Finland and Ireland could attain 535 million t.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
54005-1	Grasses, seaweed, mosses and vegetable fibres other than cotton, not coloured, nor further manufactured than dried, cleaned, cut to size, ground and sifted	free	free	free	free
54010-1	Grasses, seaweed, mosses and vegetable fibres other than cotton, nop; whether or not dried, cleaned, cut to size, ground and sifted	free	free	17.5	free
71115-1	Pots or compressed pellets wholly or in chief part of peat, for use in growing plants	7.6	7.6	25	5
93100-1	Fertilizer, formulated; Goods for use as fertilizers	free	free	free	free

MFN Reductions under GATT (effective January 1 of year given)	1985	1986	1987
		(%)	
71115-1	7.6	7.2	6.8

UNITED STATES		Most Favoured Nation		Non-MFN
		1985	1987	1985
192.5000	Peat moss Poultry grade	free	free	50¢ per long ton
480.8060	Peat moss Fertilizer grade	free	free	free

Sources: The Customs Tariff 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241.
nop Not otherwise provided for.

TABLE 1. PEAT RESOURCES OF CANADA

	Peatland areas		Indicated volume of peat (oven dry)
	ha x 10^3	% of total Canadian Peatlands	tonnes x 10^6
Newfoundland - Labrador	6 429	6	24 945
Prince Edward Island	8	..	30
New Brunswick	120	..	466
Nova Scotia	158	..	613
Quebec	11 713	11	40 057
Ontario	22 555	20	77 138
Manitoba	20 664	19	58 893
Saskatchewan	9 309	8	26 532
Alberta	12 673	11	36 118
British Columbia	1 289	1	4 410
Northwest Territories	25 111	23	65 841
Yukon Territory	1 298	1	2 960
Total	111 328	100	335 339

Source: Peat Resources of Canada, C. Tarnocai, Agriculture Canada, NRCC 24140, 1984.
.. Amount too small to be expressed.

TABLE 2. CANADA, PEAT PRODUCTION BY PROVINCE, 1980-85

Province	1980		1981		1982		1983		1984		1985P	
	Quantity (000 t)	Value ($ 000)	Quantity (000 t)	Value ($ 000)	Quantity (000 t)	Value ($ 000)	Quantity (000 t)	Value ($ 000)	Quantity (000 t)	Value ($ 000)	Quantity (000 t)	Value ($ 000)
Newfoundland	0	0	0	0	0	0	3	20	1	44	1	49
Prince Edward Island	0	0	0	0	0	0	0	0	4	1,110	4	685
Nova Scotia	12	1,625	10	1,551	10	2,172	10	2,008	5	1,424	6	920
New Brunswick	124	9,707	94	9,985	155	11,425	151	9,792	151	10,974	201	13,154
Quebec	217	14,748	190	15,539	203	16,802	238	18,216	234	17,170	220	18,488
Ontario	8	815	9	954	4	806	4	546	5	733	6	612
Manitoba	42	5,050	78	11,356	44	7,840	54	7,266	71	9,837	84	12,494
Saskatchewan	10	780	5	723	4	609	8	1,053	10	1,335	11	1,750
Alberta	49	5,912	45	6,512	47	6,922	47	6,585	49	7,555	50	10,163
British Columbia	26	3,869	31	5,134	20	3,162	14	2,324	11	1,634	3	159
Total	488	42,506	462	51,574	487	49,738	529	47,810	541	51,816	586	58,474

P Preliminary.

TABLE 3. CANADIAN, DOMESTIC EXPORTS OF PEAT, BY COUNTRY, 1980-85

Country	1980 Tonnage	1980 Value ($ 000)	1981 Tonnage	1981 Value ($ 000)	1982 Tonnage	1982 Value ($ 000)	1983 Tonnage	1983 Value ($000)	1984 Tonnage	1984 Value ($ 000)	Jan.-Sept. 1985P Tonnage	Jan.-Sept. 1985P Value ($ 000)
Australia	453	195	308	173	360	219	231	153	83	54	10	9
Barbados	11	3	14	5	11	10	0	0	0	0	5	1
Belgium - Luxembourg	92	13	12	2	0	0	0	0	0	0	..	..
Bermuda	49	9	54	18	83	20	186	42	86	40	61	19
Chile	0	0	0	0	11	6	5	3	0	0	4	1
China	0	0	22	6	22	3	28	6	0	0	..	..
Costa Rica	0	0	0	0	11	2	0	0	247	113	85	12
Denmark	0	0	179	40	119	49	0	0	128	137	..	..
Dominican R.	0	0	0	0	0	0	15	5	0	0	..	..
Egypt	2 367	350	38	22	14	6	0	0	0	0	..	..
Emirates, U.A.	0	0	0	0	0	0	0	0	30	8	..	..
France	11 970	2,363	128	17	17	2	0	0	0	0	..	..
Germany West	205	31	0	0	2	2	0	0	47	63	..	..
Greenland	0	0	16	6	16	3	6	1	0	0	14	..
Haiti	27	7	0	0	13	4	12	10	55	26	91	71
Honduras	0	0	0	0	0	0	0	0	0	0	30	23
Hong Kong	106	32	42	8	92	31	67	21	52	13	20	3
India	0	0	0	0	0	0	0	0	0	0	17	1
Ireland	0	0	32	8	0	0	0	0	0	0	..	..
Israel	536	174	487	165	330	119	95	17	0	0	..	..
Italy	2 456	656	507	106	0	0	0	0	0	0	..	..
Japan	9 705	2,182	12 375	2,849	12 256	6,959	17 395	3,676	20 717	4,218	17 491	3,773
Korea South	37	3	56	12	0	0	30	7	30	7	30	7
Leeward-Windward Islands	16	1	0	0	0	0	0	0	0	0	5	1
Mexico	20	5	45	11	68	18	15	3	0	0	..	..
Netherlands	113	17	119	16	11	3	12	1	0	0	..	..
Neth. Antilles	0	0	0	0	0	0	0	0	19	5	..	..
Norway	310	29	351	43	411	53	17	4	0	0	..	..
Panama	0	0	0	0	26	9	32	6	22	14	11	4
Puerto Rico	40	10	20	19	457	137	729	162	822	223	743	194
St. Pierre - Miq.	16	7	0	0	0	0	2	1	0	0	..	..
Saudi Arabia	1 980	368	951	239	3 013	1,228	2 937	967	912	269	77	20
Singapore	15	2	0	0	17	6	0	0	0	0	15	6
South Africa	51	8	84	14	201	34	270	57	397	150	254	66
Spain	1 160	166	23	8	0	0	0	0	0	0	..	..
Taiwan	3	1	0	0	25	9	19	8	0	0	24	6
Trinidad - Tobago	0	0	0	0	0	0	0	0	89	39	52	44
United Kingdom	2 272	336	1 530	260	8	1	0	0	19	5	..	..
United States	353 353	57,510	306 845	59,526	338 447	64,547	374 760	65,236	436 845	76,818	339 630	62,481
Venezuela	0	0	0	0	0	0	11	1	0	0	..	..
Virgin Islands	0	0	0	0	0	0	9	4	0	0	11	6
Total	387 364	64,477	324 238	63,573	356 030	69,182	396 883	70,391	460 600	82,203	358 818	66,806

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

TABLE 4. WORLD PRODUCTION OF PEAT, BY COUNTRY, 1979-84

Country	1979	1980	1981	1982	1983p	1984e
			(000 tonnes)			
Agricultural use						
U.S.S.R.	199 540	234 913	280 263	300 217	300 217	300 220
Germany West	1 848	1 554	1 741	1 841	1 868	2 000
United States	748	712	622	724	638	715
Canada	480	488	462	487	529	540
Netherlandse	400	400	400	400	400	445
Finland	733	518	204	578	274	400
Polande1	200	202	202	200	200	200
Sweden	174	134	131	123	125	125
Francee	141	141	131	120	110	110
Denmark	45	31	31	94	100	100
Ireland	91	88	81	95	95	95
Hungarye	70	70	70	70	70	70
Norwaye	60	60	60	60	60	60
Spain	37	44	39	60	40	40
Israel	18	20	20	20	20	20
Total2	204 479	239 220	284 279	304 916	304 589	304 930
Fuel use						
U.S.S.R.e	59 862	59 862	59 862	59 862	59 862	59 860
Ireland	3 665	4 425	5 357	5 279	5 299	5 300
Finland	1 551	3 067	1 302	5 499	3 354	4 000
Germany West	230	279	246	253	258	350
Norwaye	1	1	1	1	1	1
Other	200	203	201	198	201	209
Total2	65 509	67 837	66 969	71 092	68 975	69 720
World total	269 988	307 054	351 248	376 008	373 564	374 650

Source: U.S. Bureau of Mines, Peat, C. Davis, 1984.
1 Agriculture and fuel uses. 2 Total may not round due to duplication in usage totals.
e Estimated; p Preliminary.

TABLE 5. PRICES[1] IN UNITED STATES, BY TYPE OF PEAT, 1984

Type	Domestic			Imported2
	Bulk	Packaged or bales	Average	Total
		(U.S. dollars per short ton)		
Sphagnum moss	21.74	69.58	59.65	119.18
Hypnum moss	23.52	41.51	37.23	..
Reed-Sedge	23.42	23.81	23.68	..
Humus	15.92	42.91	19.07	..
Other	19.99	16.00	16.00	..

Source: U.S. Bureau of Mines, Peat, C. Davis, 1984.
1 Prices are fob mine. 2 Average Customs prices.
.. Not applicable.

Phosphate

G.S. BARRY

Naturally occurring rock deposits are the most common source of phosphorus; other sources are bones, guano, and some types of iron ores that yield byproduct basic slag containing sufficient phosphorus to warrant grinding and marketing.

Phosphate rock, 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, or phosphorite, is the most widely used phosphate raw material. Apatite, which is second in importance, occurs in many igneous and metamorphic rocks.

Phosphate rock is graded either on the basis of its P_2O_5 equivalent (phosphorus pentoxide) or its $Ca_3(PO_4)_2$ content (tricalcium phosphate of lime or bone phosphate of lime - TPL or BPL). For comparative purposes, 0.458 unit P_2O_5 equals 1.0 unit BPL, and 1 unit of P_2O_5 contains 43.6 per cent phosphorus.

Approximately 80 per cent of world phosphorus production goes into fertilizers; other products which require the use of phosphorus include organic and inorganic chemicals, soaps and detergents, pesticides, insecticides, alloys, animal-food supplements, motor lubricants, ceramics, beverages, catalysts, photographic materials, and dental and silicate cements.

A severe world contraction in the demand for phosphatic fertilizers began in 1981 and continued until mid-1983. Since that time there is a clear steady improvement in phosphate consumption, which as measured by deliveries of phosphate rock, rose by 10.2 per cent from 136.7 million t in 1983 to 150.6 million t in 1984. There was stabilization in the first nine months of 1985 with deliveries by major western world producers declining by 3.8 per cent (66.1 million t in 1985 compared to 68.7 million t in 1984). It is estimated that world phosphate rock production in 1985 will reach close to 155 million t. Stocks held by major western world producers were 23.9 million t at the end of September 1985 compared to 21.1 million at the end of 1984 and a peak of 34.2 million t reached on July 1, 1982. Among the traditional large producers and exporters, Brazil, Israel, Algeria and the United States recorded increased production while others experienced only small declines. Iraq brought new production onstream.

World exports of phosphate rock increased by 5.9 per cent from 46.9 million t in 1983 to 47.7 million t in 1984. Exports in 1985 are expected to be approximately 47 million t.

OCCURRENCES IN CANADA

Known Canadian deposits are limited 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 (carbonatites) in Ontario and Quebec; and Late Paleozoic-Early Mesozoic sedimentary phosphate rock deposits in the southern Rocky Mountains. Phosphatic mineralization was also reported in the layered rocks of the Athabasca series.

The deposit of greatest economic significance is the Kapuskasing (Cargill) phosphate deposit, where early studies indicated the presence of about 60 million t of ore grading 20.2 per cent P_2O_5. The property was optioned by Sherritt Gordon Mines Limited in 1979 from International Minerals & Chemical Corporation (Canada) Limited (IMCC). The option was exercised in December 1983. Additional drilling, test pits and bulk sample pilot plant testing confirmed the technical viability of this deposit. It has been determined that the deposit contains higher grade sections totalling 22 million t grading 27 per cent P_2O_5. The best part of the deposit, contains 6 million t grading 33 per cent P_2O_5. This ore will need only minor concentration.

Another important carbonatite deposit was discovered by Shell Canada Resources Limited near Martison Lake north of Hearst, Ontario. In December 1982 the deposit was purchased by New Venture Equities Ltd.

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which formed a 50-50 joint venture with Camchib Mines Inc. for further exploration and development. Camchib Mines Inc. is wholly-owned by Campbell Resources Inc. The joint venture continued with detailed, fill-in drilling on the property and announced in August 1983 that higher grade zones of the deposit contain 57 million t grading 23 per cent P_2O_5. A $1.2 million additional drilling program was completed in 1984.

In July 1984, Sherritt Gordon Mines, Campbell Resources and New Venture Equities combined forces on a 50/50 joint venture on the two phosphate properties at Cargill and Martison Lake. The company is confident that when North American market conditions improve the development at one or both properties could be economic.

CANADIAN PHOSPHATE INDUSTRY

Phosphate Rock. In 1984, Canada imported 3.17 million t of phosphate rock; for the first nine months of 1985 imports decreased by 18 per cent. The general economic recession was responsible for the low import levels. Approximately 75 per cent of the phosphate rock is used in fertilizer production, 18 per cent in elemental phosphorus production and 6 per cent in calcium phosphate production.

About 70 per cent of Canada's imports of phosphate rock from the United States has been from Florida since the late-1970s. The remainder was from western states. Purchase practices, which include commercial factors as well as the characteristics of rock used by the fertilizer plants, point to the continuation of this pattern of supply for at least a few years. Lately the industry in western Canada is experimenting with the usage of phosphate rock from Morocco and Togo. Very low world shipping costs make this rock competitive with imports from the United States.

Currently, eastern Canada is supplied from Florida. From 800 000 t to 850 000 t are transported by sea, with three quarters of this total being used for elemental phosphorus production and the remainder for fertilizer production in New Brunswick.

Only between 100 000 t and 150 000 t of phosphate rock is shipped annually by rail from Florida mines to Ontario fertilizer plants because direct unit train rail service is more advantageous than ocean shipping combined with short overland hauls. Another advantage is that railroad shipments can be maintained at a schedule that allows for very low inventories.

Florida is the source of phosphate rock for about 55 to 60 per cent of the five western Canadian fertilizer plants and western United States for some 40 to 45 per cent. Rock shipped from Florida via the Panama Canal to Vancouver is mainly transported as back-haul to Canadian lumber (to United States) and potash exports (to South America). The inland rail haul from Vancouver to the Edmonton area is a back-haul to exports of potash. Total shipping costs are competitive with rail haul from mines in the western United States.

Belledune Fertilizer (a division of Noranda Inc.) produced approximately 140 000 t of DAP in 1985 at its New Brunswick fertilizer plant. Shipments were marginally lower. The 1986 DAP production is forecast at about the same level. The company will convert its phosphoric acid plant from the dihydrate to the hemihydrate process which will result in substantial energy savings. The process is under the license of Norsk Hydro Fertilizers.

International Minerals & Chemical Corporation closed its Port Maitland fertilizer plant at the end of June 1984 for an indefinite period (currently the plant is "mothballed" for a duration of no less than two years).

C-I-L Inc. operated its phosphate plant intermittently, one to two weeks per month averaging less than 50 per cent capacity utilization, and producing about 70 000 t of ammonium phosphates. The company uses mainly "spent" sulphuric acid. C-I-L completed the expansion of its nitrogen capacity from 350 000 t to 750 000 t of ammonia in 1985. The company will continue to produce phosphatic fertilizers at the current low production levels.

Cominco Ltd. shut down its Kimberley fertilizer plant for three weeks in mid-1985 for annual maintenance. The Trail plant was shut down for four weeks for maintenance and the installation of a new acid reaction tank that will improve recovery of P_2O_5. Production of ammonium fertilizers at the Trail and Kimberley plants combined was 308 000 t in 1985, about the same as the previous year.

Esso Chemical Canada completed the expansion of the phosphate plant from

204 000 tpy to 370 000 tpy capacity in 1983. Since September 1983 production of ammonium phosphates was carried at almost full capacity, with part of the output being tolled for Sherritt Gordon Mines Limited.

Western Co-operative Fertilizers Limited operated its Calgary plant throughout the year except for a two-week maintenance shutdown in mid-summer. The plant produced over 250 000 t of ammonium phosphate fertilizers in 1985, mainly MAP. The Medicine Hat plant remained closed throughout the year. The company imports phosphate rock from Idaho.

Sherritt Gordon Mines Limited closed its phosphate production facilities at the Fort Saskatchewan plant between September 1983 and September 1985 except for 2 months in early-1985. During this period requirements for phosphate fertilizer were provided by Esso Chemical under a tolling agreement. Esso provided additional tolled phosphate to the end of 1985.

Elemental phosphorus. Tenneco Canada Inc. operates two thermal reduction plants in Canada where elemental phosphorus is produced by the smelting of a mixture of phosphate rock, coke and silica. One tonne of phosphorus requires the input of about 10 t of phosphate rock (60 to 67 per cent BPL), 2 t of coke and 3 t of silica.

Tenneco has plants at Varennes, Quebec with a 22 500 tpy capacity (P_4) and at Long Harbour, Newfoundland with an effective capacity of about 60 000 tpy. The elemental phosphorus production from Long Harbour is in a large part destined for Albright & Wilson, Inc. derivative plants in Europe, with some export to the Far East. Starting in 1982 a proportion was sent to Buckingham, Quebec and Port Maitland, Ontario to supplement supplies from Varennes, Quebec. In late-1984, Tenneco restarted the second main furnace idle since 1982. The company also put on-stream the second of two smaller furnaces to recover up to 2 000 tpy of phosphorus from the "mud" produced as a byproduct of furnace operation and "mud" stored on site in the past.

The Long Harbour, Newfoundland plant operated at full capacity during 1985. In total, the Tenneco plants use from 600 000 to 650 000 tpy of Florida phosphate rock. Since the low-grade phosphate rock acceptable for thermal reduction cannot be used by the fertilizer industry, it can be purchased at relatively lower prices (per P_2O_5 unit value).

Production from Varennes, Quebec is 90 per cent or more oriented toward Canadian markets. The elemental phosphorus (P_4) produced at Varennes is shipped to two Tenneco plants, one at Buckingham, Quebec and the other at Port Maitland, Ontario. At Buckingham about 9 000 tpy of P_4 is used to produce technical and food grade phosphoric acid (95 per cent H_3PO_4) and 1 000 t to produce amorphous red phosphorus and phosphorus sesquisulphide.

Tenneco's Port Maitland plant operates on phosphorus from Varennes and Long Harbour, using between 13 000 and 14 000 tpy. It is all converted to technical grade phosphoric acid.

Coproducts of elemental phosphorus are ferrophosphorus, carbon monoxide and calcium silicate slag. Ferrophosphorus contains 20 to 25 per cent phosphorus and is used by the steel industry as a direct source of the phosphorus needed in some types of steel.

Phosphate fertilizers. Nine Canadian plants produce wet phosphoric acid by the dihydrate process in which 28 to 30 per cent P_2O_5 acid is the principal product and gypsum is the waste product. Two of the nine plants are now idle. At present, there is no use for the gypsum and it accumulates in large settling ponds near all the plants except one in New Brunswick where it is disposed of in the sea.

Canadian phosphoric acid plants are designed to operate on phosphate rock which grades between 69 and 72 per cent BPL (31.1 to 33.0 per cent P_2O_5). The first stage of acid production, which is digestion and filtration, produces "filter acid" grading 28 to 30 per cent P_2O_5. This product is then upgraded by evaporation to about 40 to 44 per cent acid for most in-plant use, or to 52 to 54 per cent P_2O_5 for commercial sales or specialized uses. The evaporation step is energy intensive, and the provenance of sulphuric acid has a bearing on energy consumption. Plants using elemental sulphur as the source of in-plant sulphuric acid production have their evaporation energy requirements met by heat generated in the sulphuric acid plants since the process is exothermic, (i.e., 1 t of sulphur has a BTU content equivalent to about 2 barrels of oil). Plants using commercial sulphuric acid, (e.g., produced from SO_2 smelter gases) have to generate vapour requirements with natural gas or coal-fired boilers. To balance energy requirements, an efficient dihydrate WPA plant could theoretically operate using elemental sulphur for 70 to 75 per cent of its requirements and purchased sulphuric acid for the remainder.

Most phosphate rock contains uranium. It is in small enough quantities not to present any problems for fertilizer production. In Canada, Earth Sciences Inc. started a uranium recovery plant in Calgary in 1980. It treats phosphoric acid from the adjoining plant of Western Co-operative Fertilizers Limited, and returns the acid to the owner. The plant was placed on standby in November 1981. The plant underwent major modifications during 1982 and 1983 and was re-opened in May 1983. Since that time it is operating continuously and successfully. The recovered yellow cake is shipped to British Nuclear Fuels Limited in the United Kingdom for refining and then returned to the United States.

Capacity of Canadian phosphoric acid plants is expressed in 100 per cent P_2O_5 equivalent and the total installed annual capacity is currently estimated at 1 146 000 t. Some of this capacity is now idle and mothballed. Efficient plants can consistently operate at 90 to 95 per cent of nameplate capacity. Most Canadian plants, gauge their annual production levels to corporate marketing strategies and fertilizer demand forecasts. At times when agricultural demand is low Canadian production capacities are seriously underutilized. The recovery of P_2O_5 from phosphate rock i.e. the efficiency of conversion varies from 88 to 94 per cent.

All of the nine phosphoric acid plants in Canada are integrated to produce phosphatic fertilizers, mainly ammonium phosphates. Ammonium phosphates are produced by a neutralization reaction of phosphoric acid with ammonia and, depending on the proportions of the original constituents, either diammonium phosphate (DAP) (18-46-0) or mono-ammonium phosphate (MAP) (range from 11-48-0 to 11-55-0) are produced. Another common grade particularly in the west is 16-20-0.

Canadian fertilizer plants produce between 800 000 and 950 000 tpy of MAP, between 250 000 and 300 000 tpy of DAP and about 250 000 tpy of other ammonium and ammonium-nitrate phosphates.

Calcium Phosphate. Cyanamid Canada Inc. produces dicalcium phosphate (18.5 per cent phosphorus) at its Welland fertilizer plant. The company used to purchase its acid from IMCC but since October 1984 it is importing it from the United States. Calcium phosphates are used mainly for supplementing the calcium and phosphorus content of animal and poultry feedstocks.

WORLD DEVELOPMENTS

World phosphate rock production in 1985 was estimated at 155.0 million t, an increase of 2.9 per cent from 1984. Western world production was 109.8 million t.

The uptrend in production and sales was strong, particularly since the second half of 1983, following two and a half years of recession. Major producers like the United States and Morocco raised their production to normal levels in 1984 and 1985 but the world phosphate rock industry as a whole still suffers from a large excess of capacity and prices remain low. Production continued to increase in the U.S.S.R. and China as well as Israel, Algeria and Brazil.

The Florida phosphate rock industry is in a state of transition. A number of companies have temporarily closed mines as of mid-1985 and put several mines on sale. AMAX Phosphate, Inc. closed its Big Four Mine and put it up for sale. Furthermore the company abandoned plans to develop its Pine Level deposit. Cargill Limited has taken over the operations of Gardinier, Inc. Estech, Inc. closed its Silver City Mine and the company is reported to be for sale. American Cyanamid Company is out of the phosphate business having leased its operations to International Minerals & Chemical Corporation. USS Agri-Chemicals put its Rockland Mines for sale. W.R. Grace and Company closed its Hooker Prairie phosphate mine for an indefinite period.

In North Carolina, Texasgulf Chemicals Co. plans to expand production. The North Carolina Phosphate Corporation plans to put a new mine on-stream by 1989. In the western states, Chevron Resources Company is expanding its Vernal Mine in Utah and J.R. Simplot Company is expanding its plant at Pocatello.

PRICES

Most phosphate rock is purchased under producer-consumer negotiated prices which depart from listed prices in consideration of volume, transportation conditions and local competitive conditions. Phosrock Ltd., a

Florida-based marketing organization represents about two-thirds of producers for export markets.

The average unit price of phosphate rock sold or used in the United States was $US 24.00 per tonne fob plant in 1984 compared to $23.98 in 1983. The average value of phosphate rock exported decreased from $US 28.17 per tonne fob mine in 1983 to $27.26 in 1984. For fertilizer year 1984-85 the average unit price was only $US 25.75/t.

OUTLOOK

The outlook for 1986 is for a continuation of demand at current levels under ample supply conditions. Prices for phosphoric acid and phosphatic fertilizers, will remain low, probably not yet exceeding those of 1982. Under the current marketing conditions prices are 25 to 40 per cent lower than normal renumerative levels. A steady increase in demand after 1986, however, should result in substantially better prices.

Most experts forecast a consumption growth for phosphate, fluctuating between 3.5 and 4.5 per cent annually for the next few years. A recent development is the use of phospho-oxychloride as a coating material on asbestos to neutralize perceived negative biological effects of asbestos fibres.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
93100-2	Phosphate rock	free	free	free	free
66345-1	Defluorinated calcium phosphates for use in the manufacture of animal or poultry feeds	free	free	free	free
93103-1	Calcium phosphate dibasic	free	free	free	free
93103-2	Calcium phosphate, disintegrated, calcined, thermophosphates, fused phosphates; superphosphates	free	free	free	free
92840-1	Phosphites, phosphorus, hypophosphites and phosphates	10	13.1	25	8.5
	Sodium phosphate dibasic, and monobasic, pharmacopoeial tribasic, commercial grade; sodium pyrophosphate; sodium tripolyphosphate (temporary rate reduction 3/06/80 to 30/06/87)	free	13.1	25	free
92840-2	Di-calcium phosphate	3.8	3.8	25	2.5
	(temporary rate reduction 3/06/80 to 31/12/86)	free	3.8	25	free
93100-1	Fertilizers; goods for use as fertilizers	free	free	free	free
93105-1	Ammonium phosphates	free	free	free	free

MFN Reductions under GATT (effective January 1 of year given)	1985	1986	1987
		(%)	
92840-1	13.1	12.8	12.5
92840-2	3.8	1.9	free

UNITED STATES, Customs Tariffs (MFN)				
421.18	Sodium phosphate containing over 45 per cent water	2.7	2.6	2.5
421.22	Pyrophosphates	4.0	3.9	3.7
606.33	Ferrophosphorus	3.3	2.9	2.4

Sources: The Customs Tariff, 1985, Revenue Canada; Customs and Excise. Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241.

TABLE 1. CANADA, PHOSPHATE ROCK IMPORTS, 1983-85, AND CONSUMPTION, 1982-85

	1983		1984		(Jan.-Sept.) 1985	
	(tonnes)	($)	(tonnes)	($)	(tonnes)	($)
Imports						
United States	2 625 389	97,936,000	3 169 613	120,852,000	2 074 795	89,655,000
Togo	-	-	-	-	35 800	2,336,000
Morocco	-	-	-	-	22 000	457,000
Total	2 625 389	97,936,000	3 169 613	120,852,000	2 132 595	92,448,000

	1982	1983	1984	1985[e]
	(tonnes)			
Consumption[1]				
Eastern Canada	1 222 520	1 132 020	1 222 000	967 600
Western Canada	2 217 847	1 159 151	1 810 300	1 817 600
Total	3 440 367	2 291 171	3 032 300	2 785 200

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Breakdown by Energy, Mines and Resources Canada.
[e] Estimated; - Nil.

TABLE 2. CANADA, PHOSPHATE FERTILIZER SHIPMENTS, 1979-85[1]

	1979/80	1980/81	1981/82[r]	1982/83	1983/84	1984/85
	(tonnes P_2O_5 equivalent)					
Domestic markets:						
Atlantic provinces	19 441	24 481	26 261	29 443	24 965	26 894
Quebec	20 992	28 610	34 915	43 308	37 835	27 990
Ontario	54 602	82 496	71 033	71 959	79 160	52 843
Manitoba	110 382	97 529	75 239	81 907	90 529	92 092
Saskatchewan	131 500	135 534	144 998	153 784	195 170	182 017
Alberta	131 413	149 116	152 906	157 010	161 185	170 943
British Columbia	14 204	13 308	8 998	10 970	11 311	11 940
Total Canada	482 533	531 074	514 350	548 381	600 155	564 719
Export markets:						
United States	146 813	194 565	141 411	82 478	65 790	71 403
Offshore	44 999	77 328	20 305	715	4 652	12 743
Total exports	191 812	271 893	161 716	83 193	70 442	84 146
Total shipments	674 344	802 968	676 066	631 574	670 597	648 865

Source: Canadian Fertilizer Institute.
[1] Fertilizer year: July 1 to June 30; not 100% industry coverage.
[r] Revised.
Note: Totals may not add due to rounding.

TABLE 3. CANADA, PHOSPHATE FERTILIZER PLANTS

Company	Plant Location	Annual Capacity (tonnes P_2O_5 eq.)	Principal End Products	Source of Phosphate Rock	Basis for H_2SO_4 Supply for Fertilizer Plants
Eastern Canada					
Belledune Fertilizer div. of Noranda Inc.	Belledune, N.B.	150 000	am ph	Florida	SO_2 smelter gas
C-I-L Inc.	Courtright, Ont.	90 000	am ph	Florida	SO_2 smelter gas, pyrrhotite roast and waste acid
International Minerals & Chemical Corporation (Canada) Limited (IMCC)	Port Maitland Ont.	118 000[1]	H_3PO_4, ss ts, ca ph	Florida	Sulphur and SO_2 smelter gas
		358 000			
Western Canada					
Cominco Ltd.	Kimberley, B.C.	86 700	am ph	Montana and Utah	SO_2 pyrite roast
	Trail, B.C.	77 300	am ph	Utah	SO_2 smelter gas
Esso Chemical Canada	Redwater, Alta.	370 000	am ph	Florida	Sulphur
Sherritt Gordon Mines Limited	Fort Saskatchewan, Alta.	50 000[2]	am ph	Florida	Sulphur
Western Co-operative Fertilizers Limited	Calgary, Alta.	140 000	am ph	Idaho	Sulphur
	Medicine Hat, Alta.	65 000[3]		Idaho	
		788 000			
Canada: installed capacity		1 146 000			
effective capacity:					
end of 1983		1 031 000			
end of 1984		913 000			

P_2O_5 eq. Phosphorus pentoxide equivalent; am ph Ammonium phosphates; ss Single superphosphate; ts Triple superphosphate; ca ph Food supplement calcium phosphate; H_3PO_4 Phosphoric acid for commercial sales.
[1] Shutdown and mothballed for an indefinite period - July 1984. [2] Shutdown temporarily for two years - Sept. 1983 to Sept. 1985. [3] Shutdown for an indefinite period - May 1982.

TABLE 4. CANADA, TRADE IN SELECTED PHOSPHATE PRODUCTS, 1983-85

	1983		1984P		Jan. - Sept. 1985	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Imports						
Calcium phosphate						
United States	32 446	16,413	53 702	23,155	71 081	25,043
Other countries	733	280	981	398	146	188
Total	33 179	16,692	54 683	23,553	71 227	25,231
Fertilizers:						
Normal superphosphate, 22 per cent or less P_2O_5						
United States	465	136	27	4	1 108	217
Israel	-	-	14 043	1,498	-	-
Netherlands	930	117	-	-	-	-
Total	1 368	254	140 070	1,502	1 108	217
Triple superphosphate, over 22 per cent P_2O_5						
United States	52 832	11,304	57 724	11,659	45 327	8,863
Netherlands	1 923	258	-	-	-	-
Total	54 755	11,562	57 724	11,659	45 327	8,863
Phosphatic fertilizers, nes						
United States	303 022	82,682	266 980	78,435	281 497	76,048
Belgium-Luxembourg	673	408	1 105	622	917	503
Israel	299	213	182	111	263	135
Netherlands	101	39	58	21	-	-
Other countries	86	50	58	22	4	8
Total	304 181	83,392	268 383	79,211	282 681	76,694
Chemicals:						
Potassium phosphates						
United States	1 327	1,782	1 577	2,222	1 120	1,441
France	139	150	163	177	183	180
Israel	216	195	174	198	203	204
Netherlands	23	26	35	42	20	20
West Germany	24	37	5	5	34	36
Total	1 729	2,190	1 954	2,644	1 560	1,881
Sodium phosphate, tribasic						
United States	521	476	381	316	274	164
France	249	98	252	95	230	72
Belgium-Luxembourg	40	61	-	-	-	-
Netherlands	84	35	93	36	38	15
People's Republic of China	119	49	243	102	137	40
Total	1 013	719	969	549	679	291
Exports						
Nitrogen phosphate fertilizers, nes						
United States	193 724	43,052	182 163	40,362	138 902	31,836
India	-	-	20 999	5,555	-	-
Nicaragua	-	-	7 986	2,043	-	-
Costa Rica	5 190	1,716	2 929	887	20	7
Jamaica	3 564	1,035	7 184	2,123	3 410	1,006
Other countries	36	15	-	-	20	6
Total	202 514	45,818	221 261	50,970	142 352	32,856

Source: Statistics Canada.
P Preliminary; - Nil; nes Not elsewhere specified.

TABLE 5. WORLD PHOSPHATE ROCK PRODUCTION, 1982-85

	1982	1983	1984e	1985e
		000 tonnes product)		
WORLD TOTAL	**122 913**	**136 685**	**150 573**	**155 000**
West Europe	**389**	**538**	**716**	**700**
Finland	232	381	477	
Sweden	131	107	128	
Turkey	26	50	96	
France	15	12	15	
East Europe	**27 200**	**28 500**	**31 900**	**32 000**
U.S.S.R.	27 200	28 500	31 900	
North America	**37 414**	**42 573**	**49 197**	**51 600**
United States	37 414	42 573	49 197	
Central America	**379**	**436**	**375**	**350**
Mexico	379	436	375	
South America	**2 779**	**3 229**	**3 884**	**4 000**
Brazil	2 732	3 208	3 885	
Colombia	18	18	28	
Peru	29	3	1	
Africa	**29 907**	**34 159**	**35 967**	**37 000**
Algeria	946	893	1 000	
Egypt	708	647	1 043	
Morocco/Sahara	17 754	20 107	21 245	
Senegal	975	1 522	1 912	
South Africa	3 173	2 742	2 585	
Togo	2 035	2 081	2 696	
Tanzania	-	20	15	
Tunisia	4 196	6 016	5 346	
Zimbabwe	120	133	125	
Asia	**23 251**	**23 529**	**27 164**	**28 408**
China	11 728	12 830	11 800	
Christmas Island	1 328	1 066	1 259	
India	560	787	800	
Iraq	363	1 199	1 500	
Israel	2 711	2 969	3 312	
Jordan	4 431	4 749	6 263	
North Korea	500	500	500	
Syria	1 455	1 229	1 514	
Vietnam	160	170	200	
Sri Lanka	15	15	16	
Oceania	**1 594**	**1 705**	**1 370**	**1 350**
Australia	235	21	11	
Nauru	1 359	1 684	1 359	

Sources: Phosphate Rock Statistics, 1983, ISMA Ltd.; United States Bureau of Mines (USBM), Mineral Commodity Summaries 1984.
e Estimated; - Nil.
Totals may not add due to rounding.

TABLE 6. TIME PRICE RELATIONSHIPS FOR PHOSPHATE ROCK, 1963-85

	Average annual U.S. producer price[1]	
Year	Actual Prices	Based on constant 1983 dollars
	(dollars per tonne)	
1963	6.97	20.97
1964	6.99	20.72
1965	7.16	20.77
1966	7.42	20.85
1967	7.32	19.97
1968	6.75	17.64
1969	6.14	15.26
1970	5.80	13.68
1971	5.80	13.03
1972	5.62	12.12
1973	6.24	12.73
1974	12.10	22.68
1975	25.35	43.46
1976	21.26	34.65
1977	17.39	26.78
1978	18.56	26.61
1979	20.04	26.45
1980	22.78	27.53
1981	26.63	29.43
1982	25.52	26.60
1983	23.97	23.97
1984	24.00	23.13
1985 (6 mths)	23.47	22.50

[1] United States composite domestic and export fob mine prices.

Platinum Metals

G. BOKOVAY

During the first half of 1985, the price for all platinum group metals (PGM's) - which include platinum, palladium, rhodium, osmium, ruthenium and iridium - declined as speculative demand decreased. However, during the second half of the year, concern over the supply of these metals caused by growing political unrest in South Africa, resulted in a sharp turnaround in PGM prices. This reversal was particularly pronounced for platinum and rhodium since South Africa is the dominant supplier for both metals in the western world. At the same time, industrial demand for platinum and rhodium has been remarkably strong.

Although palladium prices strengthened in the latter part of the year, this increase was smaller than for platinum, perhaps reflecting that South Africa is not as dominant a supplier of palladium. As well, industrial demand for palladium, which had increased significantly in 1984, was relatively flat during 1985. In particular, palladium consumption in the important electrical and electronic goods sectors, actually declined during the year.

Although the PGMs have recently attracted increased investment and speculative interest, primary demand for these metals has and will remain dependant upon their industrial uses. Since the utilization of PGMs in existing industrial applications will likely increase substantially and since new uses are being developed, the outlook for the platinum group is very positive.

CANADIAN DEVELOPMENTS

Platinum group metals are produced in Canada by Inco Limited and Falconbridge Limited as byproducts from the mining of nickel-copper ores. Although the bulk of the PGMs are recovered from operations in the Sudbury basin, small amounts of these metals are also produced by Inco at Thompson, Manitoba.

The residue from the refining of nickel-copper matte, which contains platinum group metals, is shipped by Inco to its refinery at Acton in the United Kingdom for the extraction and refining of PGMs. Falconbridge ships a nickel-copper matte containing PGMs to its refinery at Kristiansand, Norway.

Canadian production of PGMs in 1985, is estimated at 10 425 kg, which is only slightly higher than the 10 369 kg produced in 1984. Although detailed information is not available, it is likely that in recent years palladium output has been somewhat higher than that for platinum. By virtue of the size of its nickel mining operations, Inco is by far the largest Canadian PGM producer.

Canadian reserves of PGMs are estimated at about 280 million g of which almost 90 per cent is platinum and palladium in almost equal proportions.

With optimistic forecasts for PGM demand together with the uncertainty caused by the situation in South Africa, there was a marked increase in the amount of activity related to PGM exploration in Canada during 1985. Near Marathon, Ontario, Fleck Resources Ltd. plans to conduct a feasibility study on a PGM deposit that was formerly held by Anaconda Canada Exploration Ltd. On the basis of the latest drilling results, reserves are estimated at 42.5 million t grading 2.3 g/t platinum/palladium, 0.42 per cent copper and traces of nickel, cobalt, rhodium, gold and silver. Meanwhile, it has been reported that Nexus Resources Corporation plans to undertake an exploration program at its property on Vancouver Island, while Lacana Mining Corporation is involved in PGM exploration on the Peter Lake Complex, northeast of La Ronge, Saskatchewan. Other potential prospects include the Tulameen property of D.K. Platinum Corporation in British Columbia, the Lac des Iles property of

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Boston Bay Mines near Thunder Bay, Ontario, the Belleterre property of Platinum Exploration Canada Inc. in Quebec and the nickel deposit of Dumont Nickel Corporation also in Quebec.

WORLD DEVELOPMENTS

The major world producers of platinum group metals are the U.S.S.R., the Republic of South Africa and Canada. Minor producers include Japan - from imported nickel ores and intermediates - Colombia, Finland, United States, Yugoslavia and Zimbabwe. Estimated 1985 world primary production of PGMs is about 235 million g which is about 7.25 per cent higher than in 1984.

The U.S.S.R., the largest producer of PGMs in the world, derives these metals principally as a byproduct of nickel-copper production. For many years, the U.S.S.R. has exported a significant proportion of its PGM production to the western world and is currently the largest supplier of palladium, iridium and osmium in this market. While overall sales have been relatively stable in recent years, there has been a discernable drop in exports of platinum owing to what is presumed to be an increase in consumption by the Comecon countries.

It is reported that about 85 to 90 per cent of Soviet production is produced from six mines in the Noril'sk region of northern Siberia. The U.S. Bureau of Mines estimates that the PGM content of Noril'sk ores is as follows: 25 per cent platinum, 67 per cent palladium and the remaining 7 per cent composed of iridium, rhodium, ruthenium and osmium.

The other principal source of PGMs in the U.S.S.R., accounting for about 10 per cent of Soviet production is the Kola Peninsula where PGMs are a byproduct of nickel-copper mining. PGMs are also recovered from placer deposits in the southern Urals, once the major source of U.S.S.R. output.

In the Republic of South Africa, the world's second largest producer, there are three producers: Rustenburg Platinum Holdings Limited, Impala Platinum Holdings Ltd. and Western Platinum Limited. Unlike production in Canada, or in the U.S.S.R., South African PGMs are derived from ores that are mined primarily for their platinum metal content. In addition, South African ores differ significantly from Soviet mineralization to the extent that they have a much higher ratio of platinum to palladium. The bulk of South Africa ores, which come from the Merensky Reef of the Bushveld Igneous Complex in the Transvaal, are thought to contain precious metals in the following proportion: 60 per cent platinum, 25 per cent palladium, 8 per cent other PGMs and 3 per cent gold. In addition, these ores also contain appreciable quantities of nickel and copper.

Despite persistent labour problems and political unrest in South Africa throughout the second half of 1985, it is reported that South African PGM production in 1985 was significantly higher than in 1984. At the end of 1985, most mines were thought to be operating at or near full capacity. While this increase in production was the result of strong demand, the precipitous fall in the value of the South African Rand has also been a contributing factor.

Rustenburg Platinum, the largest South African producer, has four active mining operations in the Merensky reef. The processing and refining of PGM concentrates and refinery residues is carried out at the Wadeville refinery at Gemistown in South Africa and another at Royston in the United Kingdom. The latter is owned by the Matthey Rustenburg Refiners (Pty) Limited which is jointly controlled by Rustenburg Platinum and the Johnson Matthey plc.

During 1985, Rustenburg announced that it was currently mining a significant amount of ore at its Union section workings from the UG2 reef. This formation, which lies up to 350 m below the Merensky reef, contains higher grades of palladium and rhodium, although significantly less platinum. While UG2 ores are more difficult to process, production from this reef will increase in the next decade as ore reserves in the easily mined areas of the Merensky reef are exhausted.

Impala's annual capacity is estimated at about 1,680,000 oz of PGM of which platinum would represent about 62 per cent. During 1985, it was reported that Impala was operating at around 95 per cent of capacity and that UG2 ore represented about 15 per cent of its mill feed.

On January 6, 1986, Impala fired 20,000 black workers in response to a strike which began on New Year's day. Although the company was forced to suspend production at three mines, it was reported ten days later that Impala was hiring replacements and that production had resumed.

Western Platinum Limited, the smallest producer in South Africa, operates one mine on the western limb of the Bushweld Complex. The company, which is owned by Lonrho plc, Falconbridge Limited and Superior Oil Company, mines ore from both the Merensky and UG2 reefs in a ratio of about 2:1. Production by Western Platinum, which began in 1973, has been steadily increasing. For the fiscal year ending on September 30, 1985, production of PGM in matte was 268,340 oz compared to 263,182 oz in fiscal year 1984.

At the end of 1985, Western Platinum announced that its new base-metal refinery in South Africa was nearing completion. This will simplify the logistics of the company's operations since PGMs are currently shipped to Falconbridge's refinery in Norway within matte and then returned to South Africa as sludges which are then refined at the Brakpan plant of Western Platinum Limited's refinery.

A potential new producer in South Africa is Gold Fields of South Africa Ltd. which has been evaluating its Northam prospect in the northwestern Transvaal for some time. To date, drilling at the site has outlined sufficient reserves to support a production rate yielding 400,000 oz of platinum per annum.

In the United States, participants in the proposed Stillwater Complex platinum/palladium project in Montana announced in the second half of 1985 that they would spend $US 40 million to drive an adit into the property and that production would begin at the end of 1987. While the original partners in the project included Chevron U.S.A. Inc., Manville Products Corporation and the Anaconda Minerals Company division of Atlantic Richfield Company. The latter's interest was purchased by Lac Minerals Ltd. of Toronto in September. To date, exploration on the property has indicated proven and probable ore reserves of 390 000 t grading 24.5 g/t of platinum-palladium and 1 500 000 t of possible reserves grading 29 g/t. It is expected that the mine will have an eventual annual output of around 150,000 oz of palladium and 50,000 oz platinum.

During 1985, the U.S. Administration put forward a proposal to radically reduce the size of its National Defence stockpile. This would include disposal of the entire stock of PGMs which currently stands at about 1.7 million oz including 1.26 million oz of palladium and 0.45 million oz of platinum.

On March 20, 1985, environment ministers from ten EEC countries reached agreement on the introduction of automobile emission standards in Europe. The adoption of these standards, which will be phased in between 1988 and 1993, will first apply to automobiles with engine displacements of more than 2 000 cc. The agreement also stipulates that lead free gasoline be available by 1989 in the member countries.

While the standards will allow car manufacturers to use a "lean burn" combustion technology or PGM catalytic converters, it is generally agreed that the former is technically feasible for smaller engines only. Furthermore, it is expected that the lean-burn technology may be used in conjunction with some sort of PGM catalytic device.

Although there remains some uncertainty about the exact nature of the technology that will be employed to meet emission standards in Europe, it is expected that demand for catalytic converters in that market will require at least 300,000 oz/y and perhaps as much as 500,000 oz/y of PGM's by 1994.

Recycling

It is estimated that less than 10 per cent of the western world supply of platinum and 20 per cent of the palladium supply, is derived from the recycling of industrial PGM scrap. Although platinum metals from spent automotive catalysts represent a potentially significant source of supply, the high cost of collecting and transporting catalysts or other scrap such as that generated by the electronics industry, to a processing facility have discouraged the necessary investment. However, in view of increasing prices and concern over the vulnerability of western supplies of platinum, in particular, secondary recovery can be expected to become more important in the next decade.

In this regard, Texasgulf Inc. recently completed a new plasma electric arc furnace plant in Alabama which is designed to recover PGMs from automobile catalytic converter materials. The company hopes to eventually process about 7 million lbs of catalysts annually which will yield about 500,000 oz of platinum and less quantities of palladium and rhodium.

PRICES

Platinum

Despite increasing consumption for platinum metal, the strong U.S. dollar, low inflation and relatively high interest rates resulted in a significant decline in platinum prices during the first half of 1985. However, with the deterioration of the political situation in South Africa, which accounts for about 80 per cent of western world supply, increasing pressure on the dollar and the trend to lower interest rates, prices in the second half were sharply higher.

New York dealer prices for platinum, which averaged $US 273.90 per oz in January 1985, declined throughout the first half of the year to reach an average price of $264.38 in June. Thereafter, platinum increased in value with the average price in December reaching $334.18. At the end of 1985 platinum held a $15 premium over the price of gold. The average platinum price in 1985 was $291.47 compared to $356.82 in 1984.

Although figures are not available it was reported that there was a significant drawdown of platinum stocks during 1985.

Palladium

Palladium prices, like platinum declined throughout the first half of 1985 with the average price of the metal falling to $US 94.48 per oz in July from $US 121.29 in January. While the palladium market was generally stronger in the second half of the year, it was somewhat unsettled with an average price in December falling to $94.55. The average palladium price for 1985 was $US 105.76 as compared to $148.18 in 1984.

Other PGMs

Prices for rhodium, ruthenium and iridium and osmium like the two principal PGMs, fell during the first part of 1985. Although the political problems in South Africa resulted in a modest recovery for iridium and osmium, rhodium prices skyrocketed due to strong demand from the automobile industry and rumoured shortages.

Unlike platinum and palladium which are at least principal products in the case of South African production, the other PGMs including rhodium are all byproducts and as such, their supply is essentially inelastic.

Since the three-way platinum/palladium/rhodium automotive catalysts being proposed for the European Community, require a percentage of rhodium which is considerably higher than that typically found in PGM ores, the possibility of continued supply shortages cannot be ruled out.

Rhodium prices, which were between $US 460 and $475 per oz in January 1985 reached a low in July of between $375 and $400. Afterwards rhodium prices rose sharply and by the end of the year had reached $1,140. Meanwhile, iridium fell from $460-$475 in January to $375-$400 in July but recovered to the $420-$430 level by the end of December. While osmium prices were generally stable in the first quarter of the year, this metal did fall by about $150 per oz in the summer months to trade in the $800-$900 range by September. At the end of the year, osmium prices had recovered to the $850-$950 level. Ruthenium prices, which were $155-$165 in January 1985, declined through most of the year reaching a low of $68-$72 in October. During the remainder of the year, ruthenium increased slightly to the range of $70-$75 per oz.

USES

Platinum group metals are used in a wide variety of applications in pure form and in a host of alloys which require both the combination of different PGMs together or with other metals. The diversity of uses for these metals reflects their varied and unique attributes which include: chemical inertness and corrosion resistance, special magnetic properties, stable catalytic and thermoelectric properties, excellent reflectivity, stable electrical contact resistance and good high temperature oxidation resistance. The major uses of PGMs are in the automotive, jewelry, chemical, electrical, petroleum and glass industries.

One of the largest uses for PGMs, particularly platinum, is in the production of automobile catalysts. Although platinum is the principal PGM used in these catalysts, its importance in this application has been somewhat reduced owing to the substitution of lower priced palladium for at least some of the total PGM requirement. In addition to platinum and palladium, auto catalysts designed to control nitrous oxides as well as hydrocarbons contain rhodium. Depending on engine size, anywhere from 1.5 to 4.0 g of PGMs are contained in a single catalytic converter.

In addition to their use in controlling automobile exhausts, the production of lead free gasoline, which is required to avoid poisoning of auto catalysts, also uses PGM catalytic agents. Moreover, the injection of platinum into the combustion chamber of automobile engines is reported to increase fuel efficiency by up to 22 per cent. Also in the refining industry, PGM catalysts are used in hydrocracking and isomerization applications.

While the consumption of PGMs for automobile catalysts is largely in the United States, their use in jewelry, which constitutes the second largest use for platinum, is particularly large in Japan and has also been growing in the Federal Republic of Germany. Iridium and ruthenium are also widely used in jewelry.

In the chemical industry, PGMs are widely used as catalysts with the most important being platinum, ruthenium and palladium. Important specific applications include the production of nitric acid and hydrogen cyanide. PGMs are also used in the manufacture of equipment that is exposed to highly corrosive environments including anodes used in electrolytic manufacturing processes for such products as chlorine and caustic soda.

One of its major markets for palladium, is in the electronics industry where it is used in the manufacture of printed circuits, electrical contacts and electrical furnaces. In addition, PGMs and particularly palladium, are extensively used in the dental and medical field. The most important applications include dental alloys, orthodontic and prothodontic devices, hypodermic needles, electrodes, casings for pacemakers and as essential ingredients for certain chemotherapeutic agents used to treat certain cancers.

Other important applications for PGMs include: themocouples used for high temperature measurement; the manufacture of glass, glass fibre and synthetic fibres; fuel cells; permanent magnets; and catalytic applications in the pharmaceutical and food processing industries.

In addition to uses by industry or in the manufacture of jewelry, Rustenburg and Impala began in 1983 to market an array of platinum, wafers and small bars to stimulate investment demand. This also includes the platinum coin known as the Noble, which is legal tender on the Isle of Man.

OUTLOOK

Since no immediate solution to the political turmoil within the Republic of South Africa seems likely to occur, PGM prices will remain volatile even though production in that country may actually increase in 1986. Assuming no disruption in supplies, it is expected that industrial demand for platinum group metals will increase at about 3.5 per cent per annum in the next decade in view of expected increase in the number of new applications and more widespread use of these metals in existing areas.

Although there is some uncertainty whether the level of automobile sales achieved in 1985 will continue over the next few years, demand for PGMs in automobile catalysts is expected to remain strong in view of more widespread and stringent emission standards such as those that are scheduled for implementation in Europe beginning in 1988. In addition, emission regulations will become effective in Australia in 1986 while diesel engine standards are scheduled for North America in 1987.

While demand for palladium has slowed somewhat in 1985, this should pick-up in the next few years in view of the multitude of new applications, particularly in the electronics industry, which have been developed. While there is undoubtedly some concern about the growing dominance of the main supplier, the Soviet Union, there has been nothing to suggest that the strategy being pursued by the U.S.S.R. is governed by other than commercial motives. Assuming that palladium supplies remain adequate, increased platinum prices will undoubtedly result in the substitution of palladium for platinum whenever possible.

Canadian production of platinum metals is expected to be slightly lower in 1986 in view of a 10-week summer shutdown that has been announced by Inco. In the longer term, it is anticipated that Canadian output of PGM's will be slightly higher than the level recorded in 1985.

TARIFFS

Item No.	British Preferential	Most Favoured Nation	General	General Preferential
			(%)	
CANADA				
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
UNITED STATES (MFN)				
601.39 Precious metals ores		free		
605.02 Platinum metals, unwrought, not less than 90% platinum		free		

MFN Reductions under GATT (effective January 1 of year given)	1985	1986	1987
		(%)	
605.03 Other platinum metals, unwrought	11.2	9.7	8.2
605.05 Alloys of platinum, semi-manufactured, gold-plated	13.8	11.9	10.0
605.06 Alloys of platinum, semi-manufactured, silver-plated	7.9	7.2	6.5
605.08 Other platinum metals, semi-manufactured, including alloys of platinum	11.2	9.7	8.2
644.60 Platinum leaf	11.2	9.7	8.2

Sources: The Customs Tariff, January 1985. Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated 1985, USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241.

TABLE 1. PLATINUM METALS, PRODUCTION AND TRADE, 1983-85

	1983		1984		1985P	
	(grams)	($000)	(grams)	($000)	(grams)	($000)
Production[1]						
Platinum, palladium, rhodium, ruthenium, iridium	6 965 000	67,885	10 369 000	..	10 425 000	..
Exports					(Jan.-Sept.)	
Platinum metals in ores and concentrates						
United Kingdom	5 675 451	55,775	8 302 000	82,012	5 941 000	42,751
United States	81 243	834	163 000	1,523	92 000	597
Total	5 756 694	56,609	8 465 000	83,545	6 033 000	43,348
Platinum metals, refined						
United States	2 471 140	31,479	3 725 000	32,449	3 353 000	22,823
United Kingdom	352 931	2,426	179 000	1,834	988 000	6,304
Japan	30 046	575	-		-	-
Brazil	17 107	292	-		-	-
Other countries	4 106	45	3 000	15	109 187	877
Total	2 875 330	34,817	3 907 000	34,300	4 450 187	30,005
Platinum metals in scrap						
United States	906 169	11,728	1 831 000	29,127	875 000	12,408
United Kingdom	220 399	2,826	2 813 000	21,080	915 000	7,913
West Germany	-		420 000	5,478	22 000	125
Total	1 126 568	14,554	5 064 000	55,686	1 812 000	20,446
Re-export[2]						
Platinum metals, refined and semiprocessed	276 000	4,384	399 000	4,967	..	..
Imports						
Platinum lumps, ingots, powder and sponge						
United States	24 416	418	144 000	2,117	11 000	126
Switzerland	17 511	265	-		-	-
United Kingdom	10 047	162	213 000	3,399	105 000	1,430
Total	51 974	845	357 000	5,516	116 000	1,556
Other platinum group metals						
United States	347 768	1,902	295 000	2,197	182 000	855
United Kingdom	169 483	792	46 000	640	8 900	1,049
West Germany	-		-		-	-
Total	517 251	2,694	341 000	2,837	271 000	1,903
Platinum crucibles[3]						
United States	483 783	8,415	715 000	12,778	526 000	10,404
West Germany	-		-		187	3
Total	484 001	8,419	715 000	12,778	526 187	10,407
Platinum metals, fabricated materials, not elsewhere specified						
United Kingdom	406 833	5,168	145 000	2,396	85 000	1,170
United States	724 182	2,976	659 000	2,969	677 000	3,690
West Germany	6 874	118	21 000	156	14 000	150
Belgium-Luxembourg	-		-		-	-
Switzerland	-		-		-	-
Total	1 137 889	8,262	825 000	5,521	776 000	5,010

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Platinum metal, content of concentrates, residues and matte shipped for export. [2] Platinum metals, refined and semiprocessed, imported and re-exported in the same form as when imported. [3] Includes spinners and bushings.
P Preliminary; - Nil; .. Not available.

TABLE 2. PLATINUM SUPPLY AND DEMAND: WESTERN WORLD

	1980	1981	1982	1983	1984
			(000 grams)		
Supply					
South Africa	72 160	55 986	60 963	64 384	71 849
Canada	4 043	4 043	3 732	2 488	4 666
Others	933	933	933	1 244	1 244
	77 137	60 963	65 628	68 117	77 759
U.S.S.R. sales	10 575	11 508	11 819	9 020	7 776
Totals	87 712	72 471	77 448	77 137	85 535
Demand					
By region					
Western Europe	9 020	13 063	10 264	10 264	12 752
Japan	29 237	35 769	32 659	29 548	35 458
North America	30 481	21 772	22 083	22 395	27 060
Rest of western world	3 732	4 977	7 154	5 599	5 288
	72 471	75 581	72 160	67 806	80 558
Western sales to Comecon/China	933	933	933	622	933
Movements in stocks	14 308	(4 043)	4 354	8 709	4 043
Totals	87 712	72 471	77 448	77 137	85 535

Source: Johnson, Matthey Public Limited Company.

TABLE 3. PALLADIUM SUPPLY AND DEMAND: WESTERN WORLD

	1980	1981	1982	1983	1984
			(000 grams)		
Supply					
South Africa	27 060	28 304	25 505	24 572	29 548
Canada	5 288	4 977	4 977	3 421	5 910
Others	1 866	2 177	2 177	2 488	2 799
	34 214	35 458	32 659	30 481	38 257
U.S.S.R. sales	38 568	44 478	48 210	48 521	52 565
Totals	72 782	79 936	80 869	79 003	90 822
Demand					
By region					
Western Europe	10 264	9 331	10 886	14 619	17 107
Japan	21 461	25 505	27 682	37 946	41 990
North America	26 127	25 505	26 438	25 816	31 103
Rest of western world	5 288	4 666	5 599	5 599	6 221
	63 140	65 006	70 605	83 979	96 421
Movements in stocks	9 642	14 930	10 264	(4 977)	(5 599)
Totals	72 782	79 936	80 869	79 003	90 822

Source: Johnson Matthey Public Limited Company.

TABLE 4. PLATINUM DEMAND BY APPLICATION

	1980	1981	1982	1983	1984
			(000 grams)		
Western World					
Auto	21 150	19 906	20 062	19 129	22 550
Chemical	8 087	7 776	8 087	7 620	9 020
Electrical	6 532	5 754	5 288	5 443	5 910
Glass	4 354	3 110	2 644	3 266	4 354
Hoarding	-	-	1 400	2 799	5 288
Jewellery	17 418	23 483	23 794	22 239	24 105
Petroleum	4 043	4 354	2 022	622	467
Other	10 886	11 197	8 864	6 687	8 864
Total	72 471	75 581	72 160	67 806	80 558
Japan					
Auto	6 532	5 910	5 288	5 288	5 288
Chemical	311	311	311	311	467
Electrical	467	467	622	622	933
Glass	1 244	1 555	1 400	1 866	2 333
Hoarding	-	-	-	156	467
Jewellery	13 686	19 440	19 284	17 418	19 440
Petroleum	467	467	467	467	622
Other	6 532	7 620	5 288	3 421	5 910
Total	29 237	35 769	32 659	29 548	35 458
North America					
Auto	13 686	13 374	14 152	13 063	16 174
Chemical	3 577	1 555	2 488	3 110	4 043
Electrical	4 510	2 177	2 177	2 799	2 955
Glass	1 555	622	311	467	933
Hoarding	-	-	1 244	1 244	933
Jewellery	467	467	467	467	467
Petroleum	4 354	1 711	622	467	467
Other	2 333	1 866	622	778	1 089
Total	30 481	21 772	22 083	22 395	27 060
Rest of western world including Europe					
Auto	933	622	622	778	1 089
Chemical	4 199	5 910	5 288	4 199	4 510
Electrical	1 555	3 110	2 488	2 022	2 022
Glass	1 555	933	933	933	1 089
Hoarding	-	-	156	1 400	3 888
Jewellery	3 266	3 577	4 043	4 354	4 199
Petroleum	(778)	2 177	933	(311)	(622)
Other	2 022	1 711	2 955	2 488	1 866
Total	12 752	18 040	17 418	15 863	18 040

Source: Johnson Matthey Public Company Limited.
- Nil.

TABLE 5. PALLADIUM DEMAND BY APPLICATION

	1980	1981	1982	1983	1984
			(000 grams)		
Western World					
Auto	9 331	8 398	9 020	9 331	10 575
Dental	16 174	14 930	18 351	25 505	29 859
Electrical	18 351	24 883	26 127	34 525	39 190
Jewellery	5 599	6 532	6 843	5 599	5 910
Other	13 686	10 264	10 264	9 020	10 886
Total	63 140	65 006	70 605	83 979	96 421
North America					
Auto	4 666	4 043	4 043	4 666	5 910
Dental	6 221	6 532	8 087	8 709	10 575
Electrical	9 953	10 264	9 953	9 020	10 575
Jewellery	311	311	311	311	311
Other	4 977	4 354	4 354	3 110	3 732
Total	26 127	25 505	26 749	25 816	31 103
Japan					
Auto	4 666	4 354	4 977	4 666	4 666
Dental	6 843	4 977	5 910	9 020	10 264
Electrical	4 977	11 197	12 130	20 839	22 706
Jewellery	1 244	1 866	1 866	933	1 244
Other	3 732	3 110	2 799	2 488	3 110
Total	21 461	25 505	27 682	37 946	41 990
Rest of western world including Europe					
Auto	-		-	-	-
Dental	3 110	3 421	4 354	7 776	9 020
Electrical	3 421	3 421	4 043	4 666	5 910
Jewellery	4 043	4 354	4 666	4 354	4 354
Other	4 977	2 799	3 110	3 421	4 043
Total	15 552	13 997	16 174	20 217	23 328

Source: Johnson Matthey Public Company Limited.
- Nil.

TABLE 6. WORLD PRODUCTION OF PLATINUM METALS, 1980-85

	1980	1981	1982	1983	1984	1985^{e}
			(tonnes)			
U.S.S.R.	101.1	104.2	108.9	112.0	115.0	116.0
Republic of South Africa	96.4	96.7	80.9	80.9	90.2	105.0
Canada	12.8	11.9	7.1	7.0	10.4	10.4
Others	2.7	2.8	3.1	3.5	3.6	3.7
Total	213.0	215.6	200.0	203.4	219.2	235.1

Sources: American Bureau of Metal Statistics, U.S. Bureau of Mines and Energy, Mines and Resources Canada.
^{e} Estimated.

Potash

G.S. BARRY

Production and shipments of potash to all markets in 1985 were lower than in 1984. Production was down 14.4 per cent and shipments were down 0.5 per cent. The volume of shipments to North American markets was disappointingly low in the spring fertilizer season but particularly in the fall season, mainly because there is no relief in sight from low demand and abnormally low prices for crops in the United States. Emerging from the shadow of the P-I-K program, producers at the beginning of 1985 expected good fertilizer sales and run the mines at full capacity for a few months. Thus, there was a very rapid buildup of inventories, which reached a high of 1 876 400 t at the end of the first quarter. Poor spring sales therefore necessitated summer shutdowns. The inventories declined gradually to 1 520 400 t at the end of the third quarter. However, both the North American demand and offshore exports remained low and inventories rose again to 1 766 000 t by the end of 1985.

Export volumes throughout 1985 remained at normal levels to all traditional markets except China. Although China imported from Canada about 30 per cent of the expected tonnage, this was at the beginning of the year and in fact represented volumes contracted in 1984. In 1985 China issued practically no new orders for potash from any source. The withdrawal is thought to be temporary, caused by oversupply during the preceding two years and due to major transportation and distribution problems. Other factors were the removal of fertilizer subsidies, the decentralization of decision making and hard currency problems.

The average value of potash fob mines in 1984 was $Cdn 108.90 per t K_2O compared to $Cdn 102.60 in 1983. The price in 1985 was estimated at $Cdn 103 per t K_2O. The average export price calculated of fob port of exit or border crossing was $Cdn 158.18 in 1983; $Cdn 172.20 in 1984 and $Cdn 163.75 in 1985 (the last based on 9 months export data.) The average net realization per t in the first nine months of 1985 was 5.5 per cent below that of the previous year.

Employment in the Saskatchewan potash industry was 4,022 in 1985 compared to 3,900 in 1984 and 3,797 in 1983. In New Brunswick direct employment by two companies was 682 plus 127 on contract on surface construction and underground development.

For short periods in the summer and fall all conventional potash mines in Saskatchewan closed for maintenance, vacation and on a limited lay-off basis. All the conventional mines except one also scheduled closures over the Christmas-New Year period.

DOMESTIC DEVELOPMENTS

At the end of 1985, Canadian installed potash production capacity was 9 275 000 t in Saskatchewan and approximately 500 000 t in New Brunswick. The largest share of capacity, 42.0 per cent, is held by Potash Corporation of Saskatchewan (PCS), a provincial Crown corporation, followed by 19.2 per cent for International Minerals & Chemical Corporation (IMC) the largest private producer in the western world.

The Potash Corporation of Saskatchewan recorded a net profit of $25.3 million in 1984 and a loss of $21.0 million in the first nine months of 1985. There was no improvement in the fourth quarter so the loss for 1985 will be higher. The five divisions of PCS Mining produced 1 979 000 t of potash (K_2O) in 1985 compared to 2 745 000 t in 1984. The outlook for part of 1986 is not much better since the company is likely to operate at only 60 to 70 per cent of its newly expanded capacity and potash prices will remain low.

PCS total employment at the end of 1985 was 1,756 compared to 1,917 at year-end 1984. The company closed its Cory mine from April 9 to 22; June 4 to 17; and June 30 to September 2. The Lanigan mine was closed April 29 to May 26 and June 30 to September 3 and the Rocanville mine from June 2 to 16; and June 30 to September 2. All of the PCS mines will be closed from December 21, 1985 to January 5, 1986, except Lanigan that re-opened December 27.

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The PCS Esterhazy division conforms to the closures of the IMC mine from which it receives 25 per cent of the output. Contrary to what has been reported in the Saskatchewan press PCS did not experience disproportionate closures as compared to other private mines. Furthermore, the company ended 1985 with less potash inventory per unit of capacity than the provincial average which was equivalent to 19 per cent or 2.3 months of supply. High inventories have a detrimental effect on market conditions.

PCS continues to operate all but one of its mines of a 10-day per fortnight schedule, thus reducing one shift per week from the traditional four shifts per week schedule. The surface plant however remains on a continuous schedule.

The Rocanville mine was also closed from December 18, 1984 to March 7, 1985 as a result of a major brine leak which occurred on November 18. Efforts were successful in placing a 26.5 meter concrete bulkhead in the affected entry and the water inflow was stopped. Subsequently cement was pumped behind the bulkhead to fill in the entire end of the drift. Pressures behind the bulkhead are stabilized. By the end of 1985, PCS announced that its major expansion at Lanigan is 97 per cent completed and at a cost below $400 million, which is considerably below the originally estimated $475 million. The capacity of the Lanigan mine was raised from 690 000 tpy to 1 740 000 tpy. The new concentrator (refinery) will be put into operation in January 1986. The Lanigan mine, however, is not expected to operate at full capacity in 1986, therefore it has been credited with a nominal capacity of 1 240 000 tpy for 1986 in the accompanying table.

The 30 000 tpy Sulphate of Potash Demonstration Plant was completed in 1985 and will be commissioned as a commercial division of the Cory mine as of January 1986. PCS also announced its intention to proceed with a 300 000 tpy potash sulphate plant at Big Quill Lake 160 km east of Saskatoon. Field testing, environmental studies and a feasibility study are in progress and largely completed and a decision is expected in early 1986. Such a plant would cost just under $100 million.

The International Minerals & Chemicals Corporation (IMC) reports Saskatchewan potash reserves in its Annual Report ending June 30, 1985 at 1 338 million t averaging 25 per cent K_2O. The company mined 8 million t in fiscal year 1985 and produced over 3 million t of product. The average realized price for potash was $US 53 per s.t. compared to $US 58 per s.t. in 1984. IMC closed its K1 and K2 mines from June 15 to July 11 and from December 8 to 15. The company also scheduled closures of both mines from December 22 to January 13, 1986 and for two more, two-week periods later in the first quarter of 1986. However, as a result of a brine leak in late December that forced the temporary closure of the K2 mine, the K1 mine was re-opened earlier, on January 6, 1986.

Flooding in a disused section of the K2 mine started between December 24 and December 29 the day when it was discovered. The water was pouring at a presumed rate of over 3 700 litres a minute, which was about one quarter of the flow encountered at the Rocanville mine in late 1984. The brine will be pumped to surface starting in the week of January 6-11. The K2 mine will be closed for an indefinite time until the water problem is brought under control. While the mine is shut just a little above half of the capacity is idle.

Cominco Ltd. produced 1 034 000 t (KCl) in 1985 compared to 1 235 000 t in 1984. The company closed its Vanscoy mine from July 28 to September 9 and from November 9 to 25. It also scheduled closure from December 20 to January 5. During the year the company added a fifth mining machine and its capacity was revised from 655 000 tpy K_2O to 816 000 tpy K_2O.

Central Canada Potash, a subsidiary of Noranda Inc., produced 1 000 000 t (KCl) in 1985 compared to 1 074 000 t (KCl) in 1984. The company closed its Colonsay mine from August 4 to October 7 and scheduled an indefinite closure from December 21, 1985 to at least the end of January 1986. The company is currently re-examining its options for expanding capacity in the late 1980s.

Kidd Creek Mines Ltd. was purchased from the Canada Development Corporation (CDC) by Falconbridge Limited, March 1. CDC will receive from Kidd Creek its 40 per cent interest in the Allan potash mine (60 per cent - PCS). It is expected that the mine will continue to be operated by PCS and that CDC will also continue to use Texasgulf Inc. as the sales agent in the United States for their potash.

Ideal Basic Industries, Inc. agreed to sell its subsidiary Potash Company of America (PCA) to Rio Algom Limited. Rio Algom will pay $US 9 million in cash and assume $US 106 million in PCA loans, releasing Ideal Basic from all loan guarantees. Rio Algom thus purchased two producing potash mines at a cost which is a fraction of replacement value. The Saskatchewan Patience Lake mine was operating fairly satisfactorily throughout the year. The company closed the mine for maintenance between July 13 and August 6 and for inventory control between August 21 and September 16. During most of the second half of the year the Patience Lake mine was operated at 80 per cent of capacity. PCA lost money in 1985 principally due to continuing problems at their new mine in New Brunswick. Ideal Basic operated a third potash mine in New Mexico, which also lost money but it was not part of the PCA-Rio Algom deal.

Kalium Chemicals, a division of PPG Canada Inc. continued work on the expansion at the Belle Plaine Mine 80 km west of Regina. The capacity will be increased from 1 055 000 t to 1 300 000 t K_2O at a cost of approximately $100 million. Completion is scheduled for the end of 1986. During expansion, improvement to the process will be carried out principally raising energy efficiency, returning a larger proportion of waste salt to underground cavities and the installation of compaction machines. During 1985, Kalium closed half of its mine for one week, twice for maintenance. The company also operated at reduced capacity levels for the second half of 1986 for inventory control.

For the period in effect from July 1, 1979 to June 30, 1984 the Saskatchewan potash producer paid resource revenues to the province under separate but similar agreements known as the "Potash Resource Payment Agreement" (PRPA). The payment system was described in detail in the 1980 potash review. The private potash companies felt that the provisions of these agreements require some improvements and hoped to negotiate a better five-year term with the new provincial government. First, the previous agreement was extended for six months to the end of 1984. Subsequently, the agreement was extended for another two years to the end of 1986 with new tax incentives for Research and Development and market development. The province agreed to grant a tax credit of 40 per cent against PRPA payments up to an annual total of $5 million ($10 million for two years). This should generate up to $25 million in R & D spending by industry. During the past six and a half years the Province of Saskatchewan collected approximately $750 million from the potash industry under PRPA.

In Manitoba, two concession areas are potential sites for future potash mines. IMC suspended further planning and consultations with the provincial government on their site until market conditions improve. Meanwhile on the second site, Canamax Resources Inc., a subsidiary of AMAX Inc., and the Manitoba government completed a feasibility study in 1985 for a 1.8 million tpy (KCl) potash mine. Reserves are approximately 440 million t grading better than 25 per cent K_2O. If a positive decision is made, a mine with a capacity of about 1.2 million tpy K_2O could be in production in the 1992-95 period. Costs of construction in 1984 dollars would be in excess of $500 million. During the year the Manitoba government and Canamax had talks with major consumers in India, China, South Korea and Japan with the objective of offering equity participation in this development.

In New Brunswick the Potash Company of America (PCA) continued to operate its Sussex Mine considerably below the 380 000 tpy capacity levels during 1985. Major improvements particularly in the surface plant were completed, however all mining problems and the requirements for conditional surface tailings storage will not be resolved until the company commits some $30 million in additional capital. The new owners, Rio Algom Limited are committed to take the necessary steps in this direction after the ownership changeover in January 31, 1986. The Sussex Mine was originally designed for a capacity of 545 000 K_2O and with additional capital expenditures in the late 1980s or early 1990s it can rapidly be upgraded to this capacity in response to anticipated better market conditions for eastern Canadian potash.

The Denison-Potacan Potash Company brought into production its Clover Leaf Mine near Salt Springs in July 1985, slightly ahead of schedule at a cost of approximately $425 million. The financial arrangement included $125 million in equity and $300 million in loans from 19 syndicated international banks. The project financing was structured on a limited recourse basis.

Although the potash bed is gently slopping it is structurally more complex than the very flat Saskatchewan deposits. Soon after commercial start-up the company found it more economic to extract ore with two methods; about two thirds with continuous mining machines and one third with conventional blasting. Under the Potacan and Denison agreement, Denison acts as the production manager and Potacan is responsible for marketing their share of the product (40 per cent) as well as Denison's share (60 per cent). Next year, 1986 will be a transition year and it is expected that the mine will achieve full capacity capability by 1987. Reserves at the Clover Leaf Mine are 254 million t and of high grade ore of which 45 million t and grading 28.5 per cent K_2O was outlined through underground exploration.

BP Resources Canada Ltd. (Selco Division) completed a drilling program on its Millstream concession near Sussex in 1983. The company encountered beds of potash at depths between 950 and 1 151 m. Tonnage and grade indications on two mineable beds are very good. In 1984, a pilot hole for a shaft was completed without encountering any problems. In early 1985, BP applied for a mining lease that was signed on July 29, 1985. The terms of the lease call for a minimum production of 500 000 tpy by July 29, 1993. BP is expected to make a decision on sinking of an exploration shaft sometime in 1986.

Potash bearing intersections were also reported in Nova Scotia where two companies did some limited drilling in the Bras d'Or Lake area. There are also some indications of potash presence in the saline formations along the west coast of Newfoundland and on the Madeleine Islands of Quebec.

A Canadian firm, Rayrock Resources Limited of Toronto acquired a 25 per cent ownership of a potash mine in Carlsbad, New Mexico, United States. The mine was sold by Potash Producers Incorporated; a subsidiary of Pennzoil Company, to Warburg Pincus Capital Parterns, a venture company of New York (75 per cent) and Rayrock (25 per cent) and will be operated under the name Western Ag-Minerals Co. The Carlsbad operation is one of two worldwide sources of langbeinite, a rare form of potash containing three essential plant nutrients - potassium, magnesium, and sulphur, marketed under the trade name K-Mag fertilizer.

INTERNATIONAL DEVELOPMENT

World production in 1985 is estimated at 28.0 million t K_2O a 3.8 per cent decline from 1984. Production in the U.S.S.R. is variously estimated at between 9.5 and 10.0 million t. The world decline was essentially due to the 1.0 million t reduction in the Canadian production.

Brazil - PETROBRAS Mineracao S.A. (PETROMISA) officially opened the Taquari-Vassouras potash mine in the Sergipe district in March 1985. However as of the end of 1985 all the mining equipment was not yet in place and commercial sales were not made. PETROMISA holds another interesting potash deposit near Fazendinha in the Amazonian basin. The deposit has an areal extent of 130 km^2 an average thickness of 2.7 m and lies at a depth of 980 m to 1 140 m. Total reserves are estimated at 560 million t grading about 27 per cent KCl. In 1984, a $700,000 feasibility contract was awarded to a joint venture consisting of Paulo Abib Engenharia, Mines de Potasse d'Alsace and Patrick Harrison & Company Limited, a Canadian firm. Phase I of this study outlining development options was completed in September 1985 and Phase II comprising a more detailed engineering feasibility is expected to be given the green light for a start during 1986.

Chile - Amax Chemical Corporation jointly with Molibdenos y Metales S.A. (Molymet) were the front runners in a bid issued by Corporacion de Fomento de la Production to develop the potash-lithium-boric acid deposits of the Salar de Atacama. The companies expect to sign the final agreement in the first half of 1986. The target size of the project is 500 000 tpy KCl, 200 000 tpy K_2SO_4, 30 000 tpy of boric acid and an undetermined amount of lithium, the last depending on demand. Following successful field testing and a feasibility study, production could become a reality by the mid-1990s.

China - A small potash plant, serving local markets exists at the eastern part of a dry lake, Lake Chaerhan in the Guinghai province. Output is about 40 000 tpy (KCl) of low-grade product grading between 45 and 50 per cent K_2O. Brines are pumped into solar ponds from trenches dug into the dry salt lake surface. Concentrated salts from the solar ponds are subject to rough flotation producing the low-grade product.

Currently, construction began on additional solar ponds that will eventually provide the raw material for a nearby plant of 200 000 tpy (KCl) capacity to be completed by 1988 or 1989. This plant will in fact be a times-five scale up model of the existing plant, based on Chinese technology. Western harvesting machine for the solar pond potash will be ordered. The Chinese are also interested in contracting a feasibility study on a 800 000 tpy (KCl) plant for the west end of Lake Chaerhan to be based on western technology that would yield a high-grade product for markets outside western China. Such a plant would require $500 to $600 million in investment and is not likely to be completed earlier than in mid- to late-1990s.

Ethiopia - A two-year feasibility study on potash production in the Danakil Depression by Entreprise Minière et Chimique for the Ethiopian-Libyan Mining Co. was in progress in 1985. The region produced some carnallite before the Second World War. In 1965 and 1966 a shaft was sunk at Musley into sylvinite beds by the Ralph M. Parsons Company of the United States but the 500 000 tpy project was abandoned in 1968.

France - Production in 1985 was at the same level as in 1984. Mines de Potasse d'Alsace (MPDA) intends to close the Theodore mine in March 1986 which will result in a net decline in French potash production of about 100 000 t K_2O in 1986. During 1985, a new flotation plant was installed at Amelie and is scheduled for start-up in the spring of 1986. The Theodore flotation plant will be kept active until the Amelie flotation circuit is fully operational. The company completed a study on brine disposal in deep wells and submitted it to the government for consideration during 1986.

German Democratic Republic (GDR) - Production from eight mines in the GDR for the past few years has been more or less steady. In 1984, production was 3.46 million t K_2O but in 1985 and 1986 production is expected to be about 100 000 t less. It has been reported that for environmental reasons West Germany will finance the installation of a flotation plant at one of GDR mines to reduce common salt emission into an adjacent river that flows into West Germany.

GDR currently exports approximately 2.85 million t K_2O of which 55 per cent is to market economies and China and 45 per cent to other COMECON countries.

Germany, Federal Republic of - Kali und Salz AG is the sole producer of potash in Germany. Production in 1985 was below the record level reached during 1984 as the company temporarily closed a mine during the summer period and closed all of its mines for the Christmas period with an extension to mid-January 1986. Production is expected to be kept at about 80 per cent of capacity for the first half of 1986 in response to the continuation of poor export demand and low prices. Grades in the K & S mines are one of the lowest in the world, varying between 8 and 12 per cent K_2O. In 1984, 31 million t of new potash ore was extracted to produce 2 645 000 t of K_2O for an average yield of 8.5 per cent.

Israel - After the completion of an expansion program the Dead Sea Works Ltd. potash plant at Sdom reached a capacity of 2.1 million tpy KCl equivalent to 1.28 million tpy K_2O. The DSW units comprise 250 000 tpy of flotation product, 1 million tpy from the hot leach plant and two cold leach units of 450 000 tpy each. DSW temporarily closed the high cost flotation unit in April 1985 and the company intends to keep it closed until March 31, 1986, because of depressed market conditions. This closure will reduce production by about 10 per cent for the fertilizer year 1985-86. DSW transports most of its product by trucks and train to the port of Ashdod and some through the port of Eilat on the Red Sea. Between 1984 and 1987 the company will construct a conveyor belt from Sodom to Nahal Zin that will link to existing rail and replace costly truck haulage on steep grades. The transport project costs are approximately $37 million; Britain's Cable Belt Ltd. will build the 18 km conveyor.

In the longer term, DSW plans a further increase in capacity to 2.3 million tpy KCl and a potassium sulphate plant of 150 000 to 300 000 tpy using a process being currently developed by a subsidiary of Israel Chemicals Ltd.

Jordan - The Arab Potash Co. Ltd. (APC) made slow but steady progress toward full capacity utilization of its Dead Sea potash plant. Production in 1985 was estimated at 932 000 t KCl compared to 486 868 t produced in 1984. Output should increase in 1986 to approximately 1.0 million t but full capacity will not be reached until modifications are made to the plant as well as to the solar ponds system. In late 1985, APC invited international bids for plant modifications in excess of $5 million.

Mexico - Fertilazantes de Mexico SA has reactivated its potash project at Cerro Prieto near Mexicali on the California border. The extraction will be from brines, using as energy geothermal steam available nearby. The projected capacity is 80 000 tpy KCl to be completed by 1987 or 1988. A byproduct capacity of 125 000 tpy of common salt and 81 000 tpy of calcium chloride is also envisaged.

Spain - Potassas de Navarra SA, a subsidiary of Instituto Nacional de Industria (INI) closed its Pamplona mine as of December 31, 1985. The mine had a theoretical capacity of 325 000 tpy but in the last few years operated substantially below capacity. With the objective of maintaining employment and continuing some production in the district, preparations were made to open the nearby Subiza deposit. A new company was formed, Potasas de Subiza which will be owned 50 per cent by INI and 50 per cent by the local government, El Gobierno Foral de Navarra. About 600 employees will be retained from the 2,000 that once worked for Potassas de Navarra. The companies will invest about 1.5 billion pesetas ($US 10 million) to bring Subiza on stream. The capacity of the new mine will be 105 000 tpy. INI also has a 51 per cent interest in Minas de Potasas de Suria S.A. The company plans to expand capacity by 50 000 tpy K_2O to 220 000 tpy K_2O at the Suria mine by 1986. As the mining will be concentrated in the Catalonia district, there is a possibility of opening a new mine between Suria and Llobregat in the more distant future. Explosivos Rio Tinto S.A. also plans to substantially increase investments in its Cordona and Llobregat mines so that by the end of this decade a substantial part of the lost capacity will be restored.

Thailand - Thailand has two potash bearing saline basins, the Khorat and the Sakhon-Nakhon basins. The Department of Mineral Resources (DMR) started a pilot project in 1982 to demonstrate the feasibility of carnallite exploitation near Chaiyaphum in the Khorat Basin. An inclined access drift was sunk but had to be abandoned because of high water inflow in 1983. In December 1985 DMR announced that it reviewed the mining project with the possibility of going ahead. In 1984 two potash concessions were awarded. One to Thai Potash Co. Ltd. (CRA Ltd. - Duval Corporation - Siam Cement) on 3 500 km^2 and the other to Thai Agrico Potash Co. Ltd. (Agrico Chemical Co. - Thai Central Chemical) on 2 333 km^2. Each company is committed to spend on exploration $US 3 million over a five-year period. The Thai deposits present a geological challenge since the disposition of sylvinitic ore is discontinuous in predominantly carnallitic potash formations.

United States - Production in 1985 declined to approximately 1 300 000 t K_2O, a decline of 17 per cent from 1984. The decline was more pronounced in the second half of 1985. About 85 per cent of production came from five underground mines in New Mexico where the average ore grade was 13.4 per cent K_2O (crop year 1984-85) compared to 13.2 per cent K_2O in the previous crop year. The remaining production is from a solution mine in Utah and brine operations in Utah and California.

Of the two brine potash producers in Utah, Kaiser Aluminum & Chemical Corporation restarted its potash plant after one year closure and Great Salt Lake Minerals & Chemicals Corp. was rehabilitating its solar ponds system and expects to be shut down until the late 1980s. Secondary potassium sulphate production from the muriate of potash is on an increase with Permian Chemicals at Odessa, Texas, adding a new reactor and raising its capacity from 35 000 tpy to 50 000 tpy. Climax Chemical at Grantsville, Utah shifted its production to potassium sulphate from sodium sulphate. The plant has a capacity of 60 000 tpy product.

PPG Canada Inc. completed the construction of test facilities at their Hersey site in Michigan in August 1985 under a $5 million program which will test the feasibility of solution mining of potash beds that occur at a depth of 7,000 to 8,000 ft in the Michigan salt basin. Favourable results could lead to construction of a 425 000 tpy K_2O plant by the late 1980s or early 1990s at a cost of about $250 million.

Amax Chemical Corporation reduced its nominal plant capacity at the Carlsbad mine in mid-1985 and closed the mine for an indefinite period on October 7, 1985. At the beginning of 1986 the company still had no plans to reopen. The Duval Corporation sold its Carlsbad langbeinite mine to Western Ag-Minerals Co. A Canadian company, Rayrock Resources has a 25 per cent ownership. Kerr-McGee Corporation sold its sylvinite mine at Hobbs to a longtime customer of the company, White Chemical

Product. The mine will be operated at half of its former capacity under the name of New Mexico Potash Corp. The Carlsbad mine of the Potash Company of America was sold to Lundberg Industries Inc., for $12 million. The mine will continue to operate at a reduced capacity level. As of the end of the year the mine was shut down for inventory control.

Between 1986 and 1991 three U.S. potash mines including two underground mines in the Carlsbad area are expected to close permanently, reducing U.S. capacity to around 800 000 tpy K_2O. Thereafter, if the PPG solution mine in Michigan is brought on-stream, U.S. capacity will return to the 1.2 million tpy level.

On March 30, 1984, Amax Chemical Corporation and the Kerr-McGee Chemical Corporation filed a petition with the International Trade Commission (ITC) alleging that subsidized producers in Israel, the German Democratic Republic, Spain and the U.S.S.R. are dumping potash in the United States. These allegations were two-pronged; countervailing duties (CVD) were sought on account of subsidies and ad valorem duties (A/D) were sought for dumping. In May 1984, ITC issued a preliminary ruling in favour of the plaintiffs. However, the CVD action against the U.S.S.R. and GDR was dismissed by the Department of Commerce on grounds that bounties or grants within the meaning of Section 303 of the Tariff Act of 1930 cannot be found in non-market economies. A net subsidy of 7.54 per cent for Spain and 8.71 per cent for Israel were preliminarily determined in June; these CVD were subsequently reduced and finally dropped when on October 22, 1984, ITC ruled no injury. On the A/D action the Department of Commerce found dumping margins of 187.03 per cent for the U.S.S.R.; 112.12 per cent for GDR; 43.65 per cent for Spain; and minimal for Israel. On January 31, 1985, the Department of Commerce made final determinations with respect to all the A/D investigations and all were fund negative except the U.S.S.R. in which case the dumping margin was found to be only 1.77 per cent. However, on July 30, 1985 the U.S. Court of International Trade instructed the Department of Commerce to resume its dumping investigations against the U.S.S.R. and GDR on grounds that the CVD law applies equally to countries with non-market economies. The investigation was still in progress at the end of 1985.

U.S.S.R. - The U.S.S.R. is the world's leading producer of potash and the second largest exporter after Canada. In 1984 the U.S.S.R. exported 3 155 600 t K_2O of which 32 per cent was to market economies and China and 68 per cent to COMECON countries. Exports in 1985 were slightly lower. The Soviet potash industry is expanding and approximately 1.0 million t of capacity will be added over the next four years. It is surmised that all of the additional production will be directed towards domestic consumption. The U.S.S.R. currently extracts approximately 75 million t of crude ore for a production of 9.5 million t K_2O for an average recovery of 12.7 per cent.

United Kingdom - Cleveland Potash Ltd. produced approximately 330 000 t K_2O in 1985. The company doubled its compaction capacity to 240 000 tpy and completed the installation of a pilot facility to recover potash from brines. The unit is working quite well; it is based on a refrigeration technique whereby potash crystals are separated from the frozen brine. The pilot plant has a capacity of 9 000 tpy, it could be expanded to 27 000 tpy in the future.

PRICES

Typical contract prices for Canadian potash product (standard grade) moving out of Vancouver were $US 79 to $83/t at the beginning of 1985; $76 to $80 at mid-year and declined to $74 to $77 at the end of the year. Prices for delivery in the United States were $US 66/t ($60/s.t.), $55/t in mid-year and $47/t in the fall and $39/t at the end of the year. The price at the end of the year was the lowest price experienced for Canadian potash since production started in the early 1960s in constant 1985 US dollars. Prices are expected to increase moderately in 1986.

OUTLOOK

Toward the end of 1985, North American prices were very weak and sale volumes low. The high year-end inventories weighed on the market. However, inventories will be reduced by closures of the potash mines for an average of two weeks during the Christmas-New Year season. Furthermore, it is expected that the K2 mine of IMC will be out of production at least for several weeks and the potential loss in production will be more than 100 000 t per month.

The wet weather in the fall of 1985 contributed significantly to below-expectation fertilizer applications and this should lead to a stronger spring season as reductions in acreage under cultivation in 1986 should in part be compensated by higher potash application per acre. This scenario suggests that prices should rise by 10 to 20 per cent during 1986.

In the international sector, producers expect normal demand from all countries, with the strong possibility that China will be back in the potash market sometime in 1986.

Prospects for 1987-1988 are better as large acreage reductions in the United States are not expected. Additional markets will be open for Canadian producers as a result of further closures of U.S. mines.

In general for the remaining 1980s the supply of potash will be fully adequate and the expected rise in world demand, averaging about 2.5 per cent per year, will allow for a gradual return to full capacity utilization at all the Canadian mines. It will be the early 1990s before new additions to capacity will be required, to start with on a modest scale and reaching perhaps 2 million t by 1995.

TABLE 1. CANADA, POTASH PRODUCTION, SHIPMENTS AND TRADE, 1983-85

	1983		1984		1985	
	(000 tonnes)	($000)	(000 tonnes)	($000)	(000 tonnes)	($000)
Production, potassium chloride						
Gross weight	9 702	..	12 768	..	..	..
K_2O equivalent	5 931	..	7 794	..	..	..
Shipments						
K_2O equivalent	6 294	645,767	7 527	867,480	6 923	642,054
	(tonnes)		(tonnes)		(tonnes)	
Imports, fertilizer potash						
Potassium chloride						
United States	2 270	1,205	1 768	889	707	622
United Kingdom	7	2	4	1	-	-
Total	2 277	1,207	1 772	890	707	622
Potassium sulphate						
United States	15 411	3,297	10 138	2,377	27 654	2,831
France	-	-	-	-	3 001	846
Italy	-	-	-	-	182	48
Total	15 411	3,297	10 138	2,377	30 837	3,725
Potassic fertilizer, nes						
United States	47 367	6,257	68 185	6,796	33 687	4,794
Potash chemicals						
Potassium carbonate	1 555	904	1 757	1,063	1 170	738
Potassium hydroxide	2 936	1,990	2 936	2,089	2 620	1,777
Potassium nitrate	4 343	1,869	3 386	1,754	4 505	2,237
Potassium phosphate	1 729	2,190	1 954	2,644	2 074	2,456
Potassium silicates	813	621	684	561	4 744	3,945
Total potassium chemicals	11 376	7,574	10 717	8,111	15 113	11,153
Exports, fertilizer potash						
Potassium chloride, muriate						
United States	6 104 898	524,449	7 028 426	651,625	6 449 767	525,651
Japan	869 316	96,032	684 981	83,623	625 882	79,828
India	428 242	47,525	636 352	77,963	528 403	67,291
People's Republic of China	536 539	59,420	577 146	71,156	194 351	24,285
Brazil	287 419	34,249	487 068	60,232	425 011	53,123
South Korea	323 236	35,897	399 322	49,042	331 681	42,252
Australia	197 214	21,894	234 633	28,630	166 130	21,485
Singapore	118 260	13,128	226 679	27,827	136 401	17,828
France	48 790	5,118	180 650	17,353	102 236	12,577
Malaysia	37 352	4,131	101 784	12,730	153 160	18,465
Indonesia	16 480	1,853	94 151	11,277	179 050	23,009
Taiwan	86 227	9,538	80 851	9,723	64 767	8,472
Bangladesh	52 000	5,778	77 153	9,376	94 846	10,778
South Africa	55 451	6,142	55 582	6,834	41 501	5,414
New Zealand	41 021	4,540	51 183	6,323	20 089	2,590
Chile	39 977	4,430	44 022	5,378	36 251	4,455
Ireland	25 261	2,886	39 823	4,861	17 229	2,270
Philippines	61 586	6,819	36 993	4,543	21 642	2,811
Denmark	-	-	30 089	2,469	27 728	2,594
Mexico	-	-	30 000	3,597	63 025	6,673
United Kingdom	12 118	1,617	29 530	3,817	33 212	4,004
Other countries	70 518	7,870	88 554	10,353	90 098	10,494
Total	9 411 905	893,318	11 214 972	1,158,732	9 802 460	946,349

Sources: Statistics Canada; Energy, Mines and Resources Canada.
- Nil; .. Not available; nes Not elsewhere specified.

TABLE 2. CANADA, POTASH PRODUCTION AND SALES BY GRADE[1] AND DESTINATION, 1983 AND 1984

	1984						1983
	Standard[2]	Coarse	Granular	Soluble	Chemical[3]	Total	Total
	(tonnes K_2O equivalent)						
Production	2 338 470	2 603 396	1 993 630	739 184	74 017	7 748 696	5 928 850
Sales							
Canada	17 423	216 222	188 314	13 878	..	435 837	384 904
United States	373 521	2 044 040	1 111 170	559 122	..	4 087 853	4 145 850
Offshore							
Argentina	-	-	-	-	..	-	68
Australia	5 633	47 666	89 698	-	..	142 996	128 839
Bangladesh	42 546	-	-	-	..	42 546	49 898
Belgium	-	-	-	-	..	-	36 430
Brazil	79 704	38 212	150 593	-	..	268 509	214 622
Chile	20 105	-	-	-	..	20 105	31 281
China	419 555	-	-	-	..	419 555	446 297
Costa Rica	8 805	2 480	1 213	-	..	12 498	8 487
Denmark	9 165	-	-	-	..	9 165	-
France	109 350	-	-	-	..	109 350	15 090
Ghana	-	-	11	-	..	11	-
India	405 887	-	-	-	..	405 887	277 085
Indonesia	74 286	-	-	-	..	74 286	6 231
Ireland	-	-	41 572	-	..	41 572	15 323
Italy	-	-	-	-	..	-	8 911
Jamaica	1 698	5 286	-	-	..	6 985	2 585
Japan	158 272	61 974	27 270	135 782	..	383 298	348 240
Korea, South	228 893	-	-	11 516	..	240 409	190 734
Malaysia	126 786	1 853	-	-	..	128 639	86 338
Mexico	18 247	-	-	-	..	18 247	-
New Zealand	40 324	6 040	-	-	..	46 364	10 179
Nicaragua	-	-	9 555	-	..	9 555	-
Philippines	25 598	-	-	-	..	25 598	42 356
Romania	32	-	-	-	..	32	32
South Africa	6 242	-	21 472	-	..	27 714	22 389
Sri Lanka	42 173	-	-	-	..	42 173	31 699
Swaziland	-	-	-	-	..		17 445
Taiwan	68 340	-	-	-	..	68 340	34 627
United Kingdom	616	-	-	-	..	616	807
Offshore total	1 892 256	163 512	341 384	147 298	..	2 544 450	2 025 993
Total sales	2 283 200	2 423 774	1 640 868	720 298	..	7 068 140	6 556 747

Source: Potash and Phosphate Institute.
[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. [2] Standard includes Special Standard, sales of which were 140 406 t K_2O equivalent in 1983, and 190 265 t in 1984. [3] Chemical sales are included in standard grade sales and totalled 66 107 t in 1984.
- Nil; .. Not available.

TABLE 3. CANADA, POTASH PRODUCTION AND TRADE, YEARS-ENDED JUNE 30, 1966, 1971, AND 1976-85

	Production[2]	Imports[1,2]	Exports[2]
	(tonnes K_2O equivalent)		
1966	1 748 910	31 318	1 520 599
1971	3 104 782	26 317	3 011 113
1976	4 833 296	16 445	4 314 150
1977	4 803 015	24 289	4 175 473
1978	6 206 542	26 095	5 828 548
1979	6 386 617	21 819	6 256 216
1980	7 062 996	20 620	6 432 124
1981	7 336 973	35 135	6 933 162
1982	6 042 623	25 437	5 400 662
1983	5 378 842	21 846	4 864 219
1984	7 155 599	17 934	6 730 733
1985	7 283 509	17 396	6 784 178

Source: Potash and Phosphate Institute, Canadian Fertilizer Institute.
[1] Includes potassium chloride, potassium sulphate, except that contained in mixed fertilizers. [2] Change of data source. Prior to 1978 figures were obtained from Statistics Canada.

TABLE 4. CANADA, POTASH PRODUCTION AND SALES BY QUARTERS, 1985 AND 1984

	Total (1984)	1st quarter	2nd quarter	3rd quarter	4th quarter
	(000 tonnes)				
Production	7 748.7	1 952.4	1 718.7	1 141.5	1 823.9
Sales					
North America	4 522.8	1 119.9	1 173.4	1 026.4	1 019.5
Offshore	2 544.4	498.9	562.1	454.3	952.4
Ending Inventory	1 543.0	1 876.4	1 859.6	1 520.4	1 765.9

Source: Potash and Phosphate Institute.

TABLE 5. CANADA, POTASH SALES BY PRODUCT AND AREA, 1983 AND 1984

		Agricultural					Industrial			Total
		Standard	Coarse	Granular	Soluble	Total	Standard	Soluble	Total	Sales
		(tonnes K_2O equivalent)								
Alberta	1983	590	4 746	19 934	1 680	26 950	1 961	469	2 430	29 380
	1984	536	2 562	20 579	1 366	25 043	2 587	849	3 436	28 479
British Columbia	1983	-	217	5 687	32	5 936	-	-	-	5 936
	1984	19	612	4 848	49	5 528	-	-	-	5 528
Manitoba	1983	22	4 618	10 551	634	15 825	-	-	-	15 825
	1984	-	4 567	12 720	970	18 256	-	-	-	18 256
New Brunswick	1983	-	11 325	2 493	-	13 818	-	-	-	13 818
	1984	-	5 981	6 581	-	12 562	15	-	15	12 577
Nova Scotia	1983	276	4 668	-	-	4 944	-	-	-	4 944
	1984	47	441	4 056	-	4 544	-	-	-	4 544
Ontario	1983	902	189 111	6 253	1 407	197 673	2 953	2 824	5 777	203 450
	1984	178	164 842	54 682	2 340	222 042	3 349	4 767	8 112	230 160
Prince Edward Island	1983	401	4 783	5 192	-	10 376	-	-	-	10 376
	1984	494	-	5 941	-	6 435	-	-	-	6 435
Quebec	1983	500	51 941	31 705	-	84 146	318	-	318	84 464
	1984	1 380	34 825	71 879	69	108 152	37	-	37	108 189
Saskatchewan	1983	12	2 011	5 230	794	8 047	5 728	2 361	8 089	16 136
	1984	396	2 392	7 028	558	10 375	6 980	2 910	9 890	20 265
Newfoundland	1983	409	-	-	-	409	166	-	166	575
	1984	833	-	-	-	833	576	-	576	1 499
Totals	1983	3 112	273 420	87 045	4 547	368 124	11 126	5 654	16 780	384 904
	1984	3 883	216 222	188 314	5 352	413 770	13 540	8 527	22 067	435 842

Source: Potash and Phosphate Institute.
- Nil.

TABLE 6. CANADA, POTASH INVENTORY, PRODUCTION, DOMESTIC SHIPMENTS AND EXPORTS, 1984

	Beginning Inventory	Production	Domestic Shipments Agri-cultural	Domestic Shipments Non-agri-cultural	Exports United States Agri-cultural	Exports United States Non-agri-cultural	Exports Offshore	Total Shipments
					(000 tonnes K_2O)			
January	861.5	669.2	31.9	2.1	376.4	13.6	227.4	651.4
February	941.1	678.6	28.1	1.6	301.7	11.6	219.4	562.4
March	1 026.8	739.8	30.3	2.1	214.6	14.6	231.7	493.9
April	1 250.3	707.9	28.5	1.1	298.8	17.2	229.6	575.2
May	1 440.9	698.6	58.7	1.8	389.8	18.0	168.3	636.6
June	1 460.7	642.2	15.9	2.1	231.5	18.7	232.6	500.7
Sub-total		4 136.3	193.4	10.8	1 812.8	93.7	1,308.9	3 419.6
July	1 656.1	401.3	9.8	1.7	205.5	9.5	260.0	486.6
August	1 558.6	485.7	43.6	1.9	604.3	15.6	210.1	875.5
September	1 153.0	665.2	33.0	1.8	426.0	16.9	241.6	719.3
October	1 112.8	734.0	29.4	2.0	263.1	17.6	181.9	489.0
November	1 372.6	720.6	23.0	1.5	217.0	26.4	180.6	448.5
December[1]	1 555.4	605.5	86.5	2.4	366.1	15.4	161.6	632.0
Sub-total		3 612.3	220.3	11.3	2 082.0	101.4	1 235.8	3 650.9
Total 1984		7 748.6	413.7	22.1	3 894.8	195.1	2 554.7	7 070.5
1983		5 928.3	368.1	16.8	3 965.1	180.6	2 026.1	6 556.7
% change 1984/83		+30.7	+12.4	+31.5	-1.8	+8.0	+25.6	+7.8

Source: Potash and Phosphate Institute of North America.
[1] Inventory at the end of December 1984 was 1 543 000 tonnes.

TABLE 7. CANADA, POTASH INVENTORY, PRODUCTION, DOMESTIC SHIPMENTS AND EXPORTS, 1985

	Beginning Inventory	Production	Domestic Shipments Agri-cultural	Domestic Shipments Non-agri-cultural	Exports United States Agri-cultural	Exports United States Non-agri-cultural	Exports Offshore Total	Total Shipments
					(000 tonnes K_2O)			
January	1 543.0	643.9	43.2	2.4	440.2	16.5	143.7	646.0
February	1 634.0	592.9	12.8	2.0	305.0	13.3	203.1	536.2
March	1 684.5	715.5	35.9	1.5	265.8	14.7	152.1	470.0
April	1 876.4	656.0	38.3	1.2	513.6	22.2	187.8	763.1
May	1 805.4	550.9	65.8	1.7	478.2	17.2	198.3	761.2
June	1 699.0	511.8	11.7	2.3	201.9	15.0	176.0	406.9
Sub-total		3 671.0	207.7	11.1	2 204.7	98.9	1 061.0	3 583.4
July	1 859.6	314.5	4.6	2.6	147.5	10.3	113.8	278.8
August	1 735.6	338.0	19.9	1.6	400.1	17.8	163.6	603.0
September	1 587.0	489.0	29.0	1.7	398.6	13.3	176.8	619.4
October	1 520.4	680.2	45.2	2.3	269.6	18.4	160.9	496.4
November	1 654.2	635.5	18.0	2.0	169.8	15.4	111.1	316.3
December[1]	1 876.4	508.2	85.8	2.4	436.9	14.7	140.6	680.4
Sub-total		2 965.4[e]	202.5	12.6	1 822.5	89.1	866.8	2 994.3
Total 1985		6 636.4	410.2	23.7	4 027.2	188.0	1 927.8	6 524.3[e]
1984		7 748.6	368.1	16.8	3 965.1	180.6	2 026.1	6 556.7
% change 1985/84		-14.4	+11.4	+41.1	+1.6	+4.1	-4.8	+0.3

Source: Potash and Phosphate Institute of North America.
[1] Inventory at the end of December 1985 is estimated at 1 765 900 tonnes. Inventory changes are based on shipments an do not exactly match the sales and production records.
[e] Estimated by Mineral Policy Sector, Energy, Mines and Resources Canada.

TABLE 8. WORLD POTASH PRODUCTION

	1980	1981	1982	1983	1984P	1985e
			(000 tonnes K_2O)			
Canada	7 303	7 147	5 352	5 930	7 749	6 640
Chile	25	21	22	22	22	22
China	12	20	26	25	25	30
France	1 894	1 828	1 706	1 539	1 740	1 750
Germany Dem. Rep.	3 405	3 497	3 200	3 341	3 463	3 400
Germany, Fed. Rep.	2 737	2 591	2 057	2 419	2 645	2 550
Israel	797	832	946	942	1 127	1 050
Italy	102	125	115	133	127	140
Jordan	-	-	9	168	291	520
Spain	658	728	694	659	677	650
U.S.S.R.	8 064	8 449	8 079	9 294	9 400	9 600
United Kingdom	306	284	240	303	319	330
United States	2 239	2 156	1 784	1 429	1 564	1 320
	27 542	27 678	24 515	26 204	29 149	28 002

Sources: International Fertilizer Industry Association Ltd.; U.S. Bureau of Mines and Energy, Mines and Resources Canada.
P Preliminary; e Estimated; - Nil.

TABLE 9. CANADA POTASH, CURRENT SITUATION AND FORECAST

	Actual						Forecast	
	1980	1981	1982	1983	1984	1985e	1986	1990
				(000 tonnes K_2O)				
Capacity	7 895	8 060	8 520	9 165	9 315	9 775	10 655	11 730
Production	7 303	7 175	5 216	5 928	7 749	6 640	7 000	9 200
Capacity Utilization	92%	89%	61%	65%	83%	68%	66%	78%
Sales:								
of which: Domestic	378	332	283	385	436	400	420	500
United States	4 563	4 182	3 241	4 146	4 090	4 200	4 200	5 000
Offshore	2 170	1 823	1 577	2 026	2 545	1 940	2 400	3 700
End-year stocks	564	1 308	1 486	862	1 543	1 765	1 800	1 600
World Production	27 542	27 678	24 515	26 204	29 150	28 000	28 500	32 000
Canada/World Production Ratio	26.5%	26.0%	21.3%	22.6%	26.6%	23.7%	24.6%	28.8%

e Estimated.

TABLE 10. CANADA, POTASH MINES - CAPACITY PROJECTIONS

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
					(000 tonnes K_2O equivalent)							
PCS												
- Allen (60%)	570	570	570	570	570	570	570	570	570	570	570	570
- Cory	830	830	830	830	830	830	830	830	830	830	830	830
- Esterhazy (25% of IMC)	580	580	580	580	580	580	580	580	580	580	580	580
- Lanigan	690	690	1 240	1 740	1 740	1 740	1 740	1 740	1 740	1 740	1 740	1 740
- Rocanville	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160
Sub-total	3 830	3 830	4 380	4 880	4 880	4 880	4 880	4 880	4 880	4 880	4 880	4 880
CCP	815	815	815	815	815	815	815	815	815	815	815	815
Cominco	655	816	816	816	816	816	816	816	816	816	816	816
IMC	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750
PPG (Kalium)	1 055	1 055	1 055	1 300	1 300	1 300	1 300	1 300	1 300	1 300	1 300	1 300
PCA	630	630	630	630	630	630	630	630	630	630	630	630
Kidd Creek (Allen 40%)	380	380	380	380	380	380	380	380	380	380	380	380
Sub-total	5 285	5 446	5 446	5 691	5 691	5 691	5 691	5 691	5 691	5 691	5 691	5 691
Total Saskatchewan	9 115	9 276	9 826	10 571	10 571	10 571	10 571	10 571	10 571	10 571	10 571	10 571
Denison, N.B.	-	200	450	650	780	780	780	780	780	780	780	780
PCA, N.B.	200	300	380	380	380	380	380	380	380	380	380	380
Total New Brunswick	200	500	830	1 030	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160
Canada (firm)	9 315	9 776	10 565	11 601	11 731	11 731	11 731	11 731	11 731	11 731	11 731	11 731
(unspecified)	-	-	-	-	-	-	-	-	50	800	1 400	2 000
TOTAL	9 315	9 776	10 656	11 601	11 731	11 731	11 731	11 731	11 781	12 531	13 131	13 731

Note: Capacity means "rated" capacity; under normal conditions Canadian mines operate at about 90 per cent of rated capacity.
- Nil.

TABLE 11. WORLD POTASH CAPACITY, 1984-95

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	(000 tonnes K_2O equivalent)											
North America												
Canada	9 315	9 775	10 665	11 600	11 730	11 730	11 730	11 730	11 780	12 530	13 130	13 730
United States	1 700	1 630	1 630	1 650	1 260	835	780	1 060	1 185	1 185	1 185	1 185
Total	11 015	11 405	12 285	13 250	12 990	12 565	12 510	12 790	12 965	13 715	14 315	14 915
Western Europe												
France	2 000	1 800	1 700	1 700	1 700	1 700	1 700	1 600	1 500	1 400	1 400	1 400
Germany, Fed. Rep.	2 700	2 800	2 800	2 800	2 800	2 800	2 800	2 850	2 850	2 850	2 850	2 850
Italy	200	200	200	200	200	200	200	200	200	200	200	200
Spain	800	740	740	720	750	815	815	715	515	515	515	515
United Kingdom	360	360	360	360	360	360	360	360	360	360	360	360
Total	6 060	5 900	5 800	5 780	5 810	5 875	5 875	5 725	5 425	5 325	5 325	5 325
Eastern Europe												
Germany, Dem. Rep.	3 600	3 600	3 600	3 600	3 600	3 600	3 600	3 600	3 600	3 600	3 600	3 600
U.S.S.R.	10 500	10 800	10 920	11 060	11 460	11 760	11 980	12 130	12 600	12 900	13 100	13 400
Total	14 100	14 400	14 520	14 660	15 060	15 360	15 580	15 730	16 200	16 500	16 700	17 000
Asia												
Israel	1 000	1 260	1 260	1 260	1 260	1 260	1 260	1 260	1 380	1 380	1 380	1 380
Jordan	300	550	650	720	720	720	720	720	720	720	720	720
China, People's Rep.	30	30	30	30	30	30	60	80	100	120	120	120
Total	1 330	1 840	1 940	2 010	2 010	2 010	2 040	2 060	2 200	2 220	2 220	2 220
Latin America												
Brazil	-	-	100	150	200	250	300	300	300	300	300	300
Chile	30	30	30	30	30	30	30	30	30	30	50	100
Total	30	30	130	180	230	280	330	330	330	330	330	330
Other	-	-	-	50	50	100	100	100	150	150	200	200
World Total	32 535	33 575	34 675	35 930	36 150	36 190	36 435	36 735	37 270	38 240	39 090	39 990

Salt

M. PRUD'HOMME

SUMMARY

Canada produces rock salt from four salt underground mines and as byproduct from two potash mines. Rock salt accounts for 68 per cent of total salt shipments. Brine is also produced in 11 plants for the manufacture of evaporated salt and chlor-alkalies.

Production of salt was estimated at 10 042 963 t for 1985, 1.8 per cent lower than in 1984; unit value increased by 9.7 per cent to $22.50 per t. However, lower production was mainly due to strikes that affected two Canadian producers, for three months.

Consumption in 1984 has been estimated at 8 014 300 t, up by 29 per cent reflecting major increases in de-icing usage because of the severe winter during 1984-85, and in industrial chemicals because of increasing demand for chlorine in the plastics and pulp and paper industries.

On a nine month basis, imports rose by 38 per cent in 1985 compared to the same period in 1984. Shipments were into Ontario, British Columbia and Quebec. Export volume declined by 10 per cent but value rose by 13.6 per cent.

An antidumping petition was filed in the United States against the principal Canadian rock salt exporters alleging dumping of rock salt and material injury to a U.S. industry. Preliminary determinations by American agencies supported the allegation and assumed dumping margins to Canadian exporters. In early–January 1986, final determination found no material injury to the U.S. industry, therefore ending this dumping petition.

Salt prices rose by 5 per cent over last year reflecting the inflation rate. Demand for salt is expected to grow, especially for the chlor-alkali industry, directly linked to strong demand in the plastics and the pulp and paper industries. Major growth in demand is expected to occur in the small but profitable market for salt used in domestic and industrial water-softening units.

DOMESTIC PRODUCTION AND DEVELOPMENTS

In 1985, Canadian production of salt was estimated at 10 042 963 t, a small drop of 1.8 per cent compared to 1984, which was largely caused by strikes that have affected both Domtar Inc. at Goderich and Seleine Mines Inc. at les Îles-de-la-Madeleine, for three months. The average unit value has increased by 9.7 per cent to $22.50 per t in 1985.

Atlantic region. Salt deposits occur in isolated sub-basins 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, Prince Edward Island, les Îles-de-la-Madeleine 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, domes and brecciated structures of rock salt.

Salt production in the Atlantic provinces is from an underground rock salt mine at Pugwash, Nova Scotia, an underground potash and salt mine at Sussex, New Brunswick and a brining operation near Amherst, Nova Scotia.

In New Brunswick, Potash Company of America (PCA) started a $150 million development plan in 1981 to produce potash with salt as byproduct. The mine, located at Plumweseep near Sussex, commenced production in July 1983 and is expected to reach 900 000 tpy of potash. Salt is extracted at a rate of 400 000 to 500 000 tpy and is sold mainly to the eastern United States. Reserves are estimated large enough to

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operate for at least 20 years. Salt is marketed for road de-icing and chemical plants, and in 1985, it was distributed by the International Salt Co., United States, or its Canadian subsidiary, Iroquois Salt Products Ltd. In late-1985, Rio Algom Limited announced its intention to purchase the outstanding common shares of Potash Company of America (PCA), from its present parent company Ideal Basic Industries, Inc.

Denison-Potacan Potash Company produced small amounts of salt from its potash mine now under development at Salt Springs near Sussex.

In Nova Scotia, The Canadian Salt Company Limited operates an underground rock salt mine at Pugwash in Cumberland county, with a rated capacity of approximately 1 350 000 t. Most of the salt from this mine is used for snow and ice control. In the evaporated salt plant, saturated brine is fed to a quadruple effect vacuum pan, rated at 13 t per hour, where brine solution is evaporated to produce high quality salt crystals for use in the chemical and food industries. Since port facilities restricted its cargo carrying capacity in 1985, the firm has studied various alternatives to increase maritime shipments from Pugwash, such as deepening the channel, using a barge or a modified Canadian vessel.

Domtar Chemicals Group division of Domtar Inc. has a brining operation at Nappan in Cumberland County. In 1985, the company continued its $9.5 million modernization program for replacement of the present multi-stage evaporators with a single thermo-compression evaporator. This project should be completed by early-1986, and is expected to generate substantial energy savings. Evaporated salt products will be used for table salt, fishery and water conditioning.

Quebec. A salt deposit located on the Archipelago of les Îles-de-la-Madeleine, in the Gulf of St. Lawrence, is part of the Mississippian Carboniferous Basin. Discovered in 1972, the Rocher-aux-Dauphins deposit is characterized by thick sequences of commercial salt, large sequences of rythmic salt and anhydrite cycles, abundance of low-grade potash horizons and some clay. The deposit is a typical piercement salt diapir generated by upward movements of the salt from the underlying anticlinal structure. It contains about 4 billion t of raw salt of which a quarter is above 97 per cent sodium chloride. The salt lies between 30 m and 75 m underneath the surface. The deposit dips about 55 degrees to the southwest. Reserves are 460 million t of which 34.2 per cent are mineable, grading an average of 94.5 per cent NaCl.

Seleine Mines Inc., a subsidiary of Société québécoise d'exploration minière (SOQUEM), mines rock salt commercially since the spring of 1983. This underground operation has a production capacity of 1.23 million tpy, and reserves are sufficient for 20 years.

In 1984, antidusting facilities were installed and have improved mining conditions. During 1985, the firm has invested more than $1 million on construction of a dehumidifying plant to keep the underground salt mine dry in summer. Investments were also made on a spiral chute to transfer ore from the upper mining level to the lower level where an underground mill is located, and on feeder breaker and conveyer belt for development level at 173 m. A three month strike, from July to September, has affected the production target for 1985. Maintenance dredging works are planned for 1986.

The shipping season is 270 days, from April 1 to December 31. All salt produced is for de-icing purposes and is shipped to mainland Quebec, Newfoundland and northeastern United States.

In 1985, several measures were taken by SOQUEM to ensure its viability including a partner or a buyer for the rock salt operation; six salt producers have shown interest.

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 at depths from 275 to 825 m, have been identified and traced from drilling records. Maximum bed thickness is 90 m, with aggregate thickness reaching as much as 215 m. The beds are relatively flat-lying and undisturbed, resulting in low-cost mining.

During 1985, those beds were worked through two rock salt mines, one at Goderich and one at Ojibway, and through brining operations at Goderich, Sarnia, Windsor and Amherstburg.

At Goderich, Domtar Chemicals Group operates an underground rock salt mine. New facilities are currently operating at full capacity; expansion has risen installed capacity up to 3.15 million t. During 1985, the firm has been affected by a three month strike, from July to early-September. Domtar's salt is marketed mainly for ice control and it is sold mainly in eastern Canada and in the north central United States, and in regions accessible through the Mississippi River system. Evaporated salt is also produced at the Domtar brining operation also located near Goderich.

At Sarnia, Dow Chemical Canada Inc. produces brines from wells for the production of caustic soda and chlorine.

The Canadian Salt Company Limited produces both rock salt from the Ogibway underground mine and vacuum salt products from brine wells near Windsor. The total rated capacity is more than 2.25 million tpy. Rock salt is extracted from the Middle F - Unit at a depth of 297 m while brine is pumped from the B - Unit at depths of 427 m and 457 m. During 1985, fused salt facilities were shut down. Water conditioning salt is now produced from compacted evaporated salt.

In the vicinity of Amherstburg, Allied Chemical Canada, division of Allied Canada Inc. operates a brining operation for the manufacture of soda ash and byproduct calcium chloride. This is the only remaining plant in North America that utilizes the Solvay process.

During 1984, several new brine wells have been drilling for salt recovery in Anderson township near Amherstburg and in Moore township near Sarnia.

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 of salt occurring in Upper Devonian rocks. Depths range from 180 m at Fort McMurray, Alberta, to 900 m in eastern Alberta, central Saskatchewan and southwestern Manitoba, and to 1 830 m around Edmonton, Alberta, and in southern Saskatchewan. Cumulative thicknesses reach a maximum of 400 m in east-central Alberta. The beds lie relatively flat and undisturbed. The same rock sequence contains a number of potash beds currently under exploitation in Saskatchewan.

In Saskatchewan, four companies produce salt from the Middle Devonian Prairies formation. International Minerals and Chemical Corporation (Canada) Limited (IMCC) supplies byproduct rock salt from its potash operation at Esterhazy. Its salt is distributed locally for road de-icing by Kleysen Transport Company. Domtar Inc. operates a brining operation, near Unity, for the production of fine vacuum-pan salt and fusion salt. The Canadian Salt Company Limited at Belle Plaine uses byproduct brine from an adjacent potash solution mining operation owned by PPG Canada Inc.'s division, Kalium Chemicals, to produce table salt. Saskatoon Chemicals, a division of Prince Albert Pulp Company Ltd., produces brines from wells near Saskatoon for the manufacture of caustic soda and chlorine, mainly used by pulp producers as a bleaching agent.

In Alberta, two producers operate brining operations: at Fort Saskatchewan near Edmonton, Dow Chemical Canada Inc. produces salt brine for the manufacture of chlor-alkali chemicals; and, at Lindberg, The Canadian Salt Company Limited produces fine vacuum pan salt and fusion salt.

British Columbia. There is no production of salt in this province where four companies operate six chlor-alkali plants: B.C. Chemicals Ltd. in Prince George, Tenneco Canada Inc. in North Vancouver, FMC of Canada Limited at Squamish and Canadian Occidental Petroleum Ltd. in North Vancouver, Squamish and Nanaimo. Raw materials are imported from Mexico and the United States.

CONSUMPTION AND TRADE IN CANADA

Consumption. Comsumption of all types of salt in 1984 has been estimated at 8 014 300 t, a 29 per cent increase compared to 1983. The increase resulted from usage for ice control which accounts for 44 per cent of total consumption, and for industrial chemicals which account for 51 per cent. Major increases were in de-icing and chemicals sectors, with 31 per cent and 26 per cent respectively.

Salt is to a large extent used as a chemical raw material accounting for 60 per cent of world consumption, followed by human diet with 17 per cent, road de-icing with 10 per cent; and the remainder 13 per cent to animal feed and water treatment. However, the pattern for consumption differs in North America where the chemical industry consumed about half of total production, followed by highway usage and the food industry.

The largest consumer of salt is the industrial chemicals industry, particularly for the manufacture of chlor-alkali, namely caustic soda (sodium hydroxyde), chlorine and soda ash (sodium carbonate). Salt for four caustic soda and chlorine plants in Canada is obtained from on-site brining and natural brines; others use mined rock salt or imported solar-evaporated salt. Chlorine is largely used by the plastic industry and as a bleaching agent for the manufacture of bleached pulp and newsprint. The principal uses for caustic soda are in the manufacture of organic and inorganic chemicals, pulp and paper, alumina and textiles. The glass industry is a major user of soda ash. Other industrial chemicals that require significant quantities of salt include sodium chlorate, sodium bicarbonate, sodium chlorite and sodium hypochlorite. The American Society for Testing and Materials (ASTM) standard method E-534-75 covers the analytical procedures for chemical analysis of sodium chloride.

Consumption for snow and ice control, varies from year to year depending on weather conditions. For the past nine years, the average proportion for this purpose in Canada was about 45 per cent of total consumption, compared to 20 per cent for the United States and 14 per cent in western Europe. On a world basis, this application accounts for 10 per cent of total world salt consumption. For road de-icing, the ASTM provides standard specifications for sodium chloride: D632-72 (78). Rates of application are controlled by several factors such as precipitation, temperature, wind effects, traffic density and road conditions. Practices for such usage also include utilization of mixtures with calcium chloride or with sand and gravel as abrasive components.

Other consumption areas for salt include the food industry, animal diet, fishery industry and water treatment which all account for less than 10 per cent of total Canadian consumption. Slight growth in these markets should continue in the short-term, although there is some pressure to use less salt for health reasons in the food industry.

There are virtually no substitutes or alternatives for salt; however, calcium chloride, hydrochloric acid and potassium chloride can substitute for salt in de-icing, chemical processing or food flavouring, but at a higher cost.

Salt used for de-icing is posing major problems of corrosion and of environmental degradation and economic substitutes are being investigated.

In West Germany, many concerns on damage to the environment have led to test the pre-wetting salt method consisting in moisturizing sodium chloride with calcium solution on the spinner disc itself to ensure an even distribution over the road surface. The results show that the application of damp salt represents a modern, safe and economical technology for snow and ice control, as a supplement to the conventional de-icing system.

Calcium-Magnesium Acetate (CMA) has been identified as a potentially acceptable, non-corrosive alternative de-icing chemical. CMA is produced through the interaction of acetic acid with dolomitic lime or limestone. However, the purchase price of CMA is about $440 per t, or about seven to eight times the current cost of road salt. CMA is non-corrosive, does not pollute water supplies and is generally less harmful to roadside vegetation.

The adverse effects of salt have been reduced through information seminars promoted by the Salt Institute. These contribute to minimize salt damages on highways, streets, and infrastructure by promoting proper storage methods and controlled spreading.

Trade. Imports are mainly from the United States (689 745 t) which account for 64 per cent of total imports, followed by Mexico with 22 per cent and Chile with 5 per cent. On a nine month basis, 1985 imports rose by 38 per cent compared to the same period in 1984. Imports are going mainly to Ontario (39 per cent), British Columbia (36 per cent) and Quebec (18 per cent). For the nine month period, exports declined by 10 per cent in 1985; almost all shipments are made to the United States, especially for ice control usage.

Because of its low unit value and availability in most key market areas, salt is seldom transported over long distances, except in the case of seaborne and intercoastal shipment where longer routes entail little additional cost. Increased capacity in eastern Canada (Ontario, Quebec and New Brunswick) will likely replace salt traditionally imported from Mexico and the northeastern United States.

WORLD PRODUCTION AND REVIEW

Total world production has increased from 133 million t in 1970 to about 172 million t in 1984, an average annual increase of 1.85 per cent. Salt is produced in about 100 countries which are self sufficient for their consumption requirements. While the United States is the leading salt producer with 18 per cent of world production, it must import additional quantities to meet demand; imports are mainly from Canada (38 per cent), Mexico (28 per cent), and the Bahamas (15 per cent).

United States. Cargill Limited began constructing a solar evaporation facility near Freedom, Oklahoma, with a planned capacity of 182 000 tpy. The company has shut down its Belle Isle rock salt mine in Louisiana, during February 1985, citing the danger of collapsing.

Domtar Chemicals sold its evaporation salt facilities, at Tooele, Utah, to AMAX Inc.; no production was reported in 1985.

FMC Corporation announced plans to close its brining operation at Sistersville in West Virginia.

Great Salt Lake Minerals & Chemicals Corp. of Utah had its outer dike breached resulting in the flooding of about 85 per cent of the company's evaporation ponds.

International Salt Co. announced some new development improving efficiency at its Avery Island rock salt mine in Louisiana; the company will deepen its production shaft and will replace an underground conveyor system.

Morton Thiokol, Inc., planned to increase production capacity by 272 000 tpy at its Weeks Island rock salt mine in Louisiana; the firm has closed its Marysville, MI, evaporated salt plant in November due to declining use of table salt.

PPG Canada Inc. has announced its intention to construct a test facility in Hershey township. If results are satisfactory a full scale potash production facility with a capacity of 680 000 tpy could be constructed in the late-1980s. The disposition of salt could be done by selling to processing companies or by filling underground cavities.

In the chlor-alkali sector, Dow Chemical U.S.A. announced in early-1985 its plan to bring on line a new calcium chloride facility in Ludington, Michigan, taking the place of its old plant built in the 1940s; while not increasing current name plate capacity, this project will increase production output because of better technology and operation efficiency.

Olin Corp. and E.I. Du Pont de Nemours and Company have announced plans to construct a chlor-alkali plant at Niagara Falls, NY. Output is estimated to reach 600 tpd by late-1987.

INTERNATIONAL TRADE

Salt is a widespread, low value and bulk commodity. It is relatively cheap to extract and transportation represents a significant proportion of the total delivered price of salt. As a result, international trade in salt is small relative to world production, i.e. 20 million t which is about 8 per cent of total world production. Major international routes consist of cross-border trade and trade within geographical areas. The cross-border trade between Canada and the United States account for 14 per cent of world total, between Mexico and the United States for 14 per cent. Trade within western Europe which involves the Scandinavian countries, the Netherlands, France, Benelux, Poland, Italy, East and West Germany accounts for 32 per cent of world total. Trade within the Pacific area, which involves principally shipments from Mexico and Australia to Japan, accounts for about 40 per cent of world total.

During 1985, a rock salt petition in the United States was filed against Canadian exporters. On January 28, the International Salt Co. of Pennsylvania, on behalf of the American rock salt producers, filed a petition alleging that imports of rock salt from Canada are being sold at less than fair value and that caused a material injury to the United States industry.

On November 27, the International Trade Administration of Commerce Department (ITA) found evidence that Domtar Inc. and Morton Thiokol, Inc., the parent company of The Canadian Salt Company, Limited, both accounting for 70 per cent of all Canadian exports to the United States, were dumping rock salt at below the foreign market value.

In July 1985, the U.S. International Trade Commission (ITC), which shares jurisdiction with ITA in dumping investigations, determined that there was reasonable indication that imports of rock salt from Canada were damaging the U.S. industry; U.S. Customs Services has been directed to suspend the liquidation of all entries of rock salt from Canada and to require a cash deposit or bond equal to the weighted-average amounts.

ITA has determined that Canadian rock salt exporters were selling rock salt at the following weighted-average dumping margins: Domtar Inc., 8.15 per cent; Morton Thiokol, Inc., 4.39 per cent; and other exporters, 6.35 per cent.

In early-January 1986, the U.S. International Trade Commission reversed the ITA decision with the final determination that there was no material injury to the United States industry resulting from these imports. Therefore, dumping duty will not be imposed on Canadian rock salt shipments to the United States as recommended by the U.S. Commerce Department in 1985.

PRICE

Salt is not a standard commodity and its price ranges depend on such factors as production methods, purity, scale of operations and transportation costs.

In 1985, Canadian rock salt prices, bulk, fob works, for de-icing purposes were about $22.00 per t, while fine evaporated salt prices range between $80-87 per t. The oversupply situation of salt remained, producing a buyer's market. Salt products prices rose slightly in 1985.

OUTLOOK

Canada is nearly self-sufficient in salt. Eastern Canadian requirements of rock salt are served locally while imports serve western needs for chlor-alkali plants in British Columbia. Current capacity should be sufficient to meet any forecast increase in demand for the next decade.

The industrial chemicals industry is likely the sector of consumption which will see strong growth in the decade. The major end-use of salt is for the production of chlor-alkali, namely caustic soda, chlorine and sodium carbonate.

Caustic soda markets are affected by its consumption in the aluminum industry, by the substitution from soda ash in the glass industry, and by fluctuations of newsprint and linerboard production in the pulp and paper industry. However, the greatest impact is coproduction with chlorine. Producers of chlor-alkali have maintained their technology up to date and trimmed their capacity. Increasing demand will be met from a new plant opened in 1984 and from the reopening of facilities closed during the recession. Plants operating rates should remain between 80 and 90 per cent of capacity through 1990.

Chlorine demand is oriented to polyvinyl chloride (PVC) usage in the construction and automobile sectors (41 per cent of total consumption), and as a bleaching agent in the pulp and paper industry (39 per cent) and the chemicals industry. Chlorine demand is expected to continue growing at about 3 per cent per year up to 1995. Availability of chlorine will be adequate in Canada until 1990 since current capacity, near 1 525 000 tpy, exceeds demand. The total consumption of chlorine in Canada was estimated at about 1 200 000 t for 1983.

The usage of salt for de-icing is tied to the North American market. In the long-term, controlled application rates, environmental considerations, substitutes and urban access optimization will limit salt consumption on a t/km basis but a slow growth rate of between 1 and 2 per cent is still forecast, due to the growth of the road network.

In the food industry, salt is a major supplement and a well used preservative. Its demand is linked to population growth and should increase despite the current public concern, in some countries, related to the high sodium diet. An annual average growth rate of 1.2 per cent is forecast for the next two decades, by the U.S. Bureau of Mines.

In agriculture, salt is used for livestock and poultry nutrition. Health concerns may limit the demand for salt which is expected to grow at an annual rate of 2.1 per cent for the period 1983-2000, in North America.

For water treatment, salt usage is likely to increase due to higher sales of domestic and commercial water-softening units. The demand for salt in this application is forecast at an annual average growth rate of 4 per cent up to the year 2000.

Growth in world consumption is forecast, by the U.S. Bureau of Mines, to average about 3.4 per cent annually to reach 290 million t in the year 2000. Demand for salt by the year 2000 in the United States is forecast to be 52.6 million tpy, indicating an average annual growth rate of 2.2 per cent from 1983 to 2000.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
92501-1	Common salt (including rock salt)	free	free	5¢/100 lb	free
92501-2	Salt for use of the sea or gulf fisheries	free	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	4.3	4.3	15	2.5
92501-4	Salt liquors and sea water	free	free	free	free

MFN Reductions under GATT (effective January 1 of year given)		1985	1986	1987
			(%)	
92501-3		4.3	4.1	4.0
UNITED STATES, Customs Tariffs (MFN)				
420.92	Salt in brine	4.0	3.9	3.7
420.94	Salt in bulk	0.8	0.4	free
420.96	Salt, other	Remains free		

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241.

TABLE 1. CANADA, SALT PRODUCTION AND TRADE, 1983-85

	1983		1984		1985P	
	(tonnes)	($)	(tonnes)	($)	(tonnes)	($)
Production						
By type						
Mined rock salt	5 951 301	..	6 851 778	..	..	..
Fine vacuum salt	726 589	..	750 110	..	..	..
Salt content of brines used or shipped	2 040 925	..	2 450 060	..	..	..
Total	8 718 815	..	10 051 948	..	..	..
Shipments						
By type						
Mined rock salt	5 846 994	97,033,906	7 030 664	125,682,259	..	..
Fine vacuum salt	714 464	62,613,030	754 675	71,219,195	..	..
Salt content of brines used or shipped	2 040 925	13,140,466	2 450 060	13,289,181	..	..
Total	8 602 383	172,787,402	10 235 399	210,190,635	10 042 963	225,994,914
By province						
Nova Scotia	..	..	..	..	..	..
New Brunswick	..	..	..	..	..	..
Quebec	..	..	..	..	..	..
Ontario	5 479 984	97,810,670	6 412 414	131,720,179	6 101 589	136,604,126
Saskatchewan	357 655	17,711,609	402 217	20,362,349	408 149	26,816,520
Alberta	915 588	15,917,948	1 263 841	15,426,431	1 402 983	16,217,730
Total	8 602 383	172,787,402	10 235 399	210,190,635	10 042 963	225,994,914
Imports					(Jan.-Sept.)	
Salt, wet in bulk						
Mexico	226 627	2,562,000	271 957	2,839,000	234 884	2,441,000
United States	11 207	136,000	183 744	2,705,000	231 917	3,644,000
Total	277 834	2,698,000	455 701	5,544,000	466 801	6,085,000
Salt, domestic						
United States	7 956	994,000	10 031	1,319,000	8 387	1,574,000
Switzerland	141	29,000	40	30,000	61	40,000
Netherlands	128	4,000	1	..	1	4,000
Other countries	52	8,000	44	8,000	62	10,000
Total	8 277	1,035,000	10 116	1,358,000	8 511	1,628,000
Salt, nes						
United States	455 302	8,650,000	505 931	10,417,000	449 456	11,011,000
Spain	44 801	716,000	16 401	261,000	33 660	624,000
Chile	37 090	307,000	24 859	252,000	59 572	616,000
Other countries	944	94,000	40 209	532,000		
Total	528 137	9,767,000	587 400	11,482,000	597 134	13,108,000
Salt and brine by province of clearance						
Newfoundland	25 561	418,000	18 389	300,000	39 053	733,000
Nova Scotia	19 974	337,000	19 117	249,000	17 481	268,000
New Brunswick	47	7,000	46	24,000	1	..
Quebec	60 500	968,000	98 094	1,761,000	195 361	3,170,000
Ontario	269 531	4,642,000	454 757	8,133,000	415 109	9,872,000
Manitoba	2 755	182,000	3 059	211,000	3 566	344,000
Saskatchewan	2 606	206,000	3 607	341,000	3 795	344,000
Alberta	7 693	563,000	8 534	630,000	5 982	525,000
British Columbia	425 583	6,177,000	447 611	6,735,000	391 199	5,668,000
Total	814 250	13,500,000	1 053 217	18,384,000	1 072 446	20,811,000
Exports						
Salt and brine						
United States	1 908 386	25,754,000	2 524 114	29,023,000	1 595 463	20,477,000
Guyana	2 001	309,000	1 001	166,000	0	0
Leeward-Windward Islands	1 860	178,000	1 452	144,000	1 214	114,000
Other countries	2 380	247,000	3 471	477,000	2 004	251,000
Total	1 914 627	26,488,000	2 530 038	29,810,000	1 596 677	20,872,000

Sources: Statistics Canada: Energy, Mines and Resources Canada.
P Preliminary; .. Not available; nes - Not elsewhere specified.
Note: Totals may not add due to rounding.

TABLE 2. CANADA, SUMMARY OF SALT PRODUCING AND BRINING OPERATIONS, 1983 AND 1984

Company	Location	Initial Production	Production[1] 1984P (1983)	Employment 1984P (1983)	Remarks
			(000 tonnes)		
Nova Scotia					
The Canadian Salt Company Limited	Pugwash	1959	625.4 (667.5)	190 (185)	Rock salt mining to a depth of 253 m.
	Pugwash	1962	81.4 (83.4)		Dissolving rock salt fines for vacuum pan evaporation.
Domtar Inc.	Amherst	1947	57.8 (68.6)	74 (74)	Brining for vacuum pan evaporation.
New Brunswick					
Potash Company of America	Sussex	1980	418.1 (377.4)	25[2] (25)	Byproduct rock salt from potash mine.
Quebec					
Seleine Mines Inc.	Îles-de-la-Madeleine	1982	923.5 (617.5)	206 (190)	Rock salt mining to a depth of up to 275 m.
Ontario					
Allied Canada Inc.	Amherstburg	1919	620.1 (518.3)	8[2] (8)	Brining to produce soda ash.
The Canadian Salt Company Limited	Ojibway	1955	2 215.9 (1 784.7)	237 (221)	Rock salt mining at a depth of 300 m.
	Windsor	1892	132.0 (123.0)	126 (132)	Brining, vacuum-pan evaporation and fusion.
Domtar Inc.	Goderich	1959	2 700.5 (2 275.3)	355 (323)	Rock salt mining at a depth of 536 m.
	Goderich	1880	103.8 (108.1)	71 (70)	Brining for vacuum-pan evaporation.
Dow Chemical Canada Inc.	Sarnia	1950	758.0 (669.3)	5[2] (5)	Brining to produce caustic soda and chlorine.
Prairie Provinces					
International Minerals & Chemical Corporation (Canada) Limited	Esterhazy, Sask.	1962	108.6 (88.7)	3 (3)	Byproduct rock salt from potash mine for use in snow and ice control.
The Canadian Salt Company Limited	Belle Plaine, Sask.	1969	100.4 (78.7)	25 (24)	Producing fine salt from byproduct brine from potash operation.
Domtar Inc.	Unity, Sask.	1949	148.1 (142.0)	87 (85)	Brining, vacuum-pan evaporation and fusion.
Saskatoon Chemicals	Saskatoon, Sask.	1968	52.0 (34.0)	5 (5)	Brining to produce caustic soda and chlorine.
The Canadian Salt Company Limited	Lindbergh, Alta.	1968	125.9 (118.3)	79 (80)	Brining, vacuum-pan evaporation and fusion.
Dow Chemical Canada Inc.	Fort Sask., Alta.	1968	1 137.9 (797.3)	3[2] (3)	Brining to produce caustic soda and chlorine.
			10 309.4 (8 581.4)	1,499 (1,433)	

[1] Shipments; [2] Employment part of a chemical complex.
P Preliminary.

TABLE 3. CANADA, SALT SHIPMENTS, 1975, AND 1979-84

	Producers' Shipments					
	Mined Rock	Fine Vacuum	In Brine and Recovered in Chemical Operations	Total	Imports	Exports
	(tonnes)					
1975	3 626 123	578 649	1 291 489	5 496 261	1 183 144	..
1979	4 934 574	735 460	1 645 914	7 315 948	1 276 179	1 822 120
1980	4 507 416	781 428	2 134 010	7 422 854	1 151 203	1 637 601
1981	4 371 314	764 037	2 107 243	7 242 594	1 254 992	1 507 710
1982	5 223 073	773 086	1 944 172	7 940 331	1 526 879	1 721 893
1983	5 846 994	714 464	2 040 925	8 602 383	814 250	1 914 629
1984	7 030 664	754 675	2 450 060	10 235 399	1 053 217	2 530 038

Sources: Statistics Canada; Energy, Mines and Resources Canada.
.. Not available.

TABLE 4. CANADA, AVAILABLE DATA ON SALT CONSUMPTION, 1981-84

	1981	1982	1983P	1984e
	(tonnes)			
Snow and ice control[1]	3 001 260	3 088 315	2 712 088	3 560 800
Industrial chemicals[2]	3 234 020	2 966 218	3 226 558	4 078 000
Fishing industry	68 000	83 000	55 000	43 000
Food processing				
Fruit and vegetable processing	19 168	18 008	14 887	22 000
Bakeries	14 079	13 746	12 686	17 000
Fish products	33 983	33 582	28 281	42 000
Dairy products	10 740	10 447	10 130	13 000
Biscuits	2 022	2 082	1 981	3 000
Miscellaneous food preparation	24 874	22 680	21 863	29 000
Grain mills[3]	67 036	63 899	64 289	85 000
Slaughtering and meat processors	44 725	37 347	32 889	50 000
Pulp and paper mills	25 344	38 939	39 310	44 000
Leather tanneries	9 964	7 708	5 138	10 000
Miscellaneous textiles	2 664	2 871	4 351	4 000
Breweries	352	279	512	500
Other manufacturing industries	10 492	7 923	13 793	13 000
Total	6 568 723	6 397 044	6 243 756	8 014 300

Sources: Statistics Canada; Salt Institute.
[1] Fiscal year ending June 30. [2] Includes rock salt, fine vacuum salt and salt contained in brine. [3] Includes feed and farm stock salt in block and base forms.
[e] Estimated by Energy, Mines and Resources Canada; P Preliminary.

TABLE 5. CHLOR-ALKALI PLANTS IN CANADA, 1984

Company	Location	Parent Company	Plant Location	Products	Capacity (tonnes)	Remarks
B.C. Chemicals Ltd.	Prince George, B.C.	B.C. Chemicals Ltd. Prince George, B.C.	Prince George, B.C.	sodium chlorate	33 500	Captive production.
BCM Technologies Inc.	Amherstburg, Ont.	BCM Technologies Inc. Amherstburg, Ont.	Amherstburg, Ont.	sodium chlorate	49 000	New capacity has been put on-stream by August 1985.
Canadian Occidental Petroleum Ltd.	Calgary, Alberta	Occidental Petroleum Corporation, Los Angeles, Cal. U.S.A.	Brandon, Manitoba	sodium chlorate	11 000	Imports Solar Salt from Mexico.
			Nanaimo, B.C.	sodium chlorate caustic soda chlorine	7 500 31 000 28 000	Has contracted to supply B.C. Highways road salt in 1980-81.
			North Vancouver, B.C.	caustic soda chlorine	155 000 141 000	
			Squamish, B.C.	sodium chlorate	11 000	
Canso Chemicals Limited	New Glascow, N.S.	C-I-L Inc., North York, Ontario	Abercrombie Point, N.S.	caustic soda chlorine	20 000 18 000	
C-I-L Inc.	Willowdale, Ont.	C-I-L Inc., North York, Ontario	Becancour, Que.	caustic soda chlorine	325 000 295 000	
			Cornwall, Ont.	caustic soda chlorine	38 500 35 000	
			Dalhousie, N.B.	caustic soda chlorine	31 000 28 000	
Tenneco Canada Inc.	Islington, Ont.	Albright & Wilson Inc. London, England	Buckingham, Que.	sodium chlorate	57 150	Expansion to 90 000 t due in 1985. (32 650 t+)
			North Vancouver, B.C.	sodium chlorate	54 500	
FMC of Canada Limited	Squamish, B.C.	FMC Corporation Chicago, Ill., U.S.A.	Thunder Bay, Ont. Squamish, B.C.	sodium chlorate caustic soda chlorine	46 250 75 000 68 000	
Great Lakes Forest Products Limited	Thunder Bay, Ont.	Great Lakes Forest Products Limited Thunder Bay, Ont.	Dryden, Ont.	caustic soda chlorine	16 000 14 500	
PPG Canada Inc. Industrial Chemical Div.	Toronto, Ont.	PPG Canada Inc. Pittsburg, Penn., U.S.A.	Beauharnois, Que.	sodium chlorate	70 000	(Stan Chem Co.)
				caustic soda chlorine	75 270 61 000	
QueNord Inc.	Magog, Que.	KemaNobel AB, Sweden	Magog, Que.	sodium chlorate	34 450	Will double capacity in 1986.
Ste Anne-Nackawic Pulp & Paper Co. Ltd.	Nackawic, N.B.	Parsons and Whitemore	Nackawic, N.B.	sodium chlorate	9 000	(34 450 t+). Captive production.
				chlorine	9 000	
Saskatoon Chemicals	Saskatoon, Sask.	Prince Albert Pulp Company Ltd. Prince Albert, Sask.	Saskatoon, Sask.	sodium chlorate	22 500	
				caustic soda chlorine	36 000 33 000	
Chlorate Alby Canada Inc.	Valleyfield, Que.	Alby, Sweden Olin Corp., U.S.A.	Valleyfield, Que.	sodium chlorate	50 000	New plant started in 1984 due for completion in 1986.

Sources: Proceedings, Pulp and Paper Chemicals Outlook Conference, November 1984, Montreal, Quebec; Ministère de l'Industrie, du Commerce et du Tourisme du Québec: Energy, Mines and Resources Canada.

TABLE 6. WORLD SALT PRODUCTION, 1980-84

Countries	1980	1981	1982	1983	1984[e]
			(000 tonnes)		
United States	36 625	35 025	34 355	31 355	34 240
U.S.S.R.[e]	14 600	15 195	15 420	16 235	16 325
China[e]	17 275	18 315	15 965	15 870	16 325
Germany, West	11 390	12 535	11 520	10 430	10 430
India	8 010	8 920	9 980	9 980	9 975
Canada	7 030	7 240	8 070	8 615	8 615
United Kingdom	7 155	6 720	6 895	7 710	7 710
Mexico	6 575	7 950	7 980	5 530	7 710
France	7 100	6 635	6 650	7 175	6 800
Australia	5 315	5 300	5 625	5 980	5 985
Italy	5 265	4 565	4 530	4 710	4 535
Poland	4 535	4 270	4 260	4 260	4 535
Other	37 490	37 650	37 450	37 900	39 015
Total	168 365	170 320	168 700	165 750	172 200

Source: U.S. Bureau of Mines.
[e] Estimated.

Selenium and Tellurium

W.J. McCUTCHEON

Selenium is a nonmetallic element which is chemically similar to sulphur but which has some properties of a metal. Selenium occurs in minerals associated with sulfides of copper, lead and iron. Commercial production is principally from electrolytic copper refinery slimes as well as from flue dusts of copper and lead smelters. A significant amount of selenium is also recovered from secondary sources. In 1985, production and demand were estimated to be nearly in balance in the western world at about 1 600 tonnes (t).

CANADIAN DEVELOPMENTS

Selenium is recovered in Canada as a byproduct of the refining of blister copper and from the retreatment of recycled materials. Annual production (Table 1) is irregular, varying according to operating rates and recoveries at copper refineries and market conditions for selenium. Xerographic scrap and other selenium scrap are imported from the United States and other countries to be refined in Canada and re-exported. The total amount of selenium refined in Canada from both primary and secondary sources was 467 t in 1984, is estimated at 458 t in 1985 and is forecast at 470 t in 1986 (Table 2).

Noranda Inc.'s CCR Division copper refinery at Montréal East, Quebec, operates the largest selenium recovery plant in the world. The refinery handles blister copper from the company's Horne and Gaspé smelters in Quebec, from the Flin Flon smelter of Hudson Bay Mining and Smelting Co., Limited in Manitoba, and anode slimes from the copper refinery at Kidd Creek Mines Ltd. The selenium recovery unit produces commercial-grade (99.5 per cent) and high-purity (99.99 per cent) selenium and a variety of selenium compounds. Nominal annual capacity is about 325 t of primary selenium in elemental form and in salts, depending upon the selenium content of the blister copper processed. In addition, production capacity of secondary selenium is nominally 165 tpy, but this too depends upon the selenium content of the feed material.

Inco Limited's selenium recovery plant at Copper Cliff, Ontario treats tankhouse slimes from the company's Copper Cliff copper refinery. The capacity of the plant is 67 tpy of minus 200 mesh selenium powder (99.5 per cent Se).

Canada consumes only a few per cent of its refined selenium production, mostly by the glass industry. Most of the Canadian selenium is exported to the United States and to the United Kingdom, with minor amounts to the rest of Europe.

WORLD DEVELOPMENTS

Producing countries include the United States, Canada, Japan, the U.S.S.R., Belgium, Sweden, Mexico, Yugoslavia, Finland, Peru, Australia, and Zambia. Total western production is estimated at about 1 600 t in 1984 and 1985 after allowances for production from Australian FRG and increased Belgian output (Table 3).

In the United States, AMAX Inc., ASARCO Incorporated, Phelps Dodge Corporation and Kennecott Corporation have selenium production facilities. Due to Kennecott's closure of its refinery and the almost complete closure of AMAX's Carteret refinery, only ASARCO and Phelps Dodge are significant selenium producers. U.S. production in 1985 is estimated at 195 t down from 254 t in 1984 when stocks of semi-processed material were reduced.

Consumption of selenium in the western world is estimated at about 1 600 t for 1985. The United States is the most important consuming nation, accounting for about the same consumption as that of the European Economic Community.

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Apparent consumption of selenium in the United States in 1985 is estimated by the United States Bureau of Mines (USBM) at 425 t down from 478 t in 1984. According to the USBM, the main end-use by industrial categories in 1983 were: electronic and photocopier components, 33 per cent; glass manufacturing, 27 per cent; pigments, 20 per cent; metallurgical applications, 7 per cent; other including animal feed and chemicals, 13 per cent. Uses have not changed appreciably from 1983 to 1985.

PRICES

Producer prices have not been published since early 1981. Metals Bulletin Inc. prints a "European Free Market" price spread for selenium. Table 4 presents the monthly high and low European Free Market prices for the period 1984 and 1985.

USES

Selenium is used in the manufacture of glass, steel, electronic components, explosives, batteries, animal and poultry feeds, fungicides and pigments, and in xerography. The 1979 edition of this review contains a more detailed description of selenium uses.

The photoreceptor industry is the major user of selenium. Fully panchromatic organic photoreceptors and amorphorus silicon photoreceptors have the potential to substitute for selenium in new generations of photocopiers. While the final decisions have not been made with respect to which materials are the best photoreceptors for new processes, there is a possibility of a reduction in demand for selenium for its largest end-use. Such a substitution, if it were to take place, is thought unlikely to affect selenium demand before the next decade.

Elemental selenium is marketed in two grades: 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 include ferroselenium, nickel-selenium, selenium dioxide, barium selenite, sodium selenate, sodium selenite and zinc selenite.

OUTLOOK

Selenium is associated with copper minerals and hence its production is dependent upon primary copper production. EMR projects future copper consumption will increase at a rate of between 1.2 per cent and 1.6 per cent annually until the end of the century. The balance between sulfide and porphyry copper production is forecast to shift in favour of porphyry deposits. Porphyrys contain less selenium on average than do sulfide deposits and hence future mine selenium production will increase at a lower rate than the increase in copper mine production forecasted. Recoverable primary selenium production is likely to grow at a rate of about 1 per cent annually.

Given higher prices, production could be increased by improving selenium recovery from the present level of between 50 and 60 per cent. A minor increase in selenium recovery is also likely due to more stringent emission standards at copper and lead smelters.

Scrap supplies are a ready extra source of selenium in case of a significant price rise. Rectifier and xerographic scrap are two components of the estimated 200 to 400 t of scrap stocks which have accumulated in the western world.

New large scale uses for selenium in the long term are not predictable. Indeed while existing uses are unlikely to be threatened by substitution at existing prices in the medium term, technological advances such as a new photocopying process or the use of alternative photoreceptors have the potential to seriously reduce consumption. Such technical advances, like new large-scale uses, are difficult to predict.

The introduction of a major new use would be inhibited by the constraint upon supplies, as primary selenium production is a function of copper production. Although selenium recoveries could be improved and significant supplies of inventoried scrap could be processed to meet the increased demand, ultimately supply is constrained. Given significant sustained new demand, prices would rise encouraging the use of substitute materials.

Health related uses are likely to increase. Selenium is now added to vitamins tablets for humans, and to animal and poultry feeds. Selenium has also been studied as dietary cancer preventative agent.

Prices are likely to remain in the range of $US 7-10/lb in 1986 and towards $US 10/lb over the medium term. Significant price rises will likely be inhibited by the stocks of scrap selenium and also by the marketing strategies of producers. Prices of $US 10/lb are thought to be insufficient to evoke reprocessing of the majority of existing scrap stocks. Much of the existing scrap inventories require a price of $US 12-15/lb before reprocessing can be profitable. The long-term interests of major producers and consumers would not be best served by large-scale price increases which encourage substitution away from selenium.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
92804-4	Selenium	5	10	15	5

MFN Reductions under GATT (effective January 1 of year given)	1985	1986	1987
		(%)	
92804-4	10.0	9.9	9.2

UNITED STATES (MFN)				
420.50	Selenium dioxide	Remains free		
420.52	Selenium salts	Remains free		
420.54	Other selenium compounds	4.0	3.9	3.7
632.40	Selenium metal, unwrought, other than alloys, waste and scrap	Remains free		
632.88	Selenium metal alloys, unwrought	6.4	5.9	5.5
633.00	Selenium metals, wrought	6.4	5.9	5.5

EUROPEAN ECONOMIC COMMUNITY (MFN)		1985	Base Rate	Concession Rate
28.04 C.2	Selenium	free	free	free

Sources: The Customs Tariff 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, Vol. 27, No. L320, 1985.

TELLURIUM

Tellurium, like selenium, is recovered in Canada from the tankhouse slimes from electrolytic copper refineries. It is refined by the same two companies who refine selenium: Noranda Inc.'s CCR Division at Montréal East, Quebec, and Inco Limited at Copper Cliff (Sudbury), Ontario. Although more "metallic" than selenium, tellurium resembles selenium and sulphur in chemical properties and, like selenium, is a semiconductor. Tellurium output is related to selenium output because tellurium is a coproduct of selenium recovery.

CANADIAN DEVELOPMENTS

Refined production of tellurium in Canada was 13.6 t in 1984, is estimated at 19 t in 1985 and is forecast at 28 t for 1986 (Table 5). The large difference between production (all forms) and refined production in some years is attributable to market conditions. Producers refine according to sales and can stockpile any surplus in less processed forms.

CCR Division has an annual capacity of up to 27.2 t of primary and secondary tellurium in powder, stick, lump and dioxide forms. The Copper Cliff refinery has an annual capacity of up to 8.2 t of tellurium in the form of dioxide (77 per cent Te).

In 1982, Cominco Ltd. built a $3 million plant at Trail, British Columbia to expand its production of mercury-cadmium telluride (MCT) in the form of single crystals. When sliced into thin wafers and polished, this compound is used in a wide range of electronic devices that detect infrared radiation to provide optical images or data. This plant is the only non-captive producer of such crystals and is the largest producer of high-purity detector grade tellurium.

WORLD DEVELOPMENTS

Total refined world production is unavailable. Information about production from Australia, U.S.S.R., Federal Republic of Germany, the United States, Chile, Zaire and Zambia is either unavailable or insufficient to allow estimation. In the United States, the sole producer is ASARCO Incorporated.

Demand in the United States increased sharply from 57 t in 1983 to 107 t in 1984 and is estimated at 110 t in 1985. Most of the increased demand results from increased application in ferroalloys which account for about 65 per cent of the total. Consumption in the United States had been higher (224 t in 1979) until a chemical plant in Texas closed in 1979. This plant had used a large quantity of tellurium as a catalyst for producing ethylene glycol (antifreeze) but had experienced problems with its patented tellurium process.

PRICES

Most of the commercial-grade tellurium sold by the primary producers is in the form of slab, stick, lump, tablet or powder. It is also sold in the form of copper-tellurium and iron-tellurium alloys. Normal commercial grades contain a minimum of 99 per cent or 99.5 per cent tellurium. Tellurium dioxide is sold in the form of minus 40 to minus 200-mesh powder containing a minimum of 75 per cent tellurium.

As a result of falling prices, producers suspended publication of tellurium prices on January 5, 1981. Prices in 1985 are believed to have ranged between $US 9.50 and $US 14/lb, depending upon lot size, frequency of purchases and market conditions.

USES

Overexposure to tellurium could be hazardous to health, but fortunately tellurium imparts a disagreeable odor at low concentrations and this early warning signal has prevented any recorded toxic industrial exposures. Major uses are as additions to ferrous and nonferrous alloys to improve machineability or otherwise improve their metallurgical properties however, bismuth is increasingly being used as a substitute. Tellurium also performs an important role in the manufacture of rubber products, thermoelectric devices, catalysts, electronics, insecticides and germicides, delay blasting caps, glass, ceramics and pigments.

The demand for tellurium in the United States by end-use in 1983 was estimated by the USBM as: iron and steel products, 65 per cent; nonferrous metals, 17 per cent; chemicals including rubber manufacturing, 8 per cent; other, including xerographic and electronic applications, 10 per cent. The 1985 distribution pattern is estimated to be similar to that of 1983.

OUTLOOK

Supply of tellurium is a function of copper output and the recovery rate from the feed material. Present prices do not generally justify expenditures to increase recovery rates. In the short to medium term, demand is expected to grow slowly and supply should be adequate to meet requirements. However as new copper production is increasingly derived from tellurium-poor ores, the total available supply of tellurium is even more limited than that of selenium. Application of significant new uses of tellurium, such as in solar collectors, or in the form of MCT in photovoltaic cells would increase demand there by causing the higher prices that would justify a higher recovery from tellurium-bearing copper ores. Military and aerospace applications have the potential to increase MCT demand, presumably even if prices were to rise significantly.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
92804-5	Tellurium	5	10	15	free
MFN Reductions under GATT (effective January 1 of year given)			1985	1986	1987
				(%)	
92804-5			10.0	9.9	9.2
UNITED STATES (MFN)					
427.12	Tellurium salts		4.0	3.9	3.7
421.90	Tellurium compounds		4.0	3.9	3.7
632.48	Tellurium metals, unwrought other than alloys, and waste and scrap		1.0	0.5	free
632.88	Tellurium metal alloys, unwrought		6.4	5.9	5.5
633.00	Tellurium metal, wrought		6.4	5.9	5.5
EUROPEAN ECONOMIC COMMUNITY					
			1985	Base Rate	Concession Rate
28.04 C.3	Tellurium metal		2.2	2.4%	2.1%

Sources: The Customs Tariff 1985, Revenue Canada Customs and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, Vol. 27, No. L320, 1985.

TABLE 1. CANADA, SELENIUM PRODUCTION, EXPORTS AND CONSUMPTION, 1983, 1984, 1985e

	1983		1984		1985	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production						
Refined[1]	352	..	467	..	458 e	..
Exports					(9 months)	
United Kingdom	111	1,236	117	2,175	52	1,023
United States	87	2,321	115	3,135	101	2,637
Netherlands	33	341	92	1,454	34	781
People's Republic of China	-	-	20	220	11	247
Spain	14	149	20	355	9	187
Belgium and Luxembourg	453	64	28	726	19	469
Other countries	9	398	26	914	8	494
Total	707	4,509	418	8,979	234	5,838
Consumption[2]	17.0	..	13.8	..	13.8	

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Refinery output from all sources, including imported materials and secondary sources.
[2] Consumption (selenium content), as estimated by Noranda Inc.
[e] Estimated; .. Not available; - Nil.

TABLE 2. CANADA, SELENIUM PRODUCTION, EXPORTS AND CONSUMPTION, 1970, 1975, 1980, 1983-85

	Production Total Refined[1]	Exports[2]	Consumption[3]
		(tonnes)	
1970	388	311	7.1[3]
1975	342	218	9.9[3]
1980	377	307	10.8[3]
1983	352	707	17.0[4]
1984	467	418	13.8[4]
1985e	458	234*	13.8[4]
1986f	470	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Refinery output of selenium from all sources, including imported concentrates, blister and scrap and domestic scrap. [2] Exports of selenium, metal powder, shot, etc. [3] Consumption (selenium content), as reported by consumers. [4] Consumption (selenium content) as estimated by Noranda Inc.
[e] Estimated; [f] Forecast; .. Not available.
* Data for 9 months of exports in 1985, not total exports for the year.

TABLE 3. NON-COMMUNIST WORLD[1,2] REFINERY PRODUCTION OF SELENIUM, 1983-85

	1983	1984P	1985e
		(kilograms)	
Japan	433	465	465
Canada	352	467	458
United States	354	254	195
Philippines	..	20	30
Sweden	44	45	44
Chile	..	40	40
Belgium and Luxembourg[e]	60	60	60
Other countries[3]	111	133	117
Subtotal[2]	1 384	1 470	1 410

Sources: U.S. Bureau of Mines, Energy Mines and Resources Canada.
[1] Includes material from primary plus secondary sources. [2] Australia, Federal Republic of Germany, and USSR refine selenium but do not report outputs. Estimates for these nations' outputs are not included in Table 3. [3] Peru, Mexico, Zambia, Finland and Yugoslavia.
[e] Estimates from USBM; other estimates are that Belgian production exceeds 100 tpy; P Preliminary.

TABLE 4. EUROPEAN FREE MARKET SELENIUM PRICES, MINIMUM 99.5 PER CENT, IN WAREHOUSES

	($US/lb)			
	1984		1985	
	low	high	low	high
January	4.10	4.76	8.83	9.36
February	4.28	5.33	8.24	8.79
March	8.78	10.81	6.81	7.34
April	10.50	12.19	6.36	6.98
May	10.50	11.69	7.09	7.61
June	10.34	11.19	6.63	7.16
July	9.78	10.42	6.37	6.94
August	9.24	9.94	7.18	7.50
September	9.74	10.09	7.27	7.44
October	9.55	9.97	7.19	7.31
November	9.27	9.75	7.10	7.29
December	9.16	9.72	..	..
Average	8.77	9.65	..	..

Source: Metals Bulletin for monthly prices; average is arithmetic average of monthly prices.
.. Not available.

TABLE 5. CANADA, PRODUCTION AND CONSUMPTION OF TELLURIUM, 1970, 1975, 1980 AND 1983-86

	Production	Consumption
	Total Refined[1]	Refined[2]
	(tonnes)	
1970	29.3	0.4
1975	42.3	w
1980	9.0	w
1983	23.5	w
1984[r]	13.6	w
1985[e]	19.0	..
1986[f]	28.0	..

[1] Refinery output of tellurium from all sources, including imported concentrates, blister, and scrap and domestic scrap.
[2] Consumption (tellurium content), as reported by consumers.
[w] Withheld to avoid disclosing company data; .. Not available; [e] Estimated; [r] Revised; [f] Forecast.

TABLE 6. IDENTIFIABLE[1] NON-COMMUNIST PRODUCTION OF TELLURIUM, 1983-85

	1983	1984[p]	1985[e]
		(tonnes)	
Japan	65	63	65
Canada	23	15	15
Peru	22	14	15

Sources: U.S. Bureau of Mines, Energy, Mines and Resources Canada.
[1] Available data. United States withholds its figures to avoid disclosing company data, but accounted for 42 per cent of world output in 1975.
[e] Estimated; [p] Preliminary.

Silica

MICHEL A. BOUCHER

SUMMARY

In 1985 silica production in Canada declined slightly in terms of tonnage but the total value of production increased by 8 per cent. Production increased in British Columbia and Alberta, decreased in Ontario and remained about the same in the rest of the country during the year.

The consumption of silica by the glass container industry continued to be affected negatively by the use of recycled glass waste, and competition from aluminium and plastics has eroded markets traditionally belonging to glass containers.

Lack of markets forced one important producer of glass containers to close its British Columbia plant in 1985.

CANADIAN SCENE

Newfoundland

All silica production from Dunville Mining Company Limited, a subsidiary of ERCO Industries Limited, is captive to ERCO, a producer of elemental phosphorus, where silica is used as a flux. The quartzite quarry at Villa Marie operates from May to December.

Nova Scotia

Nova Scotia Sand and Gravel Limited produces a high purity silica from sand deposits, for a variety of uses including sandblasting, glass, foundry sand, frac sand etc.

However, due to the closure of The Enterprise Foundry Company, Limited in New Brunswick and Fiberglas Canada Inc. also in New Brunswick, sales which were substantially reduced in 1983 and 1984 increased slightly in 1985.

New Brunswick

Chaleur Silica Ltd. produces silica for use as a flux in Brunswick Mining and Smelting Corporation Limited's Belledune lead smelter, for cement plants, and as sandblasting material. Sales were substantially increased during the year.

Quebec

Indusmin Limited is the largest producer (in terms of volume and value of production) of silica east of Ontario with a reported total production capacity of some 500 000 tpy. Silica is mined from a quartzite deposit at Saint Donat and from a sandstone deposit at Saint Canut. Silica from Saint Donat is refined at the Saint Canut plant near Montreal.

Most silica produced by Indusmin originates from Saint Canut where the ore is crushed, screened and beneficiated by attrition scrubbing, flotation and magnetic separation. Production in 1985 remained at about the same level as in 1984. The major markets for Indusmin products are the glass, fiberglass and silicon carbide industries.

Baskatong Quartz Inc. continued to produce a high-purity silica from a quartzite deposit north of Saint Urbain. The silica is used mainly by SKW Canada Inc. for the production of ferrosilicon and silicon metal. In 1985 Baskatong started production of high-purity silica from a quartzite deposit located at Lac Bouchette. The silica is sold to the ferroalloy industry.

Les Entreprises Loma Ltée of Beauport crushes and classifies the fines produced by SKW Canada Inc. The silica is sold to the silicon carbide and sandblast industries.

Armand Sicotte & Sons Limited mined Potsdam sandstone at Sainte Clothilde, south of Montreal. Lump silica is used for the production of ferrosilicon, phosphorus, and in the cement industry.

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Sable de Silice Crémazie Inc. continued to mine silica sand and gravel at St. Joseph-du-Lac and at Ormstown. The material is used mainly for sandblasting but also for fiberglass, glass and foundries.

Ontario

Indusmin Limited is also the largest producer (in terms of volume and value of production) of silica west of Quebec, with a reported total capacity of about 500 000 tpy, about the same as its Quebec operation. Lump quartzite from Badgeley Island, north of Georgian Bay is shipped by lake boat to Canadian destinations for the manufacture of ferrosilicon. The finer material produced by crushing, is shipped to Midland, south of Georgian Bay where it is further processed to a glass-grade silica sand, and silica flour for ceramic and other uses. Substantially reduced sales were reported in 1985 mainly as a result of increased recycling of glass containers.

Manitoba

In 1985 Marine Transport Limited of Selkirk, Manitoba, purchased the silica sand operation of Steel Brothers Canada Ltd. The purchase included the high-purity silica sand quarry on Black Island in Lake Winnipeg some 130 km north of Selkirk and the processing plant at Selkirk. The silica sand, mined from a poorly consolidated white sandstone, is well rounded and suitable for use in foundries, glass and fiberglass. The ore is washed, screened and dewatered at a plant on the island, and is then shipped by barge to a processing plant at Selkirk on the Red River.

Inco Limited continued to produce a low-grade silica from an impure quartzite from the Manasan quarry for its Thompson smelter and converter. Production varies from year to year depending on nickel production.

Saskatchewan

Hudson Bay Mining and Smelting Co., Limited produces smelter flux from two pits in northern Saskatchewan.

Alberta

Sil Silica a division of Strathcona Resource Industries Ltd. produces silica sand from local sand dunes in the Bruderheim area. Silica is sold mainly as fiberglass and sandblasting material. It is also sold as foundry sand, filtration sand, frac sand and as railway traction sand.

British Columbia

Mountain Minerals Co. Ltd., which mines a high-purity, friable sandstone deposit near Golden, has upgraded its processing plant. Rock is crushed, screened, washed, dried and separated into several sizes. These different sizes are sold for glass sand, sandblasting sand, foundry sand, filter media sand, golf course sand and fine sand. Sales are reported to be improving from year to year. The company is conducting on-going research and development aimed at producing a variety of new products, one of which is a high-purity silica for high-tech applications.

Domglas Inc. of Burnaby, closed its glass container plant in November 1985 due to lack of markets. Nearly all silica used at the plant was imported from the State of Washington. The company reported that production of glass containers at its Redcliff, Alberta container plant should increase as a result of the closure of the Burnaby plant.

TRADE

Most silica sand imported into Canada comes from loosely consolidated and easily processed sandstone or lake sand deposits located near the Great Lakes region of the United States in Illinois, Wisconsin, Michigan and Indiana. The imported silica sand is used mainly by iron and steel foundries and by the glass industry of Ontario and Quebec. For the past three years exports of quartzite from Canada to the United States have substantially increased.

OUTLOOK

Little improvement is expected in 1986 in Canada's three major markets for silica namely the glass, foundry and fiberglass industries. In the medium term, competition from U.S. producers of silica for glass and foundry sand will remain strong in Ontario and Quebec because of the proximity of these provinces to the low-cost producers of the U.S. Great Lakes region. Also due to the downsizing of passenger cars, recycling of silica sand at foundries, and other factors, as mentioned before, only small growth can be expected in the foundry sand industry in Canada. Competition from substitutes for glass containers such as plastics and aluminum will remain strong across Canada.

In the long-term, there is potential in Canada for the development of a deposit on Iles-de-la-Madeleine in the Gulf of St.

Lawrence where silica sand and byproduct feldspar could be produced for sale to foundries, glass and ceramic producers of northeastern United States and eastern Canada.

There is also potential for the establishment of a flat glass producing facility in western Canada, where no such plants exist; good quality silica would be readily available as well as comparatively inexpensive natural gas or electricity.

Eventually higher quality and higher value silica products could be manufactured in Canada including optical quartz, solar grade silica, fused quartz and fused silica products, fumed "pyrogenic" silica (produced chemically or through the plasma route), quinta and iota quartz, and cultured quartz based on inexpensive electricity.

PRICES

The following table gives the average price of different silica products in the United States in 1985.

Silica	$US/t fob mill or manufacturing plant
Metallurgical	7
Glass & Fiberglass	
(insulation)	7-16
Foundry	12-16
Frac sand	24
Filler	33
*Amorphous silica	
coarse (+93%-200 mesh)	35-70
very fine (99%-8 microns)	100-200
Pyrogenic (fumed) silica[1]	5,000-9,000
*Quartz rock crystals	
for fusing	500-2,700
for piezo-electrical	
and optical use	5,500-13,000
Cultured quartz[1]	
(as ground bars)	55,000-90,000

Source: Personal communications with industry and *Published prices by Engineering & Mining Journal, October 1985 and Chemical Reporter.
[1] Manufacturing plant.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			%		
CANADA					
29500-1	Ganister and sand	free	free	free	free
29700-1	Silex or crystallized quartz, ground or unground	free	free	free	free
UNITED STATES					
513.14	Sand, other		free		
514.91	Quartzite, whether or not manufactured		free		
523.11	Silica, not specially provided for		free		

Item No.		1985	1986	1987
			¢ per long ton	
513.11	Sand containing 95% or more silica, and not more than 0.6% of oxide of iron	6	3	free

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241.

TABLE 1. CANADA, SILICA PRODUCTION (SHIPMENTS) AND TRADE, 1982-85

	1982		1983		1984		1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production (shipments), quartz and silica sand								
By province								
Quebec	661 000	x	709 300	x	763 515	14,703	738 000	15,482
Ontario	438 000	8,227	874 548	11,466	1 147 602	12,125	1 013 460	11,929
Alberta	x	x	x	x	x	x	x	x
Manitoba	x	x	x	x	x	x	x	x
Nova Scotia	x	x	x	x	x	x	x	x
New Brunswick	x	x	x	x	x	x	x	x
Saskatchewan	99 000	1,066	123 062	1,476	127 578	1,658	125 000	1,705
Newfoundland	x	x	x	x	x	x	x	x
British Columbia	x	x	x	x	x	x	x	x
Total	1 703 000	31,864	2 303 451	38,467	2 658 932	40,845	2 537 884	44,110
Imports							(Jan.-Sept. 1985)	
Silica sand								
United States	788 468	15,475	982 568	16,864	1 076 068	19,403	673 866	16 031
West Germany	-	-	56	17	5	1	-	-
Other countries	300	120	38	2	9	4	17	5
Total	788 768	15,595	982 662	16,883	1 076 082	19,408	673 883	16,036
Silex and crystallized quartz								
United States	230	265	248	237	437	372	269	253
Japan	1	1	20	15	19	26	12	18
Other countries	10	16	3	3	38	9	14	16
Total	241	282	271	255	494	407	295	287
Firebrick and similar shapes, silica								
United States	2 584	2,021	1 981	2,983	3 423	2,719	1 260	2,243
France	219	254	649	454	444	521	300	352
West Germany	52	49	360	84	360	52	16	48
Other countries	129	82	37	40	-	-	16	25
Total	2 984	2,406	3 027	2,671	3 917	3,292	1 592	2,668
Exports								
Quartzite								
United States	65 314	566	103 944	936	116 265	931	78 822	778
Other countries	19	2	16	2	18	1	-	-
Total	65 333	568	103 960	938	116 283	932	78 822	778

Source: Statistics Canada; Energy, Mines and Resources Canada.
P Preliminary; - Nil; x Confidential.

TABLE 2. IMPORTS OF SILICA SAND, (FROM UNITED STATES) BY PROVINCE BY USE, 1984

Use		Newfound-land	Nova Scotia	Prince Edward Island	New Brunswick	Quebec	Ontario	Manitoba	Saskat-chewan	Alberta	British Columbia
Foundry	tonnes	-	330	-	275	36 587	479 806	711	183	1 008	22 677
	$000	-	7	-	7	702	4,989	35	7	30	936
Glass manufacturing	tonnes	-	-	-	-	16 984	257 665	-	-	-	41 860
	$000	-	-	-	-	200	2,823	-	-	-	1,067
Silex and crystal-lized quartz	tonnes	-	-	-	-	71	415	-	-	-	8
	$000	-	-	-	-	46	354	-	-	-	6
Not elsewhere specified	tonnes	-	39	-	289	9 445	91 991	7 924	41 020	25 323	41 965
	$000	-	8	-	9	249	2,084	320	1,564	1,033	3,338

Source: Statistics Canada
- Nil.

TABLE 3. CANADA, SILICA PRODUCTION AND TRADE, 1970, 1975, AND 1979-85

Year	Production	Imports			Exports	Consumption
	Quartz and Silica Sand	Silica Sand	Silex or Crystallized Quartz	Firebrick and Similar Shapes	Quartzite	Quartz and Silica Sand
			(tonnes)			
1970	2 937 498	1 176 199	186	2 020	58 917	3 979 305
1975	2 491 715	1 044 160	1 550	18 818	39 977	3 510 818
1979	2 368 497	1 651 890	1 259	4 896	60 823	3 611 815
1980	2 252 000	1 200 237	281	4 775	63 166	3 326 956r
1981	2 238 000	1 142 880	251	13 762	119 347	3 079 225r
1982	1 797 000r	788 768	241	2 984	65 333	2 623 263r
1983	2 303 451	982 662	271	3 027	103 960	..
1984	2 658 932	1 076 082	494	3 917	116 283	..
1985p	2 537 884	..	..	..	..	..

Sources: Statistics Canada; Energy, Mines and Resources Canada.
p Preliminary; .. Not available; r Revised.

Silver

D. LAW-WEST

In 1985, silver prices continued to weaken as investor interest decreased, largely due to lower inflation rates in some major market economies, a perception that inflation will remain low for the next few years and also the relatively high value of the American dollar. Western world production is estimated to be 14 600 t in 1985 compared to 13 880 t in 1984. Canadian silver production declined to about 1 210 t from 1 330 t, during the same period. Western world silver demand increased marginally in 1985 to about 12 100 t from 11 965 t in 1984.

Silver prices are expected to remain relatively weak for the next few years, partially due to the large stockpiles which overhang the market.

CANADIAN DEVELOPMENTS

Canadian silver production declined by 9 per cent in 1985 to 1 210 t compared to 1984. The primary reason was the decline in byproduct silver production from base-metal mining.

Production in Atlantic Canada came solely from New Brunswick, where production fell by 14 per cent to an estimated 190 t. The reduction in output is the result of production cutbacks at Brunswick Mining and Smelting Corporation Limited's operations.

In Quebec, silver production increased by about 6.5 per cent to 50 t, mainly as the result of increased byproduct recovery from gold mines. Byproduct silver production by the province's base-metal mining industry remained fairly stable during the year.

In Ontario, Canada's largest silver producing province, silver output fell by about 10 per cent to 490 t in 1985. Agnico-Eagle Mines Limited's silver operation in Cobalt remained the province's bright spot in silver production. The company produced some 42.2 t in the first nine months of the year compared to the previous year's 34.4 t. In addition, Agnico-Eagle was successful in reducing its operating costs to $US 4.00 per oz of silver. However, reductions in silver production by the base-metal industry more than offset Agnico-Eagle's increase.

Silver exploration was fairly active in the Cobalt region of northern Ontario. Silverside Resources Inc. and Silver Lake Resources Inc. were jointly exploring two high-grade zones discovered in 1983. The companies were driving an inclined ramp to allow for underground exploration and further delineation of the vein system.

In Manitoba, all silver production is a byproduct of the base-metal mining industry. Production in 1985 remained virtually unchanged at 35 t.

British Columbia, the second largest domestic silver producer, produced 364 t in 1985, up slightly from 361 t in 1984. Equity Silver Mines Limited (owned 70 per cent by Placer Development Limited) remained the country's largest silver mine and produced 140 t of silver. The company started an expansion of its mine concentrator from 5 300 tpd to 7 680 tpd. The construction should be completed by mid-1986 at a cost of $12 million.

Silver production in British Columbia received an additional boost with the start-up of Westmin Resources Limited's H-W zinc-copper mine and expansion of the mill complex at its Myra Falls operations. The company is expecting annual silver production of 31 t.

In the Yukon Territories, United Keno Hill Mines Limited continued efforts to reduce operating costs. Wages were reduced and lower refining, treatment and transportation costs were obtained. Near year-end, the company's operating costs were about $US 6.00 per oz of silver. United Keno has also been conducting a $10 million exploration program, aimed at discovering higher grade material. Nearby at Galena Hill, some mineralization grading 60-90 oz per t was encount-

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ered in the 2,000 ft adit which was being driven. It will take an additional six months to a year to determine the full potential of the zone.

Terra Mines Ltd. was forced to close its Camsell River silver mine in the Northwest Territories on April 1. The company identified low metal prices as the main cause for the closure. The company's closure is reflected in the drop of silver production in the Northwest Territories for 1985 to 35 t from 58 t a year before.

Canadian consumption of refined silver in 1985 was expected to have changed little from the 299 t in 1984.

INTERNATIONAL DEVELOPMENTS

Western world silver production is estimated to have dropped marginally to 10 250 t in 1985, from 10 290 t in 1984.

Silver production in Mexico dropped by about 180 t in 1985, to 2 000 t. The decline was caused by low prices which forced the closure of many of the country's smaller high-cost producers. Despite this decline, Mexico remained the world's largest silver producer.

In Peru, the Tintaya copper mine - with silver byproduct - opened during the year. As well, several other mines expanded output and Peruvian silver production increased marginally.

In Ecuador, a new silver mine is expected to start production in the near future. Armeno Resources Inc. of Vancouver, British Columbia, has acquired the San Bartolomé property through a contract with the Ecuador government. Armeno is planning an initial operating capacity of 100 tpd. The deposit has proven reserves of 90 000 t grading 684 g/t silver. An additional 1 million t of high-grade material has been indicated in a sub zone.

In 1985, primary silver production in the United States is expected to have declined by about 8 per cent, to 1 275 t. While some production was lost due to closure of some silver mines, the major drop was in output from base-metal mines.

CONSUMPTION AND USES

World silver consumption increased slightly to an estimated 12 100 t in 1985, compared to 1984. This was mainly due to increased demand for photography, electronic equipment, sterlingware and jewelery.

Photography is the largest single use for silver accounting for about 40 per cent of industrial consumption. While silver use by this industry has been rising over the past three years, it remains nearly 10 per cent below consumption in the late-1970s. The high silver prices of 1979 and 1980 led the photographic industry to reduce the amount of silver used per exposure, while at the same time increasing the silver recovered from spent photographic materials. Colour and black and white photographs account for some 55 per cent of silver used in photography, x-ray photographs account for about 35 per cent, while the remaining 10 per cent is broadly utilized in graphic arts, engineering and other industrial uses. Each of these sectors face different conditions that affect the amount of silver consumed. The colour and black and white photographic print business faces competition from silver-free technology such as electronic or video photo-imaging. At the same time, the number of amateur photographers is increasing and demand for photographic materials is increasing particularly in developing countries. According to some analysts the use of silver in this sector should continue to grow over the next few years.

Since the x-ray sector is mainly centred around hospitals, there is fairly complete recycling of used x-ray films. The rate of recycling depends upon the length of time which the x-rays are kept on record. The major threat to silver x-ray prints is from digital storage of x-ray images using chromium-dioxide video tapes. In addition, traditional x-ray machines are facing competition from other machines such as cat scanners and nuclear magnetic rosand units which could easily be linked with non-silver, video-recording equipment in lieu of the traditional silver-based x-ray prints.

The electrical and electronic industry accounts for about 30 per cent of consumption. Silver's superior electrical conductivity accounts for its extensive use in contacts, conductors, resistors and capacitors. Silver is preferred where a high degree of dependability is required. Spacecraft, satellites and aircraft guidance systems are typical examples. Also, silver-zinc and silver-cadmium batteries are used in spacecraft and jet aircraft. Consumption in the electronics industry will increase with the growing popularity of home entertainment units such as video cassette recorders and home micro-computers. However, the move toward miniaturization will in part offset the increased numbers.

Sterlingware and jewellery combined, account for about 5 per cent of consumption. Silver usage in these industries has declined substantially since the mid-1970s. At that time, sterlingware producers in the United States used 22-30 million ozs, while jewellers required about 13 million ozs.

The remaining 25 per cent of industrial silver is used mainly in: catalysts for chemical processing, mirrors, brazing alloys and solders, electroplating, dental amalgams, medical equipment, chemicals, coins, medallions and commemorative objects.

PRICES

Silver prices in 1985 averaged $US 6.13 per oz, down from $US 8.14 per oz in 1984. The silver market was much less volatile during the year fluctuating within a range of about $US 1.00. This compares with $US 3.75 the previous year.

In late-1985, a new silver price fix was introduced by three major Swiss banks. The Union Bank of Switzerland, Swiss Bank Corp. and Credit Suisse announced that the new fixing would take place at 10:30 a.m. each banking day. The Zurich fix is said to be "open" in that orders can be added or withdrawn while the fixing is in progress. According to the banks, this process would be more transparent and make it easier for the market to establish a price. The London silver price fix is "closed", meaning orders must be made before it begins, and other trading ceases while the fixing is in progress. At year-end, it was too early to judge what effect the new fixing would have on the London market.

OUTLOOK

In October, the Hunt Brothers disclosed that a substantial portion of their 1 800 t hoard of silver had been sold. This sizeable stockpile was regarded as a major depressant on the silver market. The news had a positive effect on the silver price which immediately after the disclosure, rebounded to $US 6.40 from $US 6.00. However, the rise was temporary, and the silver price dropped to the year's low of $5.76 in December.

Silver prices lost ground to gold through the year, after starting with a silver/gold price ratio of 1:49 it ended at 1:56. Silver is losing some of its investment appeal but industrial demand is increasing.

The short-term outlook for silver is for continued price weakness for at least the first half of next year. The second half may see some renewed strength to the $US 6.50 range.

In the medium to longer term, the price of silver will be partially influenced by the rate at which some stockpiles which overhang the market are reduced. Stocks which overhang the market include the 4 700 t on Comex and the 4 100 t held by the U.S. government.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
32900-1	Ores of metals, nop	free	free	free	free
35800-1	Anodes of silver	free	free	10	free
35900-1	Silver in ingots, blocks, bars, drops, sheets or plates unmanufactured; silver sweepings; scrap jewelery	free	free	free	free
35905-1	Scrap silver and metal alloy scrap containing silver	free	free	25	free
36100-1	Silver leaf	12.5	13.5	30	9
36200-1	Articles consisting wholly or in part of sterling or other silverware, nop; manufactures of silver, nop	13.9	13.9	45	9

MFN Reductions under GATT (effective January 1 of year given)	1985	1986	1987
		(%)	
36100-1	13.5	12.4	11.3
36200-1	13.9	12.4	11.0

UNITED STATES (MFN)

601.39	Precious metal ores, silver content	free
605.20	Silver bullion, silver dore and silver precipitates	free
605.70	Precious metal sweepings and waste and scrap, silver content	free
644.56	Silver leaf	2.5¢ per 100 leaves

		1985	1986	1987
			(%)	
420.60	Silver compounds	4.0	3.9	3.7
605.46	Platinum-plated silver, unwrought or semi-manufactured	9.6	8.6	7.5
605.47	Gold-plated silver, unwrought or semi-manufactured	13.8	11.9	10.0
605.48	Other unwrought or semi-manufactured silver	7.1	6.6	6.0
605.65	Rolled silver, unworked or semi-manufactured	7.1	6.6	6.0

TARIFFS (cont'd)

Item No.		1985	Base Rate (%)	Concession Rate
EUROPEAN ECONOMIC COMMUNITY (MFN)				
28.49	Colloidal silver, amalgams, salts and other compounds of silver			
A.	Colloidal silver	6	8.0	5.3
B.	Amalgams of silver	6	8.0	5.3
C.	Salts and other compounds, inorganic or organic of silver	6.9	9.6	6.0
71.05	Silver, including silver gilt and platinum-plated silver, unwrought or semi-manufactured			
A.	Unwrought	free	free	free
B.	Bars, rods, wire and sections, plates, sheets, strips	1.9	2.0	1.8
C.	Tubes, pipes and hollow bars	3.1	3.5	2.9
D.	Foil of a thickness, excluding any backing, not exceeding 0.15 mm	5.4	6.5	5.0
E.	Powder, purls, spangles, cuttings and other forms	4.1	5.0	3.8
71.06	Rolled silver, unworked, or semi-manufactured			
A.	Unworked	4.1	5.0	3.8
B.	Semi-manufactured	5.1	6.5	4.6
71.08	Rolled gold on silver, unworked or semi-manufactured	3.1	3.5	2.9
71.10	Rolled platinum or other platinum group metals on silver, unworked or semi-manufactured	3.1	3.5	2.9
71.11	Silversmiths sweepings, residues and other waste and scrap	free	free	free
71.12	Articles of jewellery and parts thereof, of silver or rolled silver			
A.	Of silver	3.6	4.5	3.5
B.	Of rolled silver	6.6	9.0	5.8
71.13	Articles of silversmiths wares and parts thereof, of silver, other than above			
A.	Of silver	4.1	7.5	3.0
B.	Of rolled silver	4.1	5.0	3.8
71.14	Other articles of silver or rolled silver			
A.	Of silver	5.1	7.5	5.1
B.	Of rolled silver	4.8	6.0	4.4

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, L320, Vol. 27, 1985.
nop Not otherwise provided for.

TABLE 1. CANADA, SILVER PRODUCTION AND TRADE, 1983-85 AND CONSUMPTION, 1983 AND 1984

	1983		1984P		1985e	
	(kilograms)	($000)	(kilograms)	($000)	(kilograms)	($000)
Production[1]						
By province and territories						
British Columbia	406 783	185,111	360 743	125,585	363 692	101,485
Ontario	419 401	190,853	541 345	188,457	489 132	136,487
New Brunswick	197 684	89,958	217 154	75,597	187 125	52,215
Quebec	46 215	21,031	46 937	16,340	49 584	13,836
Manitoba	32 858	14,952	35 519	12,365	34 849	9,724
Saskatchewan	4 795	2,182	5 273	1,836	4 797	1,325
Yukon Territories	15 142	6,891	57 074	18,825	45 924	12,675
Northwest Territories	79 151	33,743	58 487	20,361	34 458	9,615
Total	1 197 031	544,723	1 326 720	461,868	1 209 010	337,362
By source[2]						
Base-metal ores	1 000 306		1 090 323		..	
Gold ores	16 927		44 199		..	
Silver ores	178 986		191 442		..	
Placer gold ores	812		756		..	
Total	1 197 031		1 326 720		1 209 010	
Exports						
					(Jan.-Sept.)	
Silver in ores and concentrates						
Japan	185 639	68,119	202 170	49,052	174 179	34,838
United States	88 769	32,455	103 144	27,603	28 843	4,539
Belgium-Luxembourg	93 937	28,639	18 023	3,393	819	40
West Germany	18 257	3,400	14 859	2,292	11 308	1,285
Switzerland	9 919	2,987	17 614	4,868	-	-
Other countries	43 406	11,580	68 863	15,587	29 388	4,190
Total	439 927	147,180	424 673	102,795	244 537	44,912
Refined metal						
United States	1 041 674	480,533	1 076 414	362,797	1 125 466	305,960
Trinidad-Tobago	779	378	236	93	165	67
Dominican Republic	200	46	181	35	18	40
United Kingdom	229	99	379	114	43	15
Other countries	2 985	1,115	1 411	884	126	38
Total	1 045 867	482,171	1 078 621	363,923	1 125 818	306,120
Imports						
Silver in ores and concentrates						
Peru	77 788	26,752	78 503	20,353	42 494	9,128
Chile	31 748	11,681	14 908	4,770	4 858	1,147
United States	24 887	8,326	25 653	7,642	10 719	2,491
South Korea	6 230	2,641	805	265	-	-
South Africa	5 806	1,860	5 619	1,439	-	-
Other countries	6 796	2,136	22 291	6,692	18 455	3,598
Total	153 255	53,396	147 779	41,061	76 526	16,364
Refined metal						
United States	280 496	125,377	195 908	62,714	501 816	136,045
Mexico	1 968	1,016	8 922	4,974	6 138	2,813
West Germany	1 015	372	1 037	238	8 187	2,038
Belgium-Luxembourg	-	-	-	-	16 794	4,583
Chile	33 496	16,106	7 999	3,198	-	-
Others	22 464	9,471	1 268	315	937	131
Total	337 439	152,342	215 134	71,439	533 872	145,610
Consumption, by use						
Sterling	27 649		22 042			
Silver alloys	36 562		31 930			
Wire rod	5 286		5 571			
Others[3]	213 852		239 897			
Total	283 349		299 440			

Sources: Energy, Mines and Resources Canada; 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; and base and other bullion produced from domestic ores. [2] Estimated by Energy, Mines and Resources Canada; the base-metal category includes production of some mines normally regarded as silver producers, but which also recover some base-metal. [3] Includes sheet, coinage, fabricated investment bars and miscellaneous uses.
P Preliminary; e Estimated; - Nil; .. Not available.

TABLE 2. CANADA, SILVER PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975, AND 1979-85

	Production		Exports			Imports,	Consumption[3]
	All Forms[1]	Refined[2] Silver	In Ores and Concentrates	Refined Silver	Total	Refined Silver	Refined Silver
	(kilograms)						
1970	1 376 354	955 668	678 676	752 689	1 431 365	134 347	187 679
1975	1 234 642	931 540	471 410	713 566	1 184 976	420 078	642 089
1979	1 146 908	949 778	415 726	911 146	1 326 872	38 308	251 985
1980	1 070 000	985 051	396 690	881 761	1 278 451	339 180	265 938
1981	1 129 394	875 121	546 449	914 800	1 461 249	327 328	292 130
1982	1 314 000	790 358	602 603	1 134 347	1 736 950	484 240	180 459
1983	1 197 031		439 406	1 045 867	1 485 273	3397439	283 349
1984P	1 326 720		424 673	1 078 621	1 503 294	215 134	299 440
1985e	1 209 011		244 537[4]	1 125 818[4]	1 370 355[4]	533 872[4]	..

Sources: Energy, Mines and Resources Canada; 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; and base and other bullion produced from domestic ores. [2] From all sources, domestic and imported materials of both primary and secondary origin. [3] In some years includes only partial consumption for coinage. [4] 1985 exports and imports are for nine months.
P Preliminary; e Estimated; .. Not available.

TABLE 3. WORLD MINE PRODUCTION[1] OF SILVER, 1984 AND 1985

	1984	1985
	(tonnes)	
U.S.S.R.e2	1 600.0	..
Mexico	1 918.7	1 144.0
Peru	1 662.7	836.7
Canada[3]	1 326.7	1 209.0
United States	1 382.2	602.6
Australia	1 062.9	531.4
Polande	774.0	..
Chile	486.6	239.5
Japan	323.6	162.0
Republic of South Africa	217.6	143.1
Bolivia	141.8	70.8
Sweden	180.3	96.1
Yugoslaviae2	128.0	80.4
Spain	221.4	110.8
Morocco	126.6	64.0
Zaire	38.0	19.0
South Korea	61.6	28.8
Argentina	90.0	45.0
Philippines	50.0	26.2
People's Republic of Chinae	90.0	..
Greece	57.0	28.6
Italy	50.2	38.4
France	24.3	12.0
Other countriese	1 821.2	298.6
Total	13 805.4	5 788.0

Source: World Bureau of Metal Statistics.
[1] Recoverable content of ores and concentrates produced unless otherwise noted. [2] Smelter and refinery production. [3] Energy, Mines and Resources Canada estimated for all of 1985.
P Preliminary; e Estimated; .. Not available.

TABLE 4. ANNUAL AVERAGE SILVER PRICES: CANADA, UNITED STATES AND UNITED KINGDOM, 1975-85

	Canada	United States Handy & Harman, New York	United Kingdom London Spot
	($Cdn)	($US)	(pence)
	(per troy ounce)		
1975	4.503	4.419	200.118
1976	4.291	4.353	242.423
1977	4.922	4.623	265.512
1978	6.171	5.401	282.203
1979	12.974	11.094	519.607
1980	24.099	20.632	900.778
1981	12.617	10.518	515.303
1982	9.831	7.947	455.331
1983	14.154	11.441	753.644
1984	10.521	8.141	609.510
1985	8.362	6.142	473.321

Sources: Canadian prices as quoted in the Northern Miner (arithmetical average of daily quotations). United States and United Kingdom prices as quoted in Metals Week.

Sodium Sulphate

G.S. BARRY

Sodium sulphate is mainly produced from natural brines and deposits in alkaline lakes in areas with dry climates and restricted drainage, from subsurface deposits and brines, or as a byproduct of chemical processes. Canada's sodium sulphate industry is based on extraction from natural brines and deposits in several alkaline lakes in Saskatchewan and Alberta. Nine plants producing natural sodium sulphate operated in Canada in 1985. Byproduct sodium sulphate is recovered at one rayon plant and at three paper mills in Ontario.

In the United States, natural and byproduct sodium sulphate production is almost evenly split. In Europe, sodium sulphate is produced almost entirely as a byproduct of chemical processes.

PRODUCTION AND DEVELOPMENTS IN CANADA

Markets for sodium sulphate, which were strong, for five consecutive years, between 1978 and early-1983 started to decline by mid-1983 as the overall North American economy improved and additional secondary supplies became available. The Saskatchewan producers responded by gradually decreasing production by 35 per cent between 1982 and 1985. The unit value of shipments was $93.92 per t in 1983; $96.90 in 1984; and $94.38 in 1985. Exports to the United States declined by 17 per cent for the first nine months of 1985 compared with the same period last year.

Besides natural sodium sulphate, about 90 000 tpy are produced as a byproduct of industrial and chemical processes in central Canada. Between 35 and 40 per cent of the total sodium sulphate produced in Canada is the higher-grade and higher-priced "detergent-grade".

Placer Development Limited brought on-stream the Equity Silver Mines Limited property in British Columbia in December 1982. The capacity of the plant was 5 000 tpy of sodium sulphate. The leach plant was closed in April 1984.

Potash Corporation of Saskatchewan (PCS) completed the construction of a $10 million potassium sulphate demonstration plant at its Cory potash mine near Saskatoon. The plant has a designed capacity of 30 000 tpy. It was in the start-up mode since the spring of 1985 and will be run commercially under the Cory mine management starting in January 1986. The production of potassium sulphate is achieved through a reaction of sodium sulphate with potassium chloride (glaserite process).

In the spring of 1986 PCS expects to complete a feasibility study on a large potassium sulphate plant based on sulphate brines of Big Quill Lake. Depending on technical and market factors, such a plant could have a capacity of up to 300 000 tpy of product and would cost somewhat less than $100 million.

The Bishopric operation on Frederick Lake, operated by Saskatchewan Minerals, which was last in production in 1983, is now closed permanently and was taken off the potential producer list. In January 1985 Alberta Sulphate Limited, then entirely owned by Agassiz Resources Ltd., bought the Francana operations from Hudson Bay Mining and Smelting Co., Limited. The two deposits in Saskatchewan (Snakehole and Alsask Lakes) and the deposit in Alberta (Metiskow Lake) are now all operated under the name: Francana Minerals, a division of Agassiz Resources Ltd.

Deposits. The sodium sulphate deposits in Saskatchewan and Alberta have formed in shallow, undrained lakes and ponds where in-flow is greater than out-flow. Percolating ground waters carry dissolved salts into the basins from the surrounding soils. High rates of summer evaporation concentrate the brine to near saturation, and cooler fall temperatures cause crystallization and precipitation of sodium sulphate as mirabilite ($Na_2SO_4 \cdot 10H_2O$). The cycle has been

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repeated year after year and thick deposits of hydrous sodium sulphate, accompanied by other salts and mud, have accumulated.

Identified deposits in Saskatchewan contain, in total, approximately 90 million t of anhydrous sodium sulphate. Of this amount, a total of about 51 million t is in 21 individual deposits, each containing more than 500 000 t of sodium sulphate. Exploitation currently takes place on the following lakes (with reserves, in millions of t, in brackets): Whiteshore Lake (6.0), Horseshoe Lake (2.7), Chaplin Lake (2.4), Ingebrigt Lake (8.1), Alsask Lake (2.0), East Coteau Lake (3.4), and Snakehole Lake and Verlo Lake (1.2), all in Saskatchewan. Production in Alberta is from Metiskow Lake (0.9).

Recovery and processing. Because most of the sodium sulphate is recovered by evaporation of concentrated brines or by dredging of the permanent beds of crystals, weather is as important for recovery of sodium sulphate as it is for its deposition. A large supply of fresh water is also essential. One method of sodium sulphate recovery is to pump lake brines that have been concentrated by hot summer weather into evaporating ponds or reservoirs. Continued evaporation produces a saturated or near-saturated solution of mirabilite. Differential crystallization occurs in the fall when the solution cools. Hydrous sodium sulphate crystallizes and precipitates, whereas sodium chloride, magnesium sulphate and other impurities remain in solution. Before freezing weather sets in, the impure solution remaining in the reservoir is drained or pumped back into the source lake. After the crystal bed has become frozen, harvesting is carried out using conventional earthmoving equipment. The harvested crystal is stockpiled adjacent to the plant.

Some operators used floating dredges to mine the permanent crystal bed. The slurry of crystal and brine is transported to a screening house at the plant by pipeline. If sufficiently concentrated, the brine from the screens is collected in an evaporation pond.

Since 1984 one company uses solution mining in lake beds that are 3 to 11 metres thick. It pumps a concentrated brine to an air-cooled crystallizer at the plant, where sodium sulphate is separated from other insoluble salts.

Processing of a natural salt consists of dehydration (Glauber's salt contains 55.9 per cent water of crystallization) and drying. Commercial processes used in Saskatchewan include Holland evaporators, gas-fired rotary kilns, submerged combustion and multiple effect evaporators. Salt cake, the product used principally in the pulp and paper industry, contains a minimum of 97 per cent Na_2SO_4. Detergent-grade material analyzes up to 99.7 per cent Na_2SO_4. Uniform grain size and free-flow characteristics are important in material handling and use.

Of the nine plants in the prairies, three are capable of producing detergent-grade sodium sulphate. Each of the three plants has the capacity to produce 80 per cent or more of its output as a high-grade product. The "natural" sodium sulphate industry employs about 300 persons.

Byproduct recovery. Courtaulds (Canada) Inc. produced in 1985 approximately 17 000 t of detergent-grade sodium sulphate as a byproduct of viscose rayon production at its Cornwall, Ontario plant. Ontario Paper Company Limited at Thorold, Ontario produced approximately 60 000 t of salt cake in 1985 as a byproduct of paper manufacturing. It is mostly used in the glass industry and 60 per cent is exported. The capacity of the Thorold plant is 77 000 tpy. The Great Lakes Paper Company, Limited at Thunder Bay, produces salt cake for internal consumption (about 10 000 t in 1985).

PRICES

Canadian prices of natural sodium sulphate fob western plants were approximately $80 and $100 per t respectively for salt cake and detergent-grade at the beginning of 1985. Prices for detergent-grade byproduct sodium sulphate in Ontario were in the order of $160 to $175 per t (for bulk) fob plants in 1985 and were fairly strong at the end of the year.

USES

In the chemical pulping of wood the digestion reagents consist of about two-thirds caustic soda and one-third sodium sulphide obtained by using sodium sulphate as makeup. About 33 per cent of sulphur input is retained in the organic chemicals recycled in the process. Lately, technical improvements in the process significantly decreased the consumption of sodium sulphate per t of pulp produced, to about 20 kg/t. More caustic soda and emulsified sulphur is being substituted for salt cake.

Sodium sulphate is used as a builder; or more correctly as a diluent in detergents (supplies "bulk"); it is claimed to improve detergency through its effect on the colloidal properties of the cleaning system. The curtailment in the usage of phosphates on grounds of pollution control in all probability is not going to affect the use of sodium sulphate. The content of sodium sulphate in detergents varies from about 10 to 65 per cent. Roskill Information Services Ltd., suggests that as a very rough estimate sodium sulphate used in detergents of all types would represent some 10 per cent of world consumption.

Some sodium sulphate is used by the glass industry as a source of Na_2O to speed melting. Other end uses of sodium sulphate are in the dyeing industry in the manufacture of viscose sponges, the tanning industry and textiles.

A more recent use is linked to pollution abatement measures: sodium sulphate is added to coal as a conditioner, since it improves the efficiency of high-temperature electrostatic precipitators by preventing clogging by fly-ash. Only about 5 kg of sodium sulphate is used for a tonne of coal. Experiments are being conducted in using sodium sulphate as a heat storage medium in solar energy conservation (heating) projects.

OUTLOOK

It appears that the industry reached the lowest level of sales in 1985 and most managers expect a small but gradual market improvement in 1985. However as a result of increased industrial activity, secondary supplies (byproduct sodium sulphate) are plentiful. Furthermore, perhaps as much as 200 000 t of sodium sulphate, used by the North American pulp and paper industry, was substituted by caustic soda and emulsified sulphur. Caustic prices are very erratic but are currently low; emulsified sulphur may be more expensive but the product is easier to handle. The price of caustic soda may start to increase in 1986, which would be a positive development for the sodium sulphate industry as it would curtail further substitution.

The longer-term growth in sodium sulphate demand in North America will come mainly from the detergent industry sector (2 to 3 per cent increase per year).

United States commodity experts, however, still forecast none or little growth in the United States for sodium sulphate consumption in the decade of the 1980s since consumption in many traditional sectors other than detergents is declining. United States consumption which averaged above 1.0 million t for the past few years is expected to fall to just above 900 000 t in 1986.

TABLE 1. CANADA, SODIUM SULPHATE PRODUCTION AND TRADE, 1983-85

	1983		1984		1985e	
	(tonnes)	($)	(tonnes)	($)	(tonnes)	($)
Production						
Shipments						
Saskatchewan	..	38,441,000	..	33,517,773	..	29,905,147
Alberta	..	3,895,000	..	3,993,220	..	3,482,000
British Columbia	..	300,000	..	190,563	-	-
Total	453 939	42,636,000	389 086	37,701,556	353 770	33,387,147
Imports					**(Jan.-Sept. 1985)**	
Total salt cake and Glauber's salt						
United Kingdom	21 715	1,497,000	19 997	1,199,000	19 358	1,090,000
United States	713	259,000	524	222,000	385	174,000
Other countries	51	5,000	63	18,000	10	27,000
Total	22 479	1,761,000	20 584	1,440,000	19 753	1,294,000
Exports						
Crude sodium sulphate						
United States	265 525	28,718,000	238 707	26,093,000	158 715	17,760,000
New Zealand	-	-	-	-	5 117	405,000
Other countries	227	27,000	42	11,000	77	12,000
Total	265 752	28,745,000	238 749	26,104,000	163 715	18,177,000

Sources: Energy, Mines and Resources Canada; Statistics Canada.
e Estimated; .. Not available; - Nil.

TABLE 2. CANADA, NATURAL SODIUM SULPHATE PLANTS, 1985

	Plant Location	Source Lake	Annual Capacity (tonnes)
Alberta			
Agassiz Resources Ltd.	Metiskow	Metiskow	75 000
Saskatchewan			
Agassiz Resources Ltd.	Grant	Snakehole & Verlo	63 000
Agassiz Resources Ltd.	Hardene	Alsask	42 500
Millar Western Industries Limited	Palo	Whiteshore	109 000
Ormiston Mining and Smelting Co. Ltd.	Ormiston	Horseshoe	90 700
Saskatchewan Minerals	Chaplin	Chaplin	90 000
Saskatchewan Minerals	Fox Valley	Ingebrigt	163 000
Saskatchewan Minerals	Gladmar	East Coteau	45 500
Total			678 600

Source: Company reports.

TABLE 3. CANADA, SODIUM SULPHATE PRODUCTION, TRADE AND CONSUMPTION 1970, 1975, AND 1979-85

	Production[1]	Imports[2]	Exports	Consumption
	(tonnes)			
1970	445 017	26 449	108 761	291 439
1975	472 196	22 638	178 182	256 385
1979	443 279	23 156	193 268	255 059
1980	496 000	20 211	245 831	232 045
1981	535 000	24 960	284 281	216 298
1982	547 000	17 293	367 924	191 988
1983	453 939	22 479	265 752	190 625
1984	389 086	20 584	238 749	229 295
1985	353 770P			

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments of crude sodium sulphate. [2] Includes Glauber's salt and crude salt cake.
P Preliminary.

TABLE 4. CANADA, AVAILABLE DATA ON SODIUM SULPHATE CONSUMPTION, 1982-84

	1982	1983	1984
	(tonnes)		
Pulp and paper	141 573	141 212	186 596[2]
Soaps	38 437	40 219	36 444
Glass and glass wool	11 286	3 358	5 688
Other products[1]	692	636	567
Total	191 988	190 625	229 295

[1] Colours, pigments, feed supplements and other minor uses. [2] Consumption increase due to increase in number of pulp and paper companies being surveyed.

TABLE 5. CANADA, RAILWAY TRAIN LOADINGS OF SODIUM SULPHATE, 1982-84

	1982	1983	1984
		(tonnes)	
Eastern Canada[1]	37 483	39 970	61 923
Western Canada[2]	515 476	413 463	421 693
Total Canada	552 959	453 433	483 616

Source: Statistics Canada.
[1] Eastern Canada refers to provinces east of the Ontario-Manitoba border. [2] Final figure has been adjusted to reflect a recalculation of data.

Stone

D.H. STONEHOUSE

SUMMARY 1985

Increased demand for dimension stone to supply the building construction market in the United States has created a renewed interest in the building stone resources in many Canadian provinces. Since 1982 the strong United States dollar has maintained the competitiveness of many imported materials, among them dimension stone finished at more modern European plants. Under such conditions, to establish costly new technology in the United States to produce from domestic sources is not attractive. However, European technology has been set up in Canada to finish both domestic and imported stone for subsequent shipment to the United States. Granicor Inc. brought European sawing and polishing expertise to Quebec in 1982 and has encouraged the production of native stone to the extent that six new granite quarries were opened in Quebec during 1983. The technique of using gang-saws to produce thin panels from large blocks and of applying these panels to steel or concrete construction units to provide aesthetically-pleasing, well-engineered structures, at costs competitive with other cladding, has enabled Granicor and others to avail themselves of a growing United States market for such material. RPS Marbre Ltée of Montreal announced in late-1984 its intention to spend $9.2 million to expand and modernize its stone finishing facilities to enable greater production of marble, travertine and granite panels, mainly for the United States markets. In Cornwall, Ontario, Karnuk Marble Industries Inc. opened a modern marble processing plant in 1984 to cut and polish a wide variety of marble for interior and exterior applications. During 1985 the company began construction of facilities to house a second production line to process granite. The company's marketing efforts have been directed at the United States construction sector.

A number of provinces are assessing their building stone resources and attempting to identify developing foreign and domestic markets for finished stone. In many instances these efforts are being undertaken through new federal-provincial Mineral Development Agreements as part of new Economic and Regional Development Agreements (ERDA's). Promotional literature and stone specimens are part of these projects as well.

Granite, limestone, marble and sandstone are the principal rock types from which building and ornamental stone is fashioned. Over 90 per cent is used in construction-oriented projects, while less than 10 per cent is used as monument stone. Imports of rough blocks, particularly of granite, for sawing and polishing, as well as of finished stones for distribution to retailers, have cut into markets formerly supplied from domestic sources.

CANADIAN DEVELOPMENTS

Stone is produced in direct response to the demands of the construction industry, which utilizes 93 per cent of output principally as crushed stone. Less than 1 per cent of stone production is used as building stone. Since 1979, there has been a growing interest in Canadian stone for building use. Shipments of granite from Quebec, especially black anorthosite, red granite and brownish monzonite, for modular panelling have shown marked increase. The chemical uses are limited to the cement, lime, glass and metal smelting industries and account for about 4 per cent of stone production, mainly limestone. The remaining 2 to 3 per cent is consumed in pulverized form as filler and extender materials, and for agricultural purposes.

Production of stone of all types increased greatly in 1984 to nearly 82 million t, the percentage increase being

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particularly strong in Nova Scotia as a result of the activities of Construction Aggregates Ltd. at their Strait of Canso quarry, processing and stripping operation. This facility is in the unique position of providing a high quality construction aggregate, essentially at tidewater, and being able to load large sea-going barges and ships at the plant site. These conditions continue to make their product competitive in aggregate-poor regions as distant as Houston, Texas. Quarries on Texada Island, British Columbia have for many years provided limestone to markets in Vancouver and in Washington state by virtue of their quality and position relative to tidewater shipping facilities.

Most provinces have accumulated data relative to occurrences of stone of all types and in many cases have published this information. 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.

Atlantic provinces. Limestone. The many occurrences of limestone 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]. Large quantities of high-calcium limestone have been outlined in the Port au Port district.

In Nova Scotia limestone occurs in the central and eastern parts of the province and in New Brunswick is quarried at three locations - Brookville, Elm Tree and Havelock - for use as a crushed stone, as an aggregate, for agricultural application, for cement and lime manufacture, and for use as a flux. A current study under the federal-provincial Mineral Development Agreement will address the supply-demand situation and future requirements for limestones in New Brunswick.

Granite. Occurrences of granite in the Atlantic region have been described by Carr[7]. In Nova Scotia, a grey granite is produced from 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 have been used for monuments and for dimension stone. The material being quarried and shipped by Construction Aggregates Ltd. at the Strait of Canso is granite.

Granite is quarried intermittently from a number of deposits in 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. Manufacturers of monument stone continue to import dark, crude granite from South Africa.

In Newfoundland, there is a recognized potential for the development of labradorite deposits in the Nain River area of Labrador.

Sandstone. A medium-grained buff sandstone is quarried at Wallace, Nova Scotia, for use as heavy riprap and for dimension stone applications.

In New Brunswick, a red, fine- to medium-grained sandstone has been quarried in Sackville for use in construction. 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 Gaspé region. The limestones range in age from Precambrian to Carboniferous and vary widely in purity, colour, texture and chemical composition[2]. 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 Eastern Townships and the Lac St-Jean areas.

Granite. Quebec, the major Canadian granite producer, accounts for up to 95 per cent of total granite shipments for use as building stone. Since 1979, sales have increased due to improved marketing and advanced processing technology. More than 25 companies quarry granite in Quebec, mainly in the Rivière-à-Pierre, the Lac St-Jean and the Appalachians regions.[8] Granicor Inc., using advanced technology for cutting and polishing dimension stone, produces brownish monzonite modular block panels from material extracted near the Chamouchouane River in the Lac St-Jean area.

Sandstone. Of six operations producing from sandstone resources in Quebec only one is listed as marketing flagstone and construction blocks, in Hemmingford, Huntingdon County.

Ontario. Limestone. Although limestones in Ontario range from Precambrian through Devonian, the major production comes from Ordovician, Silurian and Devonian deposits[9,10]. Of particular importance are the limestones and dolomite 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 limestone 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 accounts for about 90 per cent of total stone production in Ontario. A major study, provincially funded, was commissioned in 1985 to assess the limestone industries of Ontario, to provide an up-to-date analysis of current operations, to assemble geological data and to describe the outlook and future potential of industries based on limestone resources.

Marble is widely distributed over southeastern Ontario and, according to the Ontario Ministry of Natural Resources reports, underlies as much as 250 square kilometres (km^2)[11].

Steep Rock Calcite, a division of Steep Rock Resources Inc., produces medium- to high-grade calcium carbonate at Tatlock and Perth. The filler markets have become extremely attractive recently, not only to new ventures but also to companies hitherto interested in production of only coarser aggregate materials.

Granite. Granites occur in northern, northwestern and southeastern Ontario[12,13,14]. 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. 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 Ontario. Rough building blocks were quarried from a gneissic rock near Parry Sound, while at Havelock a massive red-granite rock was quarried. In 1982, Rock of Ages Canada Ltd. of Beebe, Quebec, reopened a fine pink granite quarry in Belmont Township for the production of building stone for modular block panels but subsequently closed the operation because of problems associated with jointing.

Sandstone. Sandstone quarried near Toronto, Ottawa and Kingston has been used widely in Ontario as building stone[15]. 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 can also 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.

Western provinces. Limestone. From east to west through the southern half of Manitoba rocks of the following ages are represented: Precambrian, Ordovician, Silurian, Devonian and Cretaceous. Limestones of commercial importance occur in the three middle periods 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 Manitoba limestone 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 50 km northeast of Winnipeg. Limestone from Moosehorn, 160 km northwest of Winnipeg and from Mafeking, 40 km east of the Saskatchewan border and 160 km south of The Pas, is transported to Manitoba and Saskatchewan centres for use in the metallurgical, chemical, agricultural and construction industries.

The eastern ranges of the Rocky Mountains contain limestone spanning the geologic ages from Cambrian to Triassic, with major deposits in the Devonian and Carboniferous periods 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].

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]. Deposits on Aristazabal Island have been developed for the export market. Other operations at Terrace, Clinton, Westwold, Popkum, Dahl Lake, Doeye River and Cobble Hill produced stone for construction and for filler use[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 monument use. Grey granite located east of Winnipeg near the Ontario border is a potential source of building stone. Ten or so Manitoba granite occurrences were assessed during 1985 to determine their physical and aesthetic qualities and their adaptability as a building stone. The project was arranged under a federal-provincial Mineral Development Agreement.

In British Columbia a light-grey, to blue-grey even-grained granodiorite of medium texture is available from Nelson Island. Andesite has been quarried at Haddington Island, off the northeast coast of Vancouver Island, for use as a building stone. Canroc International Corporation produces blocks of massive pink quartzite to make cut and polished facing 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".

USES

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.

Some major uses in the chemical field are: neutralization of acid waste liquors; extraction of aluminium 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.

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 Industries Limited. A magnesite deposit at Eon Mountain in British Columbia has been quarried by Baymag Mines Co. Limited since 1982 to produce caustic magnesia and refractory grade MgO. Calcining is done in a refurbished kiln on the property of Canada Cement Lafarge Ltd. at Exshaw, Alberta.

As a dimension stone, granite is processed for interior and exterior floor- and wall-covering, modular block panelling and for monument stone. Uniformity of colour and texture, and durability are the main features sought. Quarrying must take into account geological and structural features as well as topography and accessibility.

OUTLOOK

Dimension stone has been the subject of periodic surges of interest in past years. Currently the industry, especially in Quebec, is in a period of significant growth. Completion of intensive modernization has permitted producers to offer high-quality finished products at competitive prices. Markets for building stone are still under pressure from competitive substitutes such as steel, concrete, glass and ceramics. However, for aesthetic reasons and particular physical characteristics, the demand for granite dimension stone is likely to expand as new markets are developed and producers increase capacity. 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.

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. Rehabilitation of stone quarries for subsequent land use is generally more difficult and costly than rehabilitation of gravel pits. Although an open-pit mining operation close to residential areas is seldom desirable, nonrenewable mineral resources must be fully and wisely utilized. When 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 for land use are required to coordinate all phases of development so that mineral exploitation is part of the urban growth pattern.

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TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
29635-1	Limestone, not further processed than crushed or screened	free	free	25	free
30500-1	Flagstone, sandstone and all building stone, not hammered, sawn or chiselled	free	free	20	free
30505-1	Marble, rough, not hammered or chiselled	free	free	20	free
30510-1	Granite, rough, not hammered or chiselled	free	free	20	free
30515-1	Marble, sawn or sand rubbed, not polished	free	4.3	35	free
30520-1	Granite, sawn	free	6	35	free
30525-1	Paving blocks of stone	free	6	35	free
30530-1	Flagstone and building stone, other than marble or granite, sawn on not more than two sides	free	6	35	free
30605-1	Building stone, other than marble or granite, sawn on more than two sides but not sawn on more than four sides	5	6	10	4
30610-1	Building stone, other than marble or granite, planed, turned, cut or further manufactured than sawn on four sides	7.5	9.1	15	6
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	free	20	free
30700-1	Marble, nop	11.1	11.1	40	7.0
30705-1	Manufactures of marble, nop	11.1	11.1	40	free
30710-1	Granite, nop	12.0	12	40	8
30715-1	Manufactures of granite, nop	12	12	40	8
30800-1	Manufactures of stone, nop	13.8	13.8	35	free
30900-1	Roofing slate, per square of 100 square feet	free	free	75¢	free
30905-1	Granules, whether or not coloured or coated, for use in manufacture of roofing, including shingles and siding	free	free	25	free

MFN Reductions under GATT (effective January 1 of year given)	1985	1986	1987
		(%)	
30515-1	4.3	4.1	4.0
30520-1	6.0	5.8	5.5
30525-1	6.0	5.8	5.5
30530-1	6.0	5.8	5.5
30605-1	6.0	5.8	5.5
30610-1	9.1	8.6	8.0
30700-1	11.1	10.1	9.0
30705-1	11.1	10.1	9.0
30710-1	12.0	11.1	10.2
30715-1	12.0	11.1	10.2
30800-1	13.8	13.1	12.5

TARIFFS (cont'd)

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
UNITED STATES (MFN)					
	Granite, suitable for use as monumental, paving or building stone:				
513.71	Not pitched, not lined, not pointed, not hewn, not sawed, not dressed, not polished, and not otherwise manufactured		Free		

Item No.		1985	1986	1987
			(%)	
513.74	Pitched, lined, pointed, hewn, sawed, dressed, polished, or otherwise manufactured	4.7	4.4	4.2
	Limestone, suitable for use as monumental, paving or building stone:			
514.21	Not hewn, not sawed, not dressed, not polished, and not otherwise manufactured, per cubic foot	0.2¢	0.1¢	free
514.24	Hewn, sawed, dressed, polished, or otherwise manufactured	7.1	6.6	6.0
514.51	Marble, breccia, in block, rough or squared only, per cubic foot	12.4¢	12.2¢	12.0¢
514.57	Marble, breccia, or onyx, sawed or dressed, over 2 inches thick, per cubic foot	21.2¢	20.6¢	20.0¢
	Stone suitable for use as monumental, paving, or building stone:			
515.51	Not hewn, not sawed, not dressed, not polished, and not otherwise manufactured, per cubic foot	0.2¢	0.1¢	free
515.54	Hewn, sawed, dressed, polished, or otherwise manufactured, per cubic foot	7.1¢	6.6¢	6.0¢

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated (1985) USITC Publication 1610; U.S. Federal Register, Vol. 44, No. 241.

TABLE 1. CANADA, TOTAL PRODUCTION OF STONE, 1983-85

	1983		1984		1985P	
	(000 t)	($ 000)	(000 t)	($ 000)	(000 t)	($ 000)
By province						
Newfoundland	279	1,431	558	3,328	575	3,335
Nova Scotia	1 296	7,784	4 377	21,529	4 400	21,250
New Brunswick	2 087	11,310	2 036	10,341	2 060	11,120
Quebec	27 303	121,154	30 946	139,247	31 173	142,574
Ontario	27 939	127,192	33 992	160,847	31 393	151,887
Manitoba	1 137	5,452	2 120	11,927	1 922	8,635
Alberta	286	3,457	258	3,416	180	2,324
British Columbia	4 915	27,084	6 738	38,181	6 100	36,235
Northwest Territories	2 409	14,601	729	4,617	127	795
Canada	67 651	319,465	81 754	393,432	77 930	378,115
By use[1]						
Building stone						
Rough	205	7,359	..	..	..	..
Monumental and ornamental stone	39	4,012	..	..	..	..
Other (flagstone, curbstone, paving blocks, etc.)	19	900	..	..	..	..
Chemical and metallurgical						
Cement plants, foreign	594	1,523	..	..	..	..
Lining, open-hearth furnaces	19	100	..	..	..	..
Flux in iron and steel furnaces	980	4,160	..	..	..	..
Flux in nonferrous smelters	129	1,727	..	..	..	..
Glass factories	571	4,348	..	..	..	..
Lime kilns, foreign	289	1,402	..	..	..	..
Pulp and paper mills	272	2,835	..	..	..	..
Sugar refineries	47	250	..	..	..	..
Other chemical uses	70	2,307	..	..	..	..
Pulverized stone						
Whiting (substitute)	101	5,936	..	..	..	..
Asphalt filler	45	258	..	..	..	..
Dusting, coal mines	81	1,180	..	..	..	..
Agricultural purposes and fertilizer plants	1 109	10,464	..	..	..	..
Other uses	609	4,162	..	..	..	..
Crushed stone for						
Manufacture of artificial stone	12	207	..	..	..	..
Roofing granules	326	21,523	..	..	..	..
Poultry grit	26	518	..	..	..	..
Stucco dash	12	428	..	..	..	..
Terrazzo chips	7	279	..	..	..	..
Rock wool	-	-	..	..	..	..
Rubble and riprap	4 610	22,394	..	..	..	..
Concrete aggregate	5 587	21,743	..	..	..	..
Asphalt aggregate	4 930	20,768	..	..	..	..
Road metal	20 404	73,790	..	..	..	..
Railroad ballast	3 810	20,959	..	..	..	..
Other uses	22 728	77,530	..	..	..	..
Total	67 651	313,065	..	..	..	..

[1] The 1983 value of production includes companies' transportation costs not applicable in the by use category.
P Preliminary; .. Not available; - Nil.

TABLE 2. CANADA, PRODUCTION OF LIMESTONE, 1982-84

	1982		1983		1984	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province						
Newfoundland	226	1,098	127	527	385	2,333
Nova Scotia	124	1,818	146	1,689	192	2,125
New Brunswick	546	5,178	524	5,274	511	4,083
Quebec	19 819	78,663	21 234	88,023	25 124	100,739
Ontario	21 893	75,284	26 166	94,397	31 497	121,716
Manitoba	1 922	7,748	899	3,239	1 392	5,682
Alberta	262	3,124	285	3,396	257	3,346
British Columbia	2 183	10,299	2 345	11,230	1 848	8,827
Northwest Territories	322	1,266	2 406	14,577	720	4,590
Canada	47 297	184,478	54 132	222,352	61 928	253,441
By use[1]						
Building stone						
Rough	157	1,360	139	1,091	..	..
Monumental and ornamental	1	51	4	200	..	..
Other (flagstone, curbstone, paving blocks, etc.)	10	298	11	498	..	..
Chemical and metallurgical						
Cement plants, foreign	598	1,461	594	1,523	..	..
Lining, open-hearth furnaces	38	141	18	75	..	..
Flux, iron and steel furnaces	742	2,861	980	4,160	..	..
Flux, nonferrous smelters	114	1,124	129	1,727	..	..
Glass factories	169	2,272	571	4,348	..	..
Lime kilns, foreign	512	1,903	289	1,402	..	..
Pulp and paper mills	286	2,590	286	2,750	..	..
Sugar refineries	108	586	47	250	..	..
Other chemical uses	137	2,840	70	2,309	..	..
Pulverized stone						
Whiting substitute	71	2,863	35	1,932	..	..
Asphalt filler	31	202	33	213	..	..
Dusting, coal mines	7	171	81	1,180	..	..
Agricultural purposes and fertilizer plants	1 018	10,293	1 080	9,957	..	..
Other uses	485	610	548	3,438	..	..
Crushed stone for						
Artificial stone	1	37	1	38	..	..
Roofing granules	36	274	75	740	..	..
Poultry grit	28	698	26	497	..	..
Stucco dash	15	993	9	252	..	..
Rock wool	-	-	-	-	..	..
Rubble and riprap	795	2,350	3 767	18,820	..	..
Concrete aggregate	4 226	15,162	5 022	19,010	..	..
Asphalt aggregate	3 439	12,416	3 796	15,254	..	..
Road metal	14 953	50,454	17 801	63,392	..	..
Railroad ballast	1 124	3,759	1 221	4,326	..	..
Other uses	18 196	63,399	17 499	58,312	..	..
Total	47 297	181,168	54 132	217,694	61 928	253,441

[1] The 1982 value of production includes companies' transportation costs not applicable in the by use category.
- Nil; .. Not available.

TABLE 3. CANADA, PRODUCTION OF MARBLE, 1982-84

	1982		1983		1984	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province						
Nova Scotia	-	-	-	-	2	99
Quebec	332	2,189	297	2,399	396	4,538
Ontario	153	1,028	96	4,920	105	6,153
Canada	485	3,217	393	7,319	503	10,790
By use[1]						
Building stone						
Rough	-	-	-	-	..	..
Monumental and ornamental stone	-	-	3	381	..	..
Chemical process stone						
Flux in nonferrous smelters	--	1	--	1	..	..
Pulp and paper mills	8	114	6	85	..	..
Pulverized stone						
Whiting	-	-	66	4,004	..	..
Agricultural purposes and fertilizer plants	18	269	29	507	..	..
Other uses	202	1,543	61	724	..	..
Crushed stone for						
Artificial stone	6	117	11	169	..	..
Roofing granules	1	32	1	24	..	..
Poultry grit	--	1	--	2	..	..
Stucco dash	-	-	1	14	..	..
Terrazzo chips	4	184	7	279	..	..
Concrete aggregate	30	176	38	263	..	..
Road metal	125	400	103	405	..	..
Other uses	91	363	67	450	..	..
Total	485	3,200	393	7,308	503	10,790

[1] The 1982 value of production includes companies' transportation costs not applicable in the by use category.
- Nil; -- Amount too small to be expressed; .. Not available.

TABLE 4. CANADA, PRODUCTION OF GRANITE, 1982-84

	1982		1983		1984	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province						
Newfoundland	51	304	68	400	85	573
Nova Scotia	--	42	536	2,511	3 229	14,666
New Brunswick	1 536	6,001	1 438	5,717	1 465	6,139
Quebec	3 815	20,735	4 117	22,968	3 855	26,188
Ontario	1 480	23,688	941	26,598	1 645	31,613
Manitoba	423	3,922	238	2,213	727	6,245
Alberta	1	10	-	-	-	-
British Columbia	2 127	11,607	2 570	15,847	4 891	29,347
Northwest Territories	--	1	--	1	-	-
Canada	9 434	66,310	9 908	76,255	15 897	114,771
By use[1]						
Building stone						
Rough	27	2,652	41	5,186	..	..
Monumental and ornamental	37	3,952	21	3,095	..	..
Other (flagstone, curbstone, paving blocks, etc.)	6	415	7	367	..	..
Chemical and metallurgical lining, open-hearth furnaces	-	-	1	25	..	..
Pulverized stone						
Asphalt filler	11	37	12	45	..	..
Crushed stone for						
Roofing granules	215	16,471	250	20,759	..	..
Poultry grit	1	22	--	19	..	..
Stucco dash	-	-	2	162	..	..
Rubble and riprap	897	4,001	836	3,548	..	..
Concrete aggregate	280	1,453	342	1,441	..	..
Asphalt aggregate	898	4,498	991	4,945	..	..
Road metal	2 485	10,438	1 723	7,237	..	..
Railroad ballast	1 486	8,949	2 583	16,614	..	..
Other uses	3 091	12,779	3 099	11,626	..	..
Total	9 434	65,667	9 908	75,069	15 897	114,771

[1] The 1982 value of production includes companies' transportation costs not applicable in the by use category.
- Nil; -- Amount too small to be expressed; .. Not available.

TABLE 5. CANADA, PRODUCTION OF SANDSTONE, 1982-84

	1982		1983		1984	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province						
Newfoundland	80	361	75	474	79	391
Nova Scotia	554	2,778	611	3,572	907	4,600
New Brunswick	179	376	125	319	58	119
Quebec	840	4,508	1 229	6,312	1 061	6,319
Ontario	32	259	4	291	8	375
Alberta	--	28	1	61	1	70
British Columbia	--	20	--	7	--	7
Canada	1 686	8,330	2 045	11,036	2 114	11,881
By use[1]						
Building stone						
Rough	46	816	25	1,082	..	..
Monumental and ornamental	-	-	11	336	..	..
Other (flagstone, curbstone, paving blocks, etc.)	10	313	1	35	..	..
Crushed stone for						
Rubble and riprap	37	69	4	4	..	..
Concrete aggregate	135	780	185	1,029	..	..
Asphalt aggregate	203	852	143	569	..	..
Road metal	235	964	386	1,540	..	..
Railroad ballast	16	114	6	19	..	..
Other uses	1 004	3,659	1 284	6,034	..	..
Total	1 686	7,567	2 045	10,648	2 114	11,881

[1] The 1982 value of production includes companies' transportation costs not applicable in the by use category.
- Nil; -- Amount too small to be expressed; .. Not available.

TABLE 6. CANADA, PRODUCTION OF SHALE, 1982-84

	1982		1983		1984	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province						
Newfoundland	-	-	9	30	9	31
Nova Scotia	-	-	3	12	47	39
Quebec	254	894	426	1,452	510	1,463
Ontario[2]	25	19	732	986	738	990
Northwest Territories	--	1	3	23	8	27
Canada	279	914	1 173	2,503	1 312	2,550
By use[1]						
Crushed stone for						
Rubble and riprap	1	1	3	22	..	..
Road metal	200	539	391	1,216	..	..
Other uses	78	119	779	1,108	..	..
Total	279	659	1 173	2,346	1 312	2,550

[1] The 1982 value of production includes companies' transportation costs not applicable in the by use category. [2] Includes slate.
- Nil; -- Amount too small to be expressed; .. Not available.

TABLE 7. CANADA, PRODUCTION OF STONE BY TYPES, 1975, 1980, 1983-84

	1975		1980		1983		1984	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
Granite	11 470	34,913	39 983	140,914	9 908	76,255	15 897	114,771
Limestone	72 284	152,521	58 191	185,085	54 132	222,352	61 928	253,441
Marble	356	1,843	316	1,807	393	7,319	503	10,790
Sandstone	3 753	10,881	3 064	11,540	2 045	11,036	2 114	11,881
Shale	1 551	2,566	1 812	1,810	1 173	2,503	1 312	2,549
Total	89 414	202,724	103 366	341,156	67 651	319,465	81 754	393,432

Sources: Energy, Mines and Resources Canada; Statistics Canada.

TABLE 8. CANADA, STONE EXPORTS AND IMPORTS, 1983-85

	1983		1984		Jan.-Sept. 1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Exports						
Building stone, rough	12 633	1,877	11 175	1,785	10 756	1,297
Stone crude, nes	45 779	707	208 837	1,432	154 328	1,098
Natural stone, basic products	..	22,987	..	28,977	..	18,234
Total	..	25,571	..	32,194	..	20,629
Imports						
Building stone, rough	8 049	1,177	7 470	1,203	6 714	1,043
Stone crude, nes	3 263	353	6 368	468	3 336	297
Granite, rough	24 760	4,447	31 455	5,101	21 943	4,096
Marble, rough	8 186	3,347	9 125	3,902	4 420	2,090
Shaped or dressed granite	..	7,002	..	7,796	..	4,154
Shaped or dressed marble	..	2,416	..	4,007	..	4,039
Natural stone basic products	..	4,328	..	7,017	..	6,925
Total	..	23,070	..	29,494	..	22,644

Source: Statistics Canada.
P Preliminary; nes Not elsewhere specified; .. Not available.

TABLE 9. CANADA, VALUE OF CONSTRUCTION[1] BY PROVINCE, 1983-85

	1983			1984			1985		
	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total
	($000)								
Newfoundland	500,406	966,856	1,467,262	499,344	955,432	1,454,776	545,809	937,967	1,483,776
Nova Scotia	862,518	1,243,189	2,105,707	947,772	1,230,719	2,178,491	1,040,607	1,244,812	2,285,419
New Brunswick	724,935	429,475	1,154,410	714,228	493,606	1,207,834	707,603	475,935	1,183,538
Prince Edward Island	112,102	69,861	181,963	119,655	66,139	185,794	124,646	68,880	193,526
Quebec	6,798,160	4,194,350	10,992,510	7,689,032	3,978,144	11,667,176	7,922,247	4,050,275	11,972,522
Ontario	10,114,265	4,856,478	14,970,743	11,323,048	5,287,148	16,610,196	12,130,421	5,428,646	17,559,067
Manitoba	1,025,322	620,076	1,645,398	1,082,729	712,903	1,795,632	1,178,621	803,656	1,982,277
Saskatchewan	1,383,238	1,333,645	2,716,883	1,293,247	1,492,889	2,786,136	1,345,724	1,771,544	3,117,268
Alberta	4,640,878	6,441,239	11,082,117	3,416,105	6,257,861	9,673,966	3,436,296	7,398,700	10,834,996
British Columbia, Yukon and Northwest Territories	4,590,837	5,039,937	9,630,774	4,249,136	4,320,995	8,570,131	4,150,391	4,199,396	8,349,787
Canada	30,752,661	25,195,106	55,947,767	31,334,296	24,795,836	56,130,132	32,582,365	26,379,811	58,962,176

Source: Statistics Canada.
[1] Actual expenditures 1983, preliminary actual 1984, intentions 1985.

Sulphur

MICHEL A. BOUCHER

SUMMARY

The 1984 deficit in world production over world consumption continued in 1985, although production increased by some 1.2 million t while consumption remained the same. Preliminary figures indicate that production increased in the United States, Canada, the U.S.S.R. and Mexico, but decreased in France, and also in some of the Middle East countries as a result of oil and gas production cutbacks.

The deficit between production and consumption was balanced mostly by remelt of inventories in Canada. During the year it is estimated that some 2.7 million t of sulphur were remelted from Alberta's inventories, leaving approximately 9 million t in the stockpiles at the end of 1985.

CANADIAN DEVELOPMENTS

Canada's elemental sulphur production in 1985 is estimated at 5.6 - 5.7 million t compared with 5.4 million t in 1984. The increase in production was the result of stronger demand, in Canada and the United States for natural gas, and more flexible pricing of Canadian natural gas.

Preliminary figures indicate that shipments in 1985 were 8.25 million t valued at $882 million compared with 8.35 million t valued at $609 million in 1984.

In Alberta, two new natural gas production plants by Petro-Canada and Shell Canada Limited increased annual sulphur production capacity by a total of 30 000 t in 1985. A large plant under construction by Canadian Occidental Petroleum Ltd. is expected to add a capacity of 210 000 t in 1986.

Also in Alberta field developments at existing plants of Canterra Energy Ltd. and Shell Canada Limited increased annual production capacity by 4 300 t in 1985.

Oilsands/heavy oil development projects by Syncrude Canada Ltd., in Alberta, and by Husky Oil Ltd., and Consumers' Co-operative Refineries Limited in Saskatchewan should come on-stream in 1988-89 and add a total of 240 000 tpy to capacity. Finally expansion of Suncor Inc. at its Fort McMurray oil sand plant will raise sulphur production capacity by some 6 500 tpy by the late-1980s. Oil sands are composed of a mixture of sand, heavy oil (bitumen), clays and water; the sand makes up about 86 per cent of the weight and sulphur contained in oil 4.6 per cent.

Monex International of Calgary launched a $2.3 million research program on sulphur purification of vat bottom material during the year. The firm estimates that about 1.0 million t of the 10.0 million t of sulphur that are stockpiled in Alberta is highly contaminated and will require purification before it can be marketed.

Canadian sales into the offshore market are handled mainly by Cansulex Limited (an industry marketing agency representing 22 producing companies and handling about 45 per cent of Canadian offshore sales), Shell, Canadian Superior Oil Ltd. and Amoco Canada Petroleum Company Ltd. Two small sulphur producing companies, ICG Resources Ltd. and Pensionfund Energy Resources Limited became members of Cansulex Limited during the year.

Cansulex Limited member companies are:

Aberford Resources Ltd.
BP Resources Canada Limited
Canadian Occidental Petroleum Ltd.
Canadian Reserve Oil & Gas Ltd.
Canterra Energy Ltd.
Champlin Canada, Ltd.
Chevron Canada Limited
Dome Petroleum Limited
Gulf Canada Resources Inc.
Hamilton Brothers Canada Gas Company Limited
Home Oil Company Limited
Hudson's Bay Oil and Gas Company Limited
Husky Oil Ltd.

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ICG Resources Ltd.
Interedec (USA) Inc.
Mobil Oil Canada, Ltd.
Norcen Energy Resources Limited
The Paddon Hughes Development Co. Ltd.
Pensionfund Energy Resources Limited
Petrogas Processing Ltd.
Sulfak Resources Ltd.
Union Oil Company of Canada Limited

WORLD DEVELOPMENTS

In the U.S.S.R. the development of four major gas fields was in progress during 1985. When these developments are completed they should add close to 5 million tpy to the production capacity of the U.S.S.R. by the early-1990s.

The four projects are Mubarek, Astrakhan, Tengiz and Karazseganak. Mubarek was completed during 1985; it has a production capacity of 0.4 million tpy of sulphur. Astrakhan gas, from the vicinity of the Caspian Sea, contains 24 per cent H_2S and is expected to produce some 3.1 million tpy of sulphur, when fully completed, in the late-1980s. Tengiz gas contains around 16 per cent H_2S and should produce 0.55 million tpy of sulphur, when in full production, in the late-1980s, early-1990s. Finally Karazseganak is expected to produce 0.66 million tpy of sulphur in the late-1980s. The output of Karazseganak will eventually replace the Orenburg plant, which is nearing depletion. Consulting and engineering firms from France, West Germany and Canada participate in the development of some of these projects.

In Poland, financing of the new Oziek 'Frasch' mine, that contains some 46 million t of sulphur, situated at a depth of 125 m was reported to have been approved. Production at a rate of 0.3 million tpy is expected to start in 1988, and reach its designed annual production capacity of 1.3 million t in 1992. The Oziek mine will make up for the lower production at the Grzybow mine which declined from 1.4 million t in 1980 to 0.8 million t in 1985 and is expected to produce only 0.5 million t in 1988.

In the United States, Frasch production is recovering from its 1983 low level of 3.2 million t. Production reached 4.2 million t in 1984 and 5.0 million t in 1985. The increase is a result of the re-opening of two Frasch mines by Texasgulf Inc. and Freeport-McMoRan Inc. U.S. Frasch production peaked in 1974 at 8 million t of sulphur. Sulphur recovered from gas continued to increase in 1985 as more deeper and price deregulated sour gas was being produced as a replacement for shallower and price regulated sweet gas.

In Mexico, start up of the new 400 tpd Otapa Frasch sulphur mine was delayed until March, 1986. Frasch production at Petapa (new dome) was increased from 300 to 500 tpd during the year; capacity of the Petapa mine is 1 000 tpd.

Iran is building a new gas plant at Khagiran with a sulphur recovery capacity of 400 000 tpy. Most production will be used as feedstock for a new fertilizer complex expected to be completed in 1986.

PRICES

Contract prices for offshore exports of elemental sulphur from Vancouver were $US 137 a tonne in January, 1985, rising steadily to $150 in April (mainly as a result of increased production of phosphoric acid in the United States for exports), then started to decline steadily in July and ended the year at $135. The lower price during the second half of 1985 was due mainly to a reduced demand for phosphoric acid in the United States and in the rest of the western world.

USES

Sulphur, principally in the form of sulphuric acid, is used at some stage in the production of virtually everything we eat, wear or use. As such, its consumption level traditionally has served as an indicator of the state of the economy of an individual nation or of the world. Close to 60 per cent of all sulphur is consumed in the production of phosphate and ammonium sulphate fertilizers.

OUTLOOK

In the short-term the tight supply-demand situation that existed in the sulphur industry in 1985 is expected to continue in 1986 because world consumption should again exceed production as no new major producer is expected to come on-stream. As a result sulphur inventories in Canada should continue to decline. Prices in 1986 may continue to weaken as a result of an expected lower production of phosphoric acid in the United States and in other countries.

In the long-term, the major developments in sulphur production in the world will be from gas projects in the vicinity of the Caspian Sea in the U.S.S.R. where close to 5 million tpy of sulphur production capacity will be added during the period 1985-1992. Although growth in world consumption is expected to slow down, consumption should continue to outpace production for the next three to four years; strong growth is expected mainly in Asia (China, Israel, Iraq), Africa (Morocco, Tunisia), Latin America (Mexico, Brazil) and the U.S.S.R. This imbalance between production and consumption should result in a reduction of inventories mainly in Canada, but also in other producing countries such as France and the United States, where stocks at the end of 1985 are estimated at 1.7 and 2.4 million t respectively; the tight supply situation should also maintain prices at high levels, especially in the late-1980s before Astrakhan is fully developed; more recycling of sulphuric acid; and the search for substitutes, and for new supply sources of sulphur is also expected to prevail.

World sulphur inventories should be adequate to meet deficits until the late-1980s. However, if gas projects in the U.S.S.R. are not developed on schedule, or at less than the expected scale, and if no major new sources of sulphur are developed (such as very sour gas, pyrites or native sulphur deposits) serious supply problems can be expected by the early-1990s. However if gas projects in the U.S.S.R. are developed on schedule, and on the scale expected, sulphur could be exported from the U.S.S.R. to the western world by the early-1990s.

In Canada, elemental sulphur production from natural gas operations is expected to be in the range of 5.5 to 6.0 million tpy until at least 1990.

PRICES

	1982	1983 ($/tonne)	1984	1985
Canadian sulphur prices as quoted in Alberta Energy Resources Industries monthly statistics				
Sulphur elemental, fob plant				
North American deliveries	64.36	52.64	77.47	109.86
Offshore deliveries	80.44	61.43	113.29	143.63
Canadian sulphuric acid price as quoted in Corpus Chemical Report				
Sulphuric acid, fob plants, East, 66° (93%) Be, tanks	98.80	104.0	98.80-104.00	108.00
United States prices, U.S. currency, as quoted in Engineering and Mining Journal				
Sulphur elemental				
U.S. producers, term contracts fob vessel at Gulf ports, Louisiana and Texas				
Bright	137.8	130.4	130.4	140.2
Dark	137.8	131.4	131.4	139.2
Export prices, ex terminal Holland				
Bright	143.7-150.0	130.9-137.8	130.9-137.8	152.5
Dark	143.7-150.0	130.9-137.8	130.9-137.8	152.5
Mexican export, fob vessel, U.S. currency, from Azufrera Panamericanna S.A.				
Bright	108.2-113.1	..	..	..
Dark	123.0-132.8	..	..	..

fob Free on board; .. Not available.

TARIFFS

Item No.		British Preferential	Most Favoured Nation		General	General Preferential
			(%)			
CANADA						
92503-1	Sulphur of all kinds, other than sublimed sulphur, precipitated sulphur and colloidal sulphur	free	free		free	free
92802-1	Sulphur, sublimed or precipitated; colloidal sulphur	free	free		free	free
92807-1	Sulphur dioxide	free	free		free	free
92808-1	Sulphuric acid, oleum	3.8	3.8		25	free
92813-4	Sulphur trioxide	free	free		free	free
MFN Reductions under GATT (effective January 1 of year given)			1985	1986	1987	
				(%)		
92808-1			3.8	1.9	free	
UNITED STATES						
418.90	Pyrites		free			
415.45	Sulphur, elemental		free			
416.35	Sulphuric acid		free			
			1985	1986	1987	
				(%)		
422.94	Sulphur dioxide		4.7	4.4	4.2	

Sources: The Customs Tariff, 1985 Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241.

TABLE 1. CANADA, SULPHUR SHIPMENTS AND TRADE, 1983-85

	1983		1984		1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Shipments						
Pyrite and pyrrhotite[1]						
Gross weight	-	-	-	-	-	-
Sulphur content	-	-	-	-	-	-
Sulphur in smelter gases[2]	678 286	43,322	844 276	63,200	773 477	65,901
Elemental sulphur[3]	6 631 123	427,358	8 352 978	609,141	8 250 252	881,655
Total sulphur content	7 309 409	469,680	9 197 254	672,341	9 023 729	947,556
Imports					(Jan.-Sept.)	
Sulphur, crude or refined						
United States	2 353	653	3 014	813	2 233	743
Other countries	12	3	5	2	14	4
Total	2 365	656	3 019	815	2 247	747
Sulphuric acid, including oleum						
United States	116 567	8,353	28 317	2,721	13 902	1,634
West Germany	7 484	248	3	..	4	1
Norway	2 522	172	-	-	-	-
Other countries	-	-	10	10	5	1
Total	126 573	8,952	28,330	2,731	13 911	1 635
Exports						
Sulphur in ores (pyrite)						
South Africa	-	-	-	-	..	99
United States	..	14	..	34	..	7
West Germany	-	63	-	-	-	-
Total	..	77	..	34	..	106
Sulphuric acid, including oleum						
United States	273 193	8,327	468 906	15,155	468 867	13,168
Other countries	11	3	84 874	3,416	41 792	1,772
Total	273 204	8,330	553 780	18 570	510 659	14,940
Sulphur, crude or refined, nes						
United States	1 112 860	76,797	1 781 716	134,006	1 083 049	114,209
Brazil	573 145	66,071	516 757	68,067	443 765	77,181
Morocco	358 735	40,153	346 546	43,363	533 718	100,809
Tunisia	310 095	38,261	288 107	39,408	297 619	55,120
South Africa	366 640	38,079	533 000	64,205	339 341	56,737
Australia	364 448	37,878	422 592	50,837	307 451	52,336
South Korea	296 146	33,168	325 323	39,870	364 039	61,760
People's Republic of China	217 027	24,183	248 666	28,149	162 577	30,016
U.S.S.R.	198 075	21,890	180 341	21,666	231 569	39,971
Finland	179 732	21,880	148 243	17,554	177 301	30,159
India	218 170	18,298	333 392	49,999	394 594	69,458
Israel	226 517	18,092	258 676	25,643	157 166	19,008
Taiwan	152 825	16,248	226 559	28,614	134 388	24,008
Netherlands	149 151	15,672	178 388	21,206	137 235	25,198
France	122 754	15,167	96 049	12,515	77 405	13,433
New Zealand	158 021	15,114	216 839	26,854	187 012	31,713
Other countries[4]	665 934	75,329	1 225 653	159,234	1 077 692	186,683
Total	5 670 275	572,280	7 326 847	831,190	6 105 921	987,802

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[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 small quantities of sulphur produced in the refining of domestic crude oil and synthetic crude oil. [4] Mainly Belgium-Luxembourg, Senegal, Indonesia, Argentina, Chile, Cuba, and Mozambique.
P Preliminary; - Nil; .. Not available; nes Not elsewhere specified.

TABLE 2. CANADA, SOUR GAS SULPHUR EXTRACTION PLANTS, 1982-83 AND 1985

Operating Company	Source Field or Plant Location	H_2S in Raw Gas	Daily Sulphur Capacity		
			1982	1983	1985
	(Alberta, except where noted)	(%)		(tonnes)	
Amerada Hess Corporation	Olds	13	384	389	389
Amoco Canada Petroleum Company, Ltd.	Bigstone Creek	19	382	382	382
Amoco Canada Petroleum Company, Ltd.	East Crossfield	26	1 757	1 797	1 797
Canada-Cities Service, Ltd.	Paddle River	1	19	19	19
Canadian Superior Oil Ltd.	Harmattan-Elkton	56	490	490	515
Canadian Superior Oil Ltd.	Lonepine Creek	12	157	157	157
Canterra Energy Ltd.	Brazeau River	2	42	42	42
Canterra Energy Ltd.	Okotoks	34	459	431	431
Canterra Energy Ltd.	Rainbow Lake	4	139	139	139
Canterra Energy Ltd.	Ram River (Ricinus)	19	4 567	4 572	4 572
Canterra Energy Ltd.	Windfall	8	-	-	1 199
Chevron Standard Limited	Kaybob South	20	3 521	3 537	3 557
Chevron Standard Limited	Nevis	7	260	215	-
Chieftain Development Co. Ltd.	Sinclair	5		256	256
Dome Petroleum Limited	Steelman, Sask.	1	7	7	7
Esso Resources Canada Limited	Joffre	11	17	17	17
Esso Resources Canada Limited	Quirk Creek	9	300	293	293
Esso Resources Canada Limited	Redwater	4	33	33	33
Gulf Canada Limited	Homeglen-Rimbey	2	333	333	128
Gulf Canada Limited	Nevis	7	295	297	295
Gulf Canada Limited	Pincher Creek	5	160	159	-
Gulf Canada Limited	Strachan	9	943	943	943
Gulf Canada Limited	Hanlan	9		1 092	1 092
Home Oil Company Limited	Carstairs	1	72	65	65
Hudson's Bay Oil and Gas Company Ltd.	Brazeau River	1	110	110	110
Hudson's Bay Oil and Gas Company Ltd.	Caroline	1	22	8	8
Hudson's Bay Oil and Gas Company Ltd.	Edson	2	284.5	284	284
Hudson's Bay Oil and Gas Company Ltd.	Kaybob South (1)	13	1 064	1 086	1 086
Hudson's Bay Oil and Gas Company Ltd.	Kaybob South (2)	17	1 064	1 085	1 086
Hudson's Bay Oil and Gas Company Ltd.	Lonepine Creek	10	283	283	283
Hudson's Bay Oil and Gas Company Ltd.	Sturgeon Lake	12	49	98	98
Hudson's Bay Oil and Gas Company Ltd.	Zama	8	74	74	74
Mobil Oil Canada, Ltd.	Wimborne	14	168	182	182
Mobil Oil Canada, Ltd.	Teepee	4	29	30	30
PanCanadian Petroleum Limited	Morley	5	18	18	18
Petro-Canada	Gold Creek	5	43	43	43
Petro-Canada	Wildcat Hills	4	177	177	177
Petrogas Processing Ltd.	Crossfield (Balzac)	14	1 687	1 696	1 696
Saratoga Processing Company Limited	Savannah Creek (Coleman)	20	389	389	389
Shell Canada Limited	Burnt Timber Creek	10	497	489	489
Shell Canada Limited	Innisfail	23	163	163	163
Shell Canada Limited	Jumping Pound	6	511	566	566
Shell Canada Limited	Rosevear	8	153	171	171
Shell Canada Limited	Simonette River	7	267	95	95
Shell Canada Limited	Waterton	17	3 066	3 107	3 148

TABLE 2. (cont'd)

Operating Company	Source Field or Plant Location (Alberta, except where noted)	H_2S in Raw Gas (%)	Daily Sulphur Capacity 1982	1983	1985
			(tonnes)		
Sulpetro Limited	Minnehik-Buck Lake	1	45	45	45
Suncor Inc.	Rosevear	8	110	110	110
Texaco Exploration Company	Bonnie Glen	-	15	12.5	12.5
Voyager Petroleums Ltd.	Mundare				
Westcoast Transmission Company Limited	Fort Nelson, B.C.		1 100	1 100	1 100
Westcoast Transmission Company Limited	Taylor Flats, B.C.	3	460	460	460
Westcoast Transmission Company Limited	Pine River		1 055		1 055
Western Decalta Petroleum Limited	Turner Valley	1	24	11	11

Sources: From Alberta Energy Resources Conservation Board publications; Oil Week, January 1982-83-85.
- Nil.

TABLE 3. CANADIAN PETROLEUM REFINERY SULPHUR CAPACITIES, 1983-85

Operating Company	Location	Daily Capacity 1983	1984	1985
		(tonnes)		
Canadian Ultramar Limited	St. Romuald, Quebec	81	81	81
Chevron Canada Limited	Burnaby, British Columbia	10	10	10
Consumers' Co-operative Refineries Limited	Regina, Saskatchewan	-	18	18
Gulf Canada Limited	Edmonton, Alberta	56	56	56
	Port Moody, British Columbia	25	25	25
	Clarkson, Ontario	49	49	49
Husky Oil Ltd.	Prince George, British Columbia	5	5	5
Imperial Oil Limited	Edmonton, Alberta	40	40	40
	Dartmouth, Nova Scotia	76	76	76
	Sarnia, Ontario	100	140	140
	Ioco, British Columbia	20	20	20
Irving Oil Limited	Saint John, New Brunswick	200	200	200
Petro-Canada	Oakville, Ontario	41	41	41
Shell Canada Limited	Sarnia, Ontario	31	31	31
Sulconam Inc.	Montreal, Quebec	300	300	300
Suncor Inc.	Sarnia, Ontario	10	10	10
Texaco Canada Inc.	Nanticoke, Ontario	8	8	8
Total		1 052	1 110	1 110

Sources: Oilweek, April 16, 1984; Oilweek, June 10, 1984; Company reports.
- Nil.

TABLE 4. CANADA, PRINCIPAL SULPHUR DIOXIDE AND SULPHURIC ACID PRODUCTION CAPACITIES, 1984[1]

Operating Company	Plant Location	Raw Material	Liquefied SO_2	Annual Capacity Sulphuric Acid[2]	Sulphur Equivalent
			(000 tonnes)		
Brunswick Mining and Smelting Corporation Limited	Belledune, New Brunswick	SO_2 lead zinc		160	52
Canadian Electrolytic Zinc Limited	Valleyfield, Quebec	SO_2 zinc conc.		440	144
C-I-L Inc.	Beloeil, Quebec	Elem. S.		65	21
Inco Metals Company	Copper Cliff, Ontario	SO_2 pyrrhotite & nickel conc.		550	180
	Copper Cliff, Ontario	SO_2 copper	82-90	-	45
NL Chem Canada Inc.	Varennes, Quebec	Elem. S.		56	18
Falconbridge Limited	Sudbury, Ontario	SO_2 pyrrhotite		355	116
International Minerals & Chemical Corporation (Canada) Limited[3]	Port Maitland, Ontario	Elem. S.		250	82
Gaspé Copper Mines, Limited	Murdochville, Quebec	SO_2 copper		160	52
Kidd Creek Mines Ltd.	Kidd Creek, Ontario	SO_2 zinc conc.		440	144
Subtotal Eastern Canada				2 508	865
Border Chemical Company Limited	Transcona, Manitoba	Elem. S.		150	49
Cominco Ltd.	Kimberley, British Columbia	SO_2 pyrrhotite		230	75.2
	Kimberley, British Columbia	Elem. S.		75	24.5
	Trail, British Columbia zinc roaster	Zinc conc.		430	140.6
	Trail, British Columbia zinc pressure leach				40
	Trail, British Columbia lead smelter	Lead conc.	75		37.5
Esso Chemical Canada	Redwater, Alberta	Elem. S.		965	316
Eldorado Resources Limited	Rabbit Lake, Saskatchewan	Elem. S.		45	15
Inland Chemicals Ltd.	Fort Saskatchewan, Alberta	Elem. S.		136	44
	Prince George, British Columbia	Elem. S.		35	11
Sherritt Gordon Mines Limited	Fort Saskatchewan, Alberta	Elem. S.		215	70
Western Co-operative Fertilizers Limited	Calgary, Alberta	Elem. S.		417	136
Subtotal Western Canada				2 698	958.8
Total				5 206	1 823.8

Source: Company reports.
[1] 100 per cent H_2SO_4. [2] Plant capacities are related to current production. [3] International Minerals & Chemical Corporation (Canada) Limited discontinued production at Port Maitland in June 1984. Elemental sulphur equivalent of sulphuric acid is 32.7 per ent and sulphur equivalent of liquefied sulphur dioxide is 50 per cent.
- Nil.

TABLE 5. CANADA, SULPHUR SHIPMENTS AND TRADE, 1966, 1970, 1971, 1975 AND 1979-85

	Shipments[1]				Imports	Exports	
	Pyrites	In Smelter Gases	Elemental Sulphur	Total	Elemental Sulphur	Pyrites[2]	Elemental Sulphur
	(tonnes)				(tonnes)	($)	(tonnes)
1966	147 226	453 870	1 851 924	2 453 020	131 955	981,000	1 269 157
1970	159 222	640 360	3 218 973	4 018 555	48 494	1,226,000	2 711 069
1971	140 642	561 046	2 856 796	3 558 484	27 923	1,074,000	2 401 975
1975	10 560	694 666	4 078 780	4 784 006	14 335	170,000	3 284 246
1979	13 964	667 265	6 314 244	6 995 473	1 699	281,000	5 154 831
1980	14 328	894 732	7 655 723	8 564 783	1 767	386,000	6 850 143
1981	5 000	783 000	8 018 000	8 806 000	4 633	109,000	7 309 216
1982	9 000	627 000	6 945 000	7 581 000	2 159	668,000	6 111 444
1983	-	678 286	6 631 123	7 309 409	2 365	77,000	5 670 275
1984	-	844 276	8 352 978	9 197 254	3 019	34,000	7 326 847
1985P	-	773 477	8 250 252	9 023 729			

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] See footnotes for Table 1. [2] Quantities of pyrites exported not available.
P Preliminary; - Nil.

TABLE 6. CANADA, SULPHURIC ACID PRODUCTION, TRADE AND APPARENT CONSUMPTION, 1966, 1970, 1971, 1975, AND 1979-84

	Production	Imports	Exports	Apparent Consumption
		(tonnes - 100% acid)		
1966	2 267 962	6 303	49 848	2 224 417
1970	2 475 070	9 948	129 327	2 355 691
1971	2 660 773	4 492	91 711	2 573 554
1975	2 723 202	154 020	225 402	2 651 820
1979	3 666 080	170 618	139 425	3 697 273
1980	4 295 366	18 048	323 775	3 989 639
1981	4 116 860	82 495	337 518	3 861 837
1982	3 130 854	192 514	259 740	3 063 628
1983	3 686 427	126 573	273 204	3 539 796
1984P	4 053 391	28 330	553 780	3 527 941

Sources: Statistics Canada; Energy, Mines and Resources Canada.
P Preliminary.

TABLE 7. WORLD PRODUCTION OF SULPHUR, 1981-83

	1981		1982		1983	
	All-forms[1]	Elemental	All-forms	Elemental	All-forms	Elemental
World Total	**58,830**	**33,964**	**50,895**	**31,539**	**50,909**	**30,886**
Western world	**35,335**	**24,956**	**32,479**	**22,703**	**31,951**	**21,831**
Western Europe	**7,691**	**3,591**	**7,355**	**3,587**	**7,354**	**3,353**
Finland	491	45	470	40	541	48
France	2,127	1,970	1,969	1,819	1,960	1,810
West Germany	1,797	1,093	1,751	1,125	1,538	864
Italy	525	76	448	90	436	106
Norway	263	8	304	8	282	8
Spain	1,207	20	1,034	20	1,154	20
Sweden	338	37	334	22	353	20
Others	943	342	1,045	463	1,090	477
Africa	**959**	**38**	**907**	**38**	**886**	**60**
Asia	**4,184**	**2,207**	**4,446**	**2,472**	**4,463**	**2,426**
Iran	6	6	20	20	16	16
Iraq	145	145	200	200	300	300
Japan	2,743	1,041	2,740	1,062	2,764	1,074
Others	1,290	1,015	1,486	1,190	1,383	1,036
Oceania	**206**	**14**	**196**	**18**	**216**	**35**
North America	**19,533**	**16,578**	**16,957**	**14,224**	**16,775**	**14,032**
Canada	6,743	5,971	6,249	5,610	6,696	5,875
United States	12,790	10,607	10,708	8,614	10,079	8,157
Latin America	**2,762**	**2,528**	**2,618**	**2,365**	**2,287**	**1,921**
Mexico	2,160	2,076	2,020	1,925	1,566	1,494
Others	602	452	608	440	721	427
Centrally Planned Economies[2]	**18,495**	**9,007**	**18,416**	**8,835**	**18,958**	**9,053**
Poland	5,111	4,962	5,094	4,935	5,130	4,960
USSR	9,501	3,710	9,132	3,556	9,314	3,737
Others	3,883	335	4,190	344	4,514	356

Source: The British Sulphur Corporation Limited, January-February 1985.
[1] All-forms includes elemental sulphur, sulphur contained in pyrites and contained sulphur recovered from metallurgical waste gases mostly in the form of sulphuric acid. [2] Includes China, North Korea, Vietnam and Cuba.

TABLE 8. CANADA, SULPHURIC ACID CONSUMPTION BY END USE, 1982-84

	1982	1983	1984
		(tonnes)	
Uranium mines	339 294	300 236	365 002
Miscellaneous metal mines	44 535	12 111	15 629
Crude petroleum and natural gas industry	4 449	4 174	8 116
Sugar, vegetable oil and miscellaneous food processors	2 253	837	8 591
Leather industries) Textile industries)	..	31 424	27 774
Pulp and paper mills	257 863	290 932	295 374
Iron and steel mills	7 406	6 360	6 209
Smelting and refining	219 675	211 649	198 343
Electrical products industries	17 150	22 230	17 709
Petroleum refineries and coal products	31 201	34 365	29 713
Fertilizers and other industrial chemicals	2 353 015	2 404 399	2 715 003
Plastics and synthetic resins	39 299	5 606	9 439
Soap and cleaning compounds	15 323	11 544	14 494
Explosives and miscellaneous chemical industries	56 527	38 003	40 680
Miscellaneous manufacturing industries	10 861	10 484	15 905
Other end uses[1]	33 146	31 927	25 592

Source: Reports from producing companies.
[1] Other end uses include miscellaneous non-metal mines; automotive; hydro, municipal utility and water; metal fabricating; and miscellaneous manufacturing industries.
.. Not available.

Talc, Soapstone and Pyrophyllite

M. PRUD'HOMME

SUMMARY

Since 1982, Canadian production of talc, soapstone and pyrophyllite has risen continuously due to new capacity and aggressive marketing, especially in the United States. In 1985, shipments of talc and pyrophyllite were up by 7.0 per cent while the average unit value of talc rose by 9.4 per cent. On a nine month basis, talc imports rose slightly to 30 920 t in 1985 from 27 679 t in 1984, although the value of imports increased around 23 per cent. Average value of imports in 1985 is estimated at $209 per tonne, compared to $193 per tonne for high quality talc. Imports are mainly from United States into Ontario, British Columbia, Quebec and Alberta. In 1986, exports are expected to increase due to expansion of production capacities and to new talc products of high quality.

During 1985, Bakertalc Inc., Quebec, carried out an expansion program to double its current production capacity for wet ground talc used in paper and plastics. B.S.Q. Talc Inc. at St.-Pierre-de-Broughton formed a new company, LUZCAN Inc., through its association with Talcs de Luzenac of France. The new company plans to expand production capacity and to diversify its talc product line. Canada Talc Limited completed an expansion with a new processing plant of 70 000 tpy capacity for talc products. Steetley Talc Limited continued its multiphase expansion program due for completion in mid-1986 at a capacity of 60 000 t with new micronizing and drying facilities. Exploration activity has been recorded in British Columbia, Ontario and Quebec.

Talc prices rose by an average of 5 per cent since last year. Over the short-term, talc markets should continue to grow because of the versatility of talc and because of its competitive selling prices. Markets dependent on the construction sector should show steady growth, depending on the level of economic activity. Appreciable growth is expected in the plastics and the pulp and paper sectors over the next few years.

TALC MINERALS

Talc is a hydrous magnesium metasilicate, $Mg_3Si_4O_{10}(OH)_2$, and is usually intimately associated with numerous other minerals such as serpentine, dolomite and quartz. The colour is characteristically a pale green, grey or creamy white. It exhibits a pearly lustre, a low hardness, a greasy feel and an extreme smoothness. Talc is derived from the alteration of magnesian rocks in an intensive metamorphic environment. It occurs as veinlets, tabular bodies or irregular lenses. Talc is valued for its various properties: extreme whiteness, smoothness, high fusion point, low thermal and electrical conductivity and chemical inertness. Talc is produced in various grades which are usually classified by end-use: paint, ceramic, pharmaceutical and cosmetic.

Steatite (soapstone) is an impure, massive, compact form of talc which can be sawn or machined easily. "Steatite grade" is a special block talc suitable for making ceramic insulators. Soapstone is a mixture of talc, serpentine, chlorite, dolomite with, sometimes, small percentages of quartz and calcite. Its durability depends on its chemical inertness and non-absorbency properties. 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 this rock has survived among the Inuit people of Canada up to the present era. Present uses include metalworkers' crayons, refractory bricks, and blocks for sculpturing.

Pyrophyllite is a hydrous aluminum silicate, $Al_2Si_4O_{10}(OH)_2$, formed by hydrothermal alteration of acid igneous rocks, predominantly lavas which are andesitic to rhyolitic in composition. It occurs in

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low- and medium-grade metamorphic rocks rich in aluminum. Its physical properties are practically identical to those of talc, and, for this reason, pyrophyllite finds industrial uses similar to talc, notably in ceramic bodies and as a filler in paint, rubber and other products.

PRODUCTION AND DEVELOPMENTS IN CANADA

Talc, soapstone. Talc is produced commercially in two provinces, Quebec and Ontario, while pyrophyllite is produced only in Newfoundland.

Bakertalc Inc. produces talc and soapstone from an underground operation at South Bolton, Quebec, 95 km southeast of Montreal. Talc occurs as dykes and sills, associated with serpentine and magnesite, in Cambrian and Lower Ordovician schists. Ore is extracted at the Van Reet mine and is trucked 16 km south to the company's mill facilities at Highwater. It produces around 10 000 tpy of high quality floated material for use principally in the pulp and paper industry, and a similar tonnage of dry-milled talc used as an industrial filler in paints and plastics. Soapstone is also supplied as sculpture blocks. St-Lawrence Chemical Inc. is the distributor for all Bakertalc's products. In 1985, Bakertalc Inc. expanded its production of high quality talc, by doubling its capacity. The addition of a ball mill to its wet grinding facilities will result in increasing the production of its finely ground talc for the plastics and pulp and paper industries. Successful tests to develop the use of talc as a substitute for asbestos have resulted in increased sales. Development work to recover tailings continued in 1985. Exploration drilling underground has increased reserves of talc of similar quality to that being mined.

LUZCAN Inc., formerly B.S.Q. Talc Inc., near St.-Pierre-de-Broughton in Quebec, quarries two deposits associated with the Pennington dyke in Leeds and Thetford townships. Occurrences are associated with ultrabasic intrusives, peridotite-serpentinite, in quartz-carbonate-chlorite schists. LUZCAN Inc. produces ground material containing nearly 70 per cent talc, which is used as a filler in joint cement and auto-body compounds and as a dusting agent in asphalt roofing shingles and rubber production. It also supplies soapstone products such as refractory slabs and sculpture blocks. In 1985, Talcs de Luzenac of France acquired a 50 per cent equity in B.S.Q. Talc Inc. to form a new company, LUZCAN Inc. Future plans for this operation include expansion to double production capacity to 50 000 tpy, with an investment of $2.0 million, and diversification of products to increase the range of grades. Started in August 1985, this development is scheduled for completion by March 1986. Further exploration work and site development have increased proven and probable reserves to over 3 million t. Talcs de Luzenac, which is the largest talc producer in the western world with a total capacity around 427 000 tpy, is getting a production foothold in the North American market with this operation. LUZCAN Inc. will benefit from marketing knowledge and technological expertise.

Canada Talc Limited operates an underground talc mine and also quarries a newly-discovered talc orebody at Madoc, Ontario. The orebodies occur in crystalline dolomite, where tabular hydrothermal replacements have taken place. The talc is of exceptional whiteness and may contain accessory minerals such as sulphides, mica and prismatic tremolite. The company continued its production of dolomite and talc from the new orebodies, west and south of the headframe. A third talc mine in Elzevir Township is in preparation. Talc products will be suitable for use as low-grade fillers. In late-1984, Canada Talc Limited opened a new 100 000 tpy talc and dolomite processing plant at Marmora. With a rated capacity of 70 000 tpy for talc only, this company supplies a range of products suitable for paints, plastics, paper and floor covering.

Steetley Talc Limited, a division of Steetley Industries Limited, produces talc from an open-pit mine in Penhorwood Township, 70 km southwest of Timmins. Talc occurs in talc-magnesite deposits derived from the alteration of ultrabasic volcanic rocks. The ore is processed by flotation and fine-grinding to a high purity, platy material for use mainly in the pulp industry as a pitch control agent. Other markets are in paints, plastics, paper and cosmetics. R.T. Vanderbilt Co. Inc. is the distributor for the American market. Steetley Talc Limited is in the midst of a $4.5 million multi-stage expansion program to increase capacity to around 60 000 tpy by July 1986. This investment will also improve operating efficiency with new micronizing and drying facilities. Exploration work has also been carried out to define the orebodies and to increase reserves.

During 1985, the following developments worthy of note occurred in Canada:

In Quebec, geologists of the Department of Energy and Resources completed a study of talcose rocks in the Eastern Townships.

In Ontario, Twin Buttes Exploration Inc. carried out exploration work near Madoc. A drilling program outlined about 1.8 million t of impure talc from which filler grade material could be produced.

In British Columbia, Trifco Minerals Ltd. did some exploration work in the Quesnel area. Talc occurrences there are confined to serpentinite and serpentinized ultramafic intrusions.

Pyrophyllite. Newfoundland Minerals Limited, a subsidiary of American Olean Tile Company, Inc. (a division of National Gypsum Company), mines pyrophyllite from an open-pit operation near Manuels, 19 km southwest of St. John's, Newfoundland. The deposit appears to be a hydrothermal alteration of sheared rhyolite. Altered zones are associated mainly with extensive fracturing near intrusive granite contacts. Reserves are believed to be sufficient for about 40 years at the present production rate. The mine has operated continuously since 1955. Ore is crushed, sized and hand-cobbed at the mine-site prior to being trucked a short distance to tidewater. Annual production varies between 30 000 and 45 000 t. The cut-off grade is 17 per cent aluminum oxide. High-quality crude ore is shipped to the parent company's ceramics plants at Lansdale, Pennsylvania, and Jackson, Mississippi. Some lower grade pyrophyllite has been used in the local manufacture of joint cement, stucco, paints and other products, since 1975.

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; occurrences near Senneterre in Abitibi County, Quebec and deposits in British Columbia, near Ashcroft and on Vancouver Island.

USES AND SPECIFICATIONS

Talc is used mostly in a fine-ground state; soapstone in massive or block form. There are many industrial applications for ground talc, but fewer than a dozen countries use ground talc on a major scale.

In pulp and paper manufacture softness, chemical inertness, high reflectance, hydrophobic and organophilic properties and the particle shape of talc, are characteristics that permit its use as a pitch-adsorbing agent, as a paper filler and as a coating pigment. For filler usage, maximum particle size should be below 20 microns; however, 40 micron grades are also used. For coating applications, particle size must be below 10 microns and close to 1 micron for pitch control.

The ceramic industry utilizes very finely ground talc to increase the translucence and toughness of the finished product and to aid in promoting crack-free glazing. Talc must be low in iron, manganese and other impurities which would discolour the fired product. Average particle size for most ceramics must range between 6 and 14 microns, with 90-98 per cent of material passing through 325 mesh.

In plastics, talc improves dimensional stability, chemical and heat resistances, impact and tensile strengths, electrical and insulation properties. It is used in thermoplastics and in thermosets, mainly in polypropylene, nylon and polyester. Chemical coupling agents are used to enhance the bond between the talc filler and the resin matrix in plastic materials. Talc must be free of iron impurities and grits, and must be superfine with an average particle size below 8 microns.

High-quality talc is used as an extender pigment in paints. Specifications for a talc pigment, as established in American Society for Testing and Materials (ASTM) designation D605-69 (1976), relate to its chemical composition, colour, particle size, oil absorbency and fineness of dispersion. A low carbonate content, 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 extender are gloss, adhesion, flow, hardness and hiding power.

Pharmaceutical industries are well-known users of high-purity talc for pharmaceutical preparations and cosmetics, relying on its softness, hydrophobic property and chemical inertness. Finely ground, it is used as a filler in tablets and as an additive in medical pastes, creams and soaps.

Lower-grade talc is used as a dusting agent for asphalt roofing and rubber products, as a filler in drywall sealing compounds, floor tiles, asphalt pipeline enamels, auto-body patching compounds, and as a carrier for insecticides. Other applications for talc include use in cleaning compounds, polishes, electric cable coating, foundry facings, adhesives, linoleum, textiles and in the food industry.

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. In ceramics, it imparts a very low coefficient of thermal expansion to tiles. It must be graded minus 325 mesh and contain a minimum of quartz and sericite which are common impurities. It may also be used in refractories as its expansion on heating tends to counteract the shrinkage of the plastic fraction. Massive pyrophyllite, the compact and homogenous variety, is chiefly used in the manufacture of refractories, although small amounts of the crystalline or radiating variety find similar use. Foliated or micaceous pyrophyllite is used as a filler and ceramic raw material.

CONSUMPTION AND TRADE IN CANADA

Canadian producers operated at nearly full capacity in 1985. The value of shipments of talc and pyrophyllite increased by 7.0 per cent in 1985. The value of pyrophyllite shipments represents 11.0 per cent of the total production value of talc minerals. The average unit value of talc increased by 9.4 per cent. The increased tonnage and value are the result of major expansion programs by all Canadian talc producers during 1985 and this should continue into 1986.

For 1984, the value of imports of crude talc rose by 9.5 per cent. On a nine month basis in 1985, imports of talc increased by 11.5 per cent in terms of tonnage, and by 23.0 per cent in terms of value in current dollars. The unit value of imports increased by 8 per cent, up to nearly $209 per tonne. The United States accounts for 99 per cent of Canadian imports. High quality talc is imported mainly into Ontario (40 per cent), British Columbia (23 per cent), Quebec (22 per cent), and Alberta (7 per cent).

Canadian talc is exported to Europe, Japan and the United States which accounts for 99 per cent of total exports. For 1984, exports of talc into the United States increased by 38 per cent compared to 1983. In 1985, Canadian producers benefitted from the closure of a major talc producer in the northeastern states by reacting promptly to the new market opportunities. Any increase in the American markets will be the result of better acceptance of the Canadian products and of aggressive marketing.

WORLD PRODUCTION AND REVIEW

In 1984, world production of talc and pyrophyllite increased by 2.0 per cent, to 7.22 million t. Japan is the largest producer of pyrophyllite and also the largest importer of talc for use in the paper industry. The United States is the largest producer of talc accounting for 15 per cent of the world total, followed by China with 13 per cent.

In Australia, Westside Mines Pty Ltd., which operates a talc deposit near Mount Seabrook, has suspended its production due to a court injunction; the legal ownership of the deposit is being contested. The company is one of the world's major suppliers of cosmetic grade talc in competition with China, Italy, Spain and United States.

In Brazil, Mineraçao Matheus Leme Ltd., has announced the inauguration of its new pyrophyllite processing facility, with a rated capacity of 50 000 tpy. The pyrophyllite products will be used in the paint and rubber industries both in the domestic and foreign markets.

In the United States, NICOR-Meridian Mineral Co. plans to develop an open-pit talc mine and a processing plant at Ennis in Montana. Capital investment will be about $US 12 million for a 50 000 tpy plant. Mill construction and mine development are scheduled to start in 1985.

Vermont Talc at Chester has bought the grinding facilities of Eastern Magnesia, formerly owned by Engelhard Minerals and Chemicals, which produced an average of 50 000 tpy of talc. Vermont Talc is a subsidiary of Omya Inc.

INTERNATIONAL TRADE

Compared to many other commodities, talc must be considered in the context of a small, specialty market for functional usage dependent on its unique physical properties. Talc is also widely distributed throughout the world and many countries have been developing deposits. These widespread occurrences enjoy limited international trade except for high-grade materials, where small shipments compete with substitutes. 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.

In the United States, talc consumption has been estimated at about 997 700 t for 1985. The largest volume use of talc is in the ceramics industry with 35 per cent of the total consumption, followed by paint (18 per cent), pulp and paper (9 per cent), plastics (6 per cent), and cosmetics. United States manufacturers of vinyl flooring products are looking for substitutes as a phase-out of asbestos filler. Asphalt roofing producers are also shifting from other fillers such as dolomite and silica to exclusive use of talc. Approximately 96 per cent of the United States supply of talc comes from American mines. Production follows demand fairly closely, and demand has been quite stable over the past decade.

Japanese imports of talc were stable at around 592 000 t for both 1983 and 1984, although value has increased slowly by 3.6 per cent. Major imports were from China with 70 per cent of total imports, followed by Australia (20 per cent) and North Korea (4 per cent).

With nearly 30 countries producing talc and with potential for even wider distribution in the future, supplies should be sufficient to adequately meet forecast growth in world demand.

PRICES

Prices of talc vary according to quality, method of processing, specifications and transportation cost. Due to the many industries served, prices are not very sensitive to minor economic fluctuations but are more reactive to markets competition. Prices of pyrophyllite vary between $30-45 per short ton, fob plant, for bulk materials. In 1985, Canadian prices ranged between $35-70 per t for medium-grade talc, $95-160 per t for high-grade talc, $180-250 per t for highly-beneficiated talc, and around $1,000 per t for steatite blocks. For 1984, prices were fairly steady. During 1985, prices for various categories have shown a slight increase between 2 and 8 per cent, averaging 5 per cent increase for the full year. For 1986, prices are expected to increase by a similar percentage, around 5-6 per cent depending on the grade. However, list prices and actual prices differ as negotiations occur between producers and consumers.

OUTLOOK

Demand for talc and pyrophyllite in the world is expected to be about 15.8 million t in 2000, 9.6 million t in 1990, with an average annual growth rate of 5.0 per cent during the 1983-2000 period. Demand for talc minerals in the United States is forecast at 2.2 million t in 2000 by the U.S. Bureau of Mines.

Talc will be in demand especially as a reinforcement in plastics with a forecast annual growth rate of between 10-12 per cent for the 1983-2000 period.

Promotion of cosmetics for men will not be offset by concerns related to health-hazard in the usage of some talc. Shift from low-alumina and silica refractories to basic refractories will contribute to increasing acceptance of talc minerals, in the metallurgical industry.

Increasing consumption of coated paper and the uniqueness of the use of talc for pitch control and for filler purposes will contribute to a high growth rate of around 7 per cent. In ceramics, paints, insecticides, roofing and rubber products consumption growth is forecast to be around 3.5 per cent in North America.

New technology, environmental considerations and alternative materials are factors that should limit growth rates up to 2000. However, new markets, innovative products and increasing consumption of manufactured goods should benefit the talc industry, especially in the plastics, ceramics and papermaking sectors.

Substitutes for talc are numerous in its major markets; they include nepheline syenite, kaolin and calcium carbonate in paints; pyrophyllite and feldspar in ceramics; mica and calcium carbonate in plastics; kaolin and calcium carbonate in paper. However, talc is still the primary pitch control agent in the pulp and paper industry.

PRICES

Talc; free on board mine, carload lots, containers included unless otherwise specified: U.S. $ per short ton.

New Jersey	
mineral pulp, ground; (bags extra)	18.50-20.50
Vermont	
98% through 325 mesh, bulk	70
99.99% through 325 mesh, dry processed, bags	147
99.99% through 325 mesh, water beneficiated, bags	213-228
New York	
96% through 200 mesh	62-70
98-99.25% through 325 mesh (fluid energy ground)	85-100
100% through 325 mesh (fluid energy ground)	165
California	
Standard	130
Fractionated	37-71
Micronized	150-220
Cosmetic/Steatite	33-65
Georgia	
98% through 200 mesh	50
99% through 325 mesh	60
100% through 325 mesh (fluid energy ground)	100

Source: Engineering and Mining Journal, December 1985.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
71100-3	Talc or soapstone	10	10.7	25	7.0
29646-1	Talc for use in manufacture of pottery or ceramic tile (expires June 30, 1986)	free	free	25	free
29647-1	Micronized talc, not exceeding 20 microns	free	4.3	25	free
29655-1	Pyrophyllite	free	free	25	free

MFN Reductions under GATT (effective January 1 of year given)		1985	1986	1987
			(%)	
71100-3	Talc or soapstone	10.7	9.9	9.2
29647-1	Micronized talc, not exceeding 20 microns	4.3	4.1	4.0
UNITED STATES				
523.31	Talc and soapstone, crude and not ground	0.02¢ per lb.		
523.33	Talc and soapstone, ground, washed, powered or pulverized	3.3	2.9	2.4
523.35	Talc and soapstone, cut or sawed, or in blanks, crayons, cubes, disks or other forms, per lb.	free	free	free
523.37	All other, not provided for	4.8	4.8	4.8

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated 1985, USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241.

TABLE 1. TALC, SOAPSTONE AND PYROPHYLLITE PRODUCTION, TRADE 1983-85 AND CONSUMPTION 1982-84

	1983		1984		1985P	
	(tonnes)	($)	(tonnes)	($)	(tonnes)	($)
Production (shipments)						
Talc and soapstone						
Quebec[1]	..	1,960,844	..	2,388,443	..	3,007,000
Ontario[2]	..	4,894,441	..	7,111,330	..	9,181,000
Total	..	6,855,285	..	9,499,773	..	12,188,000
Pyrophyllite						
Newfoundland	..	1,140,659	..	1,654,406	..	1,495,382
Total production	97 030	7,995,944	122 992	11,154,182	131 668	13,683,382
Imports		($000)		($000)		($000)
					(Jan.-Sept. 1985)	
Talc, incl. micronized						
United States	34 718	6,123	37 920	7,341	30 733	6,425
France	-	-	73	21	91	35
Japan	2	3	24	3	29	3
United Kingdom	46	19	75	11	25	3
Italy	18	14	0	0	24	3
Austria	0	0	0	0	18	9
Greenland	0	0	24	7	0	0
Sub-total, talc	34 824	6,159	38 117	5,266	30 920	6,478
Soapstone, exc. slabs						
United States	34	7	50	12	68	10
Sub-total, soapstone	34	7	50	12	68	10
Pyrophyllite						
United States	548	41	650	43	428	28
Sub-total, pyrophyllite	548	41	650	43	428	28
Total talc, soapstone and pyrophyllite	35 406	6,207	38 817	7,438	34 416	6,516

	1982	1983	1984[4]
		(tonnes)	
Consumption[3] (ground talc available data)			
Pulp and paper products	6 660	9 660	19 707
Roofing products	6 631	5 671	14 743
Paint and varnish	8 612	7 959	6 708
Gypsum products	2 735	3 133	5 545
Ceramic products	5 546	3 376	3 523
Rubber products	2 470	3 400	3 332
Chemicals	2 734	2 577	2 601
Toilet preparations	1 513	1 722	1 613
Other products[5]	1 732	1 999	1 497
Total	38 633	39 497	59 269

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Ground talc, soapstone, blocks and crayons. [2] Ground talc. [3] Breakdown by Energy, Mines and Resources, Canada. [4] Consumption increase due to increase in number of pulp and paper products companies and roofing products companies surveyed. [5] Adhesives, cleaners, floor covering, insecticides, refractories and other miscellaneous uses.
P Preliminary; .. Not available; - Nil.

TABLE 2. CANADA, TALC AND PYROPHYLLITE PRODUCTION AND IMPORTS, 1970, 1975, AND 1980-85

	Production[1]	Imports
	(tonnes)	
1970	65 367	29 999
1975	66 029	30 428
1980	91 848	50 774
1981	82 715	30 322
1982	70 523	34 522
1983	97 030	35 406
1984	122 992	38 817
1985P	131 668	..

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Producers' shipments.
P Preliminary; .. Not available.

TABLE 3. WORLD PRODUCTION OF TALC, SOAPSTONE AND PYROPHYLLITE, 1981-84

	1981	1982	1983P	1984e
	(000 tonnes)			
Japan	1 545	1 492	1 466	1 510
United States	1 218	1 030	967	1 060
People's Republic of China[e]	898	952	952	950
Republic of Korea	620	591	632	600
U.S.S.R.[e]	500	510	510	520
Brazil	503	384	454	450
India	367	336	353	360
Finland	307	325	318	310
France	309	277	285	290
North Korea	168	168	168	170
Italy	163	164	158	150
Australia	91	152	150	150
Canada	83	70	97	125
Austria	116	117	121	120
Norway	33	85	87	85
Other countries	303	385	357	380
Total	7 224	7 038	7 075	7 230

Sources: U.S. Bureau of Mines Preprints 1984; Energy, Mines and Resources Canada.
P Preliminary; e Estimated.

Tin

A. BOURASSA

On October 24, the Buffer Stock Manager halted all tin price support operations. Tin trading was immediately stopped on the London Metal Exchange and the Kuala Lumpur commodity exchange. Bank loans and forward trading undertaken by the Buffer Stock Manager had left the International Tin Council (ITC) with liabilities of over $Cdn 1.5 billion.

Tin prices are bound to drop significantly when trading resumes. The prices could decline even more steeply in the absence of a negotiated settlement between the ITC and its creditors, if creditors rapidly unload tin held as collateral. A negotiated settlement should dampen the price drop through a more orderly release of tin stocks over a number of years and the possible extension of export controls. Several tin producers would still have to close but the adjustments would be less dramatic. Tin prices will have to fall below long term equilibrium levels in order to allow markets to absorb the huge tin stock overhang.

In 1985 tin-in-concentrate supply again exceeded consumption. World tin consumption was slightly lower in 1985 compared to 1984. Tin prices reached an all-time high on the LME in February at £10,265 per t. The last tin quote on the LME on October 24 was at £8,140 per t.

CANADIAN DEVELOPMENTS

In 1985, Canada still produced relatively little tin. The new Canadian tin mine in East Kemptville, Nova Scotia started trial production during October but did not make any shipments. First concentrate shipments are projected for early-1986. The official mine opening is scheduled for April 1986.

The open-pit mine produces concentrates which will be smelted by Capper Pass & Son Ltd. in the United Kingdom. Mill capacity is 9 000 tpd of ore. The concentrates produced are expected to contain over 4 000 tpy of tin, or close to the current domestic tin consumption level for Canada. The life of the mine is expected to be 17 years. Concentrate production will peak early in the operations then fall off with the passing years. The orebody was estimated in 1985 to contain some 56 million t grading 0.16 per cent tin, recoverable by open-pit mining. The new mine required a $150 million investment and will create 200 permanent jobs.

New tin markets realities will place great demands on the operators of the mine. Although production costs have yet to be precisely determined, the mine is expected to rank among lower cost producers in the world. Mill recovery will be one determining element of cost. Rio Algom Limited officials have expressed satisfaction with initial results.

Tin concentrates in Canada are now recovered as byproducts of base-metal mining by Cominco Ltd. at Kimberley, British Columbia. Cominco recovers the tin-lead alloy containing about 8 per cent tin at its Trail, British Columbia smelter and produces small quantities of special high purity tin from imported commercial grade metal.

Tin mineralization is known in various parts of Canada and higher prices in recent years have encouraged exploration. The first major discovery was the East Kemptville deposit, although there are other known deposits across the country. In early-October, Lac Minerals Ltd. reached an agreement with Billiton Metals Canada Inc. for the exploration of the North Zone tin prospect at the Mount Pleasant deposit in New Brunswick. It will spend at least $4 million over a 39-month period and pay Billiton $500,000 to acquire the option to earn a 50 per cent interest in the property. Previous drilling has indicated 5.1 million t of potential reserves grading .79 per cent tin.

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Canada relies on imports for its tin requirements except for small amounts recovered from recycled solders and detinning and in primary tin lead alloys production. Consumption has been falling for several years but this trend was reversed in 1984 when imports grew by almost 20 per cent. Increased consumption was especially noted in tin plate produced by two large Canadian steelmakers, Stelco Inc. and Dofasco Inc. Consumption has dropped slightly in 1985.

WORLD DEVELOPMENTS

Since 1973, world tin consumption has trended downwards because of substitution away from tin in some end uses and because of technological developments that have decreased the quantities of tin for other uses. This trend was reversed in 1984 mostly as a result of the worldwide economic recovery, but the structural factors that caused the previous decline are still at work. However, consumption should now stabilize around present levels due to the growth potential of some tin uses and lower future tin prices which should reduce pressure for substituting tin.

Production of tin in concentrates and tin metal both dropped sharply since 1982 as a result of export controls imposed on producer members of the Sixth International Tin Agreement (ITA). While ITA producers were cutting back production, some non-ITA producers, Brazil and China especially, were sharply increasing production and exports. Tin production by ITA member countries accounts for about 55 per cent of world production versus 70 per cent in 1982. Total concentrate production in 1985 was projected at about the same level as in 1984, based on rates of production for the first three quarters of the year. However, the advent of the tin crisis and ensuing lower prices are likely to bring lower than projected production in the last quarter. Therefore, the table on Production of Tin-in-Concentrate could overstate production by some 2 or 3 per cent.

Until the tin crisis comes to a conclusion and new price levels are determined, future tin production cannot be predicted. If the price of tin drops below £5,000 per t, tin production will be much lower in 1986. Severe production cutbacks would not be as likely if prices could remain around £6,000 per t or above. At that level, reactivation of some of the shut-in capacity, should export controls be removed, could offset drops in production resulting from the closure of some of the mines.

Statistics in the accompanying tables do not include information on most centrally planned countries. Leading producers among these countries include the U.S.S.R. and the People's Republic of China, for which the United States Bureau of Mines estimates production in 1983 at 37 000 t and 15 000 t, respectively. The Democratic Republic of Germany is estimated to have produced 1 700 t in 1983. Tin from these countries is generally consumed domestically, although China is a net exporter to the west (estimated at 6 000 t in 1985). The combined net imports from the west of the U.S.S.R. and East Germany are estimated at over 14 200 t in 1985.

A substantial tonnage of tin production, included in the accompanying tables, is of unspecified origin. This was estimated at 11 000 t in 1985. These tin concentrates are generally channelled through Singapore where they are smelted or re-exported to smelters elsewhere. Their origin is believed to be largely southeast Asian countries, particularly Thailand, having been smuggled out of these countries to avoid payment of royalties and export duties and, since 1982, to bypass export controls.

The United States General Services Administration (GSA) continued sales of tin from the strategic stockpile. Sales in 1984 totalled 2 397 t, and were about 2 425 t in 1985 (all GSA figures are in long tons). Total sales by the end of 1985 were about 17 779 t, under the program which had begun in 1980. The goal for the United States strategic stockpile is 42 700 t, compared to over 185 000 t at the end of 1985. By October 1, 1984, sales of 20 000 t were authorized. Although GSA sales represent only a small percentage of the total market, producers believe that they place great downward pressure on prices, especially under the current unfavourable circumstances.

Australia is regarded as one of the higher cost major tin producers. Several of its mines are therefore vulnerable when tin prices will fall. Aberfoyle Limited, 47 per cent owned by Cominco Ltd., will likely close its two tin mines, in Ardlethan, New South Wales, and Cleveland in Tasmania. Tin reserves at both mines were nearing depletion. At the last annual general meeting, the company chairman had raised the possibility of closure in 1986. Renison Ltd. will be hard-pressed to maintain its profitability at lower price levels but more selective mining should allow the company to successfully go through the next few difficult years. Australia's tin and concentrate production in 1985 was about equal to last year's at 7 851 t. It should be lower in 1986.

Bolivia's production of tin in concentrates has been falling steadily since the mid-1970s. Due to renewed labour problems in the latter part of the year, production in 1985 should be much below the projected 18 000 t compared to 19 911 t in 1984. Tin exports are the country's largest single source of foreign exchange for this heavily indebted country. Tin production costs are probably the highest in the world and have been above tin prices over the last few years. The state-owned Corporacion Minera de Bolivia (Comibol) accounts for over 70 per cent of the country's tin production. It is faced with repeated losses and mainly obsolete facilities. There are also several smaller independent producers which must sell their concentrate to the state-owned Vinto smelter or Banco Minero de Bolivia. Prices paid in local currency are too low for these operations to be profitable.

Brazil boosted its tin-in-concentrate production to almost 25 000 t in 1985 from 19 957 t in 1984. The country's tin consumption is about 4 500 t so that exports are around 20 000 t. The largest tin producer, Paranapanema SA, is responsible for most of that increase with 1985 production running at about 18 000 t. The second largest tin producer is Brascan Recursos Naturais S.A. (BRN), a joint venture by Brascan Limited of Canada and British Petroleum. Production from its present 11 working sites is estimated at about 4 000 t tin-in-concentrate for 1985. The third largest producer, Empresas Brumadinho, produced about 2 000 t in 1985. The stage is set for further production increases in Brazil. A new mine is starting in Itauiba in the Para state with a capacity of 500 tpy of tin-in-concentrate. Brascan is investing $US 16 million to increase production and is opening two new mines. Paranapanema SA is investing $US 15 million in infrastructure at its Pitinga site and is commissioning an electric bucketwheel excavator. A smaller company, Mineracao Canopus S.A. in the Para state, will commission a third concentrator which will increase capacity to 100 tpd and has a major ongoing exploration program. Empresas Brumadinho also has major exploration and modernization programs. Brazil's tin mining industry is relatively young and efficient. It generally operates in remote regions which increases operating costs but it is generally endowed with rich deposits. Paranapanema SA has some of the richest known alluvial deposits in the world. To counteract lower tin prices, the industry is likely to push for higher production in 1986 to maintain and increase market share and amortize substantial recent investments. The country has sufficient smelting capacity for increased production. Production in 1986 could exceed 28 000 t.

China's tin metal exports peaked at 13 000 t ten years ago but had been steadily declining since then. They were estimated at about 3 000 t in 1984. Earlier reports indicate that they may reach close to 6 000 t in 1985. Although information from China is sketchy, this increase comes at the time of the opening of a new tin mine at Dachang in the Zhuang autonomous region. Production of tin-in-concentrate at this site was projected at about 4 000 tpy with potential for future increases. A new smelter is due to open at Liepan in Guangxi; the capacity should be less than 10 000 tpy. A new mine is under development in the Yunnan Province with production targeted at 3 000 tpy of tin in concentrate. Chinese production should therefore keep increasing, however, exports may not increase as much since domestic demand is growing rapidly.

Indonesia's tin-in-concentrate and tin metal production in 1985 were similar to 1984 levels. The state mining company, P.T. Tambang Timah, which accounts for about 75 per cent of the country's production, is cutting its operating budget for 1986 and laying off people in an effort to reduce costs. Lower tin prices should not affect Indonesian tin production levels as much as in other surrounding countries. This will partly be as a result of the government's likely effort to maintain some level of economic activities in areas of the country where tin is a major source of income.

Malaysia's tin in concentrate production fell somewhat in 1985 while production of tin metal rose slightly. The country's industry is now bracing itself to face the new market realities. By the end of 1985, almost a third of the mines were temporarily shut down, unable to generate sufficient cash flow to maintain operations. Lower prices are likely to hit the gravel pump sector of the industry especially hard. Tin prices below $5,000 per t would probably mean permanent closure for at least half of them.

Thailand has reacted rapidly to adapt to the new economic realities of the tin market. On November 25, the government sharply reduced levies on tin. Thailand tin miners were paying up to 27 per cent of the Penang price in taxes or royalties to the government. The government also lifted the ban on the export of concentrates. These measures should go a long way to curtailing the smuggling of concentrate from Thailand. The government also decided to set up its own tin market in the wake of the prolonged trading suspension in Kuala Lumpur and in London. The first daily price was posted on December 17. While lower tin prices are expected to take their toll among Thailand miners, the cuts could be somewhat less severe than in Malaysia.

United Kingdom tin production exceeded 5 000 t again in 1985. However, this peak is unlikely to be repeated over the next few years. The United Kingdom has a relatively high cost tin industry and lower prices are likely to cut deeply into the country's production capacity. For example, the chairman of Geevor Tin Mines PLC said that by year-end the company would require some assistance from the government to stay in operation. The situation in other mines will also be critical if tin prices fall below £6,000 per t.

INTERNATIONAL ORGANIZATIONS

The International Tin Agreement

Tin is the only metal, for which there is an agreement involving producing and consuming countries, that contains economic provisions for market stabilization. Successive five-year pacts have been in force since 1956. The Sixth International Tin Agreement entered provisionally into force on July 1, 1982, to replace the Fifth Agreement. Provision is made in the agreements for market stabilization measures, including purchases and sales under a buffer stock arrangement, and the implementation of export controls on producing members if buffer stock operations are insufficient to protect the floor price.

Upon its entry into force, countries that had either signed or ratified the Sixth Agreement comprised six producers (Australia, Indonesia, Malaysia, Nigeria, Thailand and Zaire), which together accounted for 70 per cent of reported 1982 world tin mine production, and 18 consuming members, including Canada, which together accounted for 51 per cent of 1982 world tin consumption. Leading members of the Fifth Agreement that did not join the Sixth were the United States, U.S.S.R. and Bolivia.

The Sixth Agreement, as negotiated, provided for a buffer stock of up to 50 000 t of tin: 30 000 t financed by mandatory cash contributions from both producing and consuming members and 20 000 t by borrowing, with member government guarantees if necessary. Mandatory contributions from consuming members were introduced for the first time in the Sixth Agreement, replacing voluntary consumer contributions in the Fifth Agreement.

Implementation of the Sixth Agreement required that countries accounting for at least 65 per cent of both production and consumption ratify the agreement by April 30, 1982. Although this level was not achieved on the consumption side, countries that had signed the agreement agreed to implement it provisionally on July 1, 1982. The member-financed buffer stock was reduced from 30 000 t to 19 666 t but the loan-financed portion remained at 20 000 t. Stockholdings necessary to permit implementation of export controls were reduced proportionately. Price levels established under the new agreement remained unchanged, with a floor of 29.15 Malaysian ringgits ($M) per kg and a ceiling of $M 37.89. The buffer stock must be a net buyer in the lower range ($M 29.15 - $M 32.06) and a net seller in the upper range ($M 34.98 - $M 37.89). These ranges were last changed in October 1981. Under the export control scheme, producers may stockpile excess tin in concentrates up to a maximum of about 25 per cent of their base annual production, to be held for smelting and sale upon removal of the controls.

Association of Tin Producing Countries

The Association was officially formed on August 13, 1983, after lengthy negotiations. It had five members: Bolivia, Malaysia, Indonesia, Thailand and Zaire. Nigeria joined on August 31 and Australia in November of the same year. These seven participating members produce 75 per cent of the tin in non-communist countries. The Association's head office is in Kuala Lumpur, Malaysia.

The main objectives proposed by the Association are the promotion of tin use through research and technological development, support of the Sixth ITA's market stabilization activities and an increase in the economic spinoffs from tin production in the economies of member countries.

The Association works closely with the International Tin Research Council in London, England and the South East Asia Tin Research and Development Centre, in Malaysia. Both of these organizations are already financed by these same tin producers.

Research Organizations

The International Tin Research Council is entrusted with the task of maintaining and extending the use and effectiveness of tin in modern technology. It is financed by the governments of six of the major tin producing countries of the world, Bolivia, Indonesia, Malaysia, Nigeria, Thailand and Zaire.

The Council's headquarters and laboratories are the International Tin Research Institute in Greenford, Middlesex, England. The Council also has organizations for information, service and technical development in several major tin consumer and producer countries.

The South East Asia Tin Research and Development (SEATRAD) Centre is a regional organization established by the governments of Indonesia, Malaysia and Thailand, with assistance from the Economic and Social Commission for Asia and the Pacific (ECAP) and other United Nations agencies. The purpose of the Centre is to promote, conduct and coordinate research and training in relation to the technical and economic aspects of exploration, mining, mineral processing and smelting of tin. The Centre's headquarters and laboratories are located in Ipoh, Malaysia. In addition to the work being conducted in the laboratories, field projects are maintained in various member countries in southeast Asia.

The Centre is financed by equal contributions from member countries.

THE TIN "CRISIS"

The Sixth Tin Agreement came provisionally into force as tin markets were faced with a growing imbalance between production and demand. Export controls, imposed at the end of the Fifth Agreement, on ITA producer member countries were increased in 1983 in order to bring down excessive stock levels. Cutbacks were set at 39.6 per cent of past export levels. Unfortunately, tin support prices were set in Malaysian dollars which followed the strong U.S. dollar. Tin prices on the LME therefore increased, consistently attracting new producers like Brazil that were not subjected to export controls. In fact, tin prices have been above a market clearing level since about 1981. In 1985, tin stock depletion stopped.

Under the terms of the agreement, the Buffer Stock Manager had limits on the amount of tin that could be held in the Buffer Stock. In order to maintain tin prices and increase the amount of tin under his control, he dealt increasingly on the forward market, buying and selling tin forward in a manner that effectively was keeping it off the market. In 1985, financing and transaction costs as well as losses in trading following the fall of the U.S. dollar and the ensuing tin price decline, depleted the financial resources of the Buffer Stock Manager. On October 24 tin price support was halted.

Tin trading was immediately suspended on the LME and the Kuala Lumpur Exchange. As a result of the forward transactions of the Buffer Stock Manager, and bank borrowings, the liabilities of the ITC were estimated at close to £1 billion → $Cdn 2 billion. The assets consist primarily of about 63 000 t of tin metal held in the Buffer Stock under the Fifth and Sixth Agreements and some priced three month forward tin sales (about 8 000 t).

Tin held in the Buffer Stock was paid for through the initial contributions of member countries and borrowings from banks which took tin as collateral. The forward transactions were financed by LME brokers who stand to loose about $Cdn 1 billion if the ITC cannot meet contractual obligations. About half the LME brokers have exposure in tin. The exposure of some of the brokers was deemed sufficient by analysts to cast doubts about their ability to avoid bankruptcy if they do not get paid. It was suggested that bankruptcies by these brokers could trigger other bankruptcies among LME brokers that may hold contracts with the former in other metals and thus threaten the LME itself.

At the time of writing (January 1986), the ITC creditors were still discussing a possible negotiated settlement with ITA member countries.

PRICES AND STOCKS

In 1985, tin prices were again subject to the vagaries of currency fluctuations. The year started with the relatively strong Malaysian dollar and weak British pound so tin prices reached an all-time high of £10,265 per t in February. Thereafter, tin prices steadily declined on the LME, and on October 24, the last quote was £8,140 per t. From that date until the end of the year there were no official tin prices on either the LME or the Kuala Lumpur Exchange. However, "grey" markets had developed and by the end of the year, unofficial tin prices were being quoted around the £6,500 per t level.

Should a negotiated settlement to the crisis be reached, tin prices could be about £6,000 per t. Failure to reach a negotiated settlement is likely to bring a much steeper fall in prices as creditors may rapidly unload tin held as collateral. Tin prices could then drop to £5,000 per t or lower until much of the tin stocks are used up.

By mid-October, the buffer stock manager was holding about 63 000 t of tin, 24 156 t under the Fifth Agreement and about 39 000 under the Sixth. Under export control regulations, ITA member countries can hold stocks of tin up to a level of 25 per cent of their yearly quota. Tin stocks in those countries were estimated at about 25 000 t. In October, LME stocks were up to about 38 000 t. World tin stocks were therefore greatly in excess of 125 000 t and were probably close to 140 000 t (excluding GSA tin). Tin stocks were therefore just about 25 000 t short of the yearly world consumption level.

USES

Tinplate has traditionally been the largest use of tin worldwide. However, falling demand in the developed world has more than offset gains in developing countries. Rising tinplate production in the developing countries is curtailing imports from developed countries. In the latter competition from substitutes in the food and beverage market as well as thinner tin coatings have brought about the decline. In the United States, aluminum has taken over the large beverage container market. Similarly, the increasing popularity of the microwave oven has food producers looking at alternate packaging material like plastics and cellulose. Tinplate competition also comes from non-tin coated steels, TFS or ECCS.

In the United States and Japan solder now surpasses tinplate as the major tin user. Solder is another traditional use of tin. Strong growth in the electronics industry has provided a new impetus for this tin use. Growth in tin solder is however limited by the trend towards the use of less and less solder per assembly. This trend is more evident in the increasing use of surface mounted components which permits greater solder savings.

Chemicals have been the fastest growing newer use for tin. Tin is used in an array of chemicals called organotin with applications as P.V.C. stabilizers, agricultural pesticides, anti-fouling paints for ships and biocidal compounds for the protection of materials such as paints, textiles and building materials.

Tin is also used for tinning (which includes electronic uses, hot dipping and electroplating in the electronics industry) in bronze, brass and other tin containing alloys; these products are used in construction, machining and equipment and consumer durables.

According to the International Tin Council, consumption of tin and tinplate is estimated at 52 000 t in 1985 and is projected at about 49 000 t in 1988. Solder is expected to take over from tinplate as the main use of tin worldwide within the next few years. Demand for tin solder, estimated at about 48 000 t in 1985 should exceed 50 000 t in 1988. Demand for tin in chemicals should keep growing and reach 21 000 t in 1988 from about 19 000 t in 1985. Most other uses, except tinning which should grow to 8 000 t in 1988 from 7 000 t in 1985, should either be stable or show a slight decline for an aggregated consumption of 34 000 t of tin in 1988 versus 35 000 t in 1985.

OUTLOOK

In 1986, tin prices will probably fall below £6,000 per t with or without a negotiated settlement. At that price level, the first tin mine closures should take place in 1986. Tin production for 1986 should be below consumption levels and allow for stock depletion.

Prices should remain below a long-term market equilibrium price for three years or more to allow for the necessary stock depletion. An equilibrium price is probably around £7,000 per t in 1985 dollars. Prices could fall to £5,000 per t or below in the absence of a negotiated settlement. The sharper the price decline, the larger the number of mines that will be forced to close, the larger a future potential imbalance between production and consumption could be once stocks are depleted. Too low a price now could mean much higher prices in the 1990s if tin was again in short supply.

The ITA will never be the same after the "crisis" if it survives at all. However, potential long-term problems in the tin markets suggest there is a continuing need for an ongoing dialogue between producers and consumers for their future mutual benefit. Such a dialogue will be needed at least until market adjustments have been made and a new equilibrium has been reached in the markets.

Lower tin prices are not likely to bring increases in tin consumption for the short- to medium-term. Tin consumption is rather price inelastic. Tin is not a major cost component of tinplate. Solder is not a major cost component of electronic parts. Lower prices will however remove some of the pressure for substituting tin in some of its uses but upcoming market adjustments will maintain uncertainty as to future tin prices and availability. Tin consumption is therefore likely to remain between 160 000 to 170 000 tpy until the end of the decade.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
32900-1	Tin in ores and concentrates	free	free	free	free
33507-1	Tin oxides	free	13.1	25	free
33910-1	Collapsible tubes of tin or lead coated with tin	10	12	30	free
34200-1	Phosphor tin	5	6	10	4.0
34300-1	Tin in blocks, pigs, bars or granulated/ granular granule form	free	free	free	free
34400-1	Tin strip waste and tin foil	free	free	free	free
38203-1	Sheet or strip, iron or steel, corrugated or not, coated with tin	9.5	9.5	25	6
43220-1	Manufactures of tin plate	12	12	30	8

MFN: Reductions under GATT (effective January 1 or year given)	1985	1986	1987
		(%)	
33507-1	13.1	12.8	12.5
33910-1	12.0	11.1	10.2
34200-1	6.0	5.8	5.5
38203-1	9.5	8.8	8.0
43220-1	12.0	11.1	10.2

UNITED STATES (MFN)

601.48	Tin ore and black oxide in tin	free
622.02	Unwrought tin other than alloys of tin	free
622.04	Unwrought tin, alloys of tin	free
622.06	Unwrought tin, other	free
622.10	Tin waste and scrap	free

		1985	1986	1987
			(%)	
622.15	Tin plates, sheets and strips, not clad	3.3	2.9	2.4
622.17	Tin plates, sheets and strips, clad	6.6	5.7	4.8
622.20	Tin wire, not coated or plated with metal	2.4	2.4	2.4
622.22	Tin wire, coated or plated with metal	4.7	4.4	4.2
622.25	Tin bars, rods, angles shapes and sections	4.7	4.4	4.2
622.35	Tin powder and flakes	4.7	4.4	4.2
622.40	Tin pipes, tubes and blanks	3.3	2.9	2.4
644.15	Tin foil	9.6	8.3	7.0

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated 1985, USITC Publication 1610; U.S. Federal Register, Vol. 44, No. 241.

TABLE 1. CANADA, TIN PRODUCTION, IMPORTS AND CONSUMPTION, 1983-85

	1983		1984		1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production						
Tin content of tin concentrates and lead-tin alloys	140	2,013	209	3,761	113	1,795
Imports					(Jan.-Sept.)	
Blocks, pigs, bars						
United States	1 428	21,590	1 502	23,747	616	9,828
Brazil	965	15,681	912	14,874	1 219	19,670
Bolivia	798	13,028	429	6,963	384	6,296
Netherlands	60	1,004	521	8,518	60	943
Singapore	240	4,068	480	7,960	360	5,834
Other countries	278	3,876	262	3,005	181	3,488
Total	3 769	59,247	4 106	65,067	2 820	46,059
Tinplate						
United States	1 902	1,906	2 159	1,973	406	501
West Germany	298	239	-	-	50	31
United Kingdom	3	3	1	1	-	-
Total	2 203	2,148	2 160	1,974	456	532
Tin, fabricated materials, nes						
United States	320	1,432	267	1,382	242	1,019
West Germany	9	58	3	17	7	34
United Kingdom	7	49	18	105	12	87
Other countries	13	48	7	32	5	27
Total	349	1,587	298	1,544	266	1,167
Exports						
Tin in ores, concentrates and scrap[1]						
United Kingdom	271	1,647	286	1,821	39	251
United States	48	262	27	149	996	571
Spain	52	225	-	-	-	-
U.S.S.R.	-	-	-	-	- 6	-
Other countries	-	-	-	-	156	931
Total	371	2,134	313	1,973	1 191	1,753
Tinplate scrap						
United States	4 984	226	3 297	137	2 145	222
Indonesia	305	125	-	-	-	-
Italy	94	38	-	-	-	-
Taiwan	34	12	36	9	-	-
Other countries	-	-	-	-	105	22
Total	5 417	401	3 333	146	2 250	244
Consumption						
Tinplate and tinning	2 049	..	2 503			
Solder	1 032	..	1 128			
Babbit	174	..	212			
Bronze	60	..	155			
Other uses (including collapsible containers, foil, etc.)	69	..	88			
Total	3 381	..	4 086			

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Tin content of ores and concentrates plus gross weight of tin scrap.
P Preliminary; .. Not available; - Nil; nes Not elsewhere specified.

TABLE 2. CANADA, TIN PRODUCTION, EXPORTS, IMPORTS AND CONSUMPTION, 1970, 1975 AND 1980-85

	Production[1]	Exports[2]	Imports[3]	Consumption[4]
		(tonnes)		
1970	120	268	5 111	4 565
1975	319	1 052	4 487	4 315
1980	243	883[r]	4 527	4 517
1981	239	513	3 791	3 766
1982	135	601	3 235	3 528
1983	140	371	3 769	3 381
1984	209	313	4 160	4 086
1985P	113	1 191	2 820[5]	

Sources: Energy, Mines and Resources Canada; 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 re-exported primary tin. [3] Tin metal. [4] Current coverage exceeds 90 per cent, whereas until 1972, coverage was in the order of 80 to 85 per cent. [5] Jan.-Sept. only.
[P] Preliminary; [r] Revised.

TABLE 3. WORLD[1] TIN PRODUCTION, CONSUMPTION AND PRICES, 1970-85

	Production			Prices	
	Tin in Conc.	Primary Metal	Consumption	Malaysia[2]	NY Dealer[3]
			(000 t)		
1970	185	185	185	10.99	1.74
1971	188	187	189	10.44	1.67
1972	196	191	192	10.36	1.77
1973	189	188	215	11.35	2.27
1974	184	182	200	18.79	3.96
1975	181	179	173	15.94	3.40
1976	180	183	194	18.96	3.49
1977	188	180	185	26.26	4.99
1978	197	194	185	28.82	5.87
1979	200	201	186	32.42	7.11
1980	201	198	174	35.72	7.73
1981	205	197	163	32.34	6.48
1982	190	180	157	30.09	5.86
1983	172	159	155	30.19	6.01
1984	167	161	165	29.16	5.67
1985[e]	166	161	163	29.69	5.25

Source: International Tin Council.
[1] Excludes countries with centrally planned economies, except Bulgaria, Czechoslovakia, Hungary, Poland, Romania and Yugoslavia. [2] Cash price ex-smelter for Grade A tin, shipment within 60 days, in Malaysian ringgits per kg, the ringgit being the unit used to define price levels under successive International Tin Agreements. [3] Metals Week.
[e] Estimate.

TABLE 4. WORLD[1] CONSUMPTION OF PRIMARY[2] TIN, 1970 AND 1983-85

	1970	1983	1984	1985[e]
	(tonnes)			
EEC, total[3]	58 246	38 214	40 710	40 542
West Germany	14 062	13 792	15 591	15 764
France	10 500	7 564	7 799	7 040
United Kingdom	16 951	6 123	5 838	5 799
Netherlands	5 467	4 400	4 842	5 114
Italy	7 200	4 200	4 500	4 100
Belgium/Luxembourg	3 000	1 804	1 697	1 199
United States	53 807	34 300	37 819	38 000
Japan	24 710	30 504	33 275	32 344
Spain	3 040	4 400	3 900	4 000
Poland	..	4 351	3 634	3 140
Brazil	2 139	3 942	4 271	4 700
Canada	4 640	3 776	4 106	4 000
Czechoslovakia	3 420	3 550	3 000	2 800
Republic of Korea	394	2 628	3 632	3 400
Australia	3 837	2 500	2 600	2 600
Total, incl. Others	184 800	154 700	164 800	162 900

Source: International Tin Council.
[1] Excludes countries with centrally planned economies, except Bulgaria, Czechoslovakia, Hungary, Poland, Romania and Yugoslavia. [2] May include secondary tin in some countries.
[3] Includes all 1982 members in all years except Greece in 1970.
.. Not available; [e] Estimate.

TABLE 5. WORLD[1] PRODUCTION OF TIN-IN-CONCENTRATES, 1970 AND 1983-85

	1970	1983	1984	1985[e]
	(tonnes)			
Malaysia	73 794	41 367	41 307	59 687
Indonesia	19 092	26 554	23 223	22 845
Bolivia	30 100	24 736	19 911	18 000
Thailand	21 779	19 942	21 607	19 688
Brazil	3 610	13 083	19 957	24 888
Australia	8 828	9 578	7 922	7 851
United Kingdom	1 722	4 067	5 047	5 323
South Africa	1 986	2 668	2 301	2 298
Peru	20	2 200	2 991	3 000
Zaire	6 458	2 004	2 410	2 472
Total, incl. Others	184 900	171 700	167 400	166 700

Source: International Tin Council.
[1] Excludes countries with centrally planned economies, except Czechoslovakia, Poland and Hungary.
[e] Estimate.

TABLE 6. WORLD[1] PRODUCTION OF PRIMARY TIN METAL, 1970 AND 1983-85

	1970	1983	1984	1985e
		(tonnes)		
Malaysia	91 945	53 338	46 911	47 525
Indonesia	5 190	28 390	22 467	22 116
Thailand	22 040	18 467	19 729	19 070
Bolivia	300	14 293	15 842	12 000
Brazil	3 100	12 560	18 877	24 507
United Kingdom	22 035	6 498	7 105	7 200
Netherlands	5 937	3 650	6 188	4 576
Australia	5 211	2 878	2 687	2 716
Spain	3 908	2 783	3 426	3 091
United States	4 540	2 500	4 000	4 000
South Africa	1 491	2 200	2 200	2 200
Singapore	..	1 800	3 500	4 000
Nigeria	8 069	1 400	1 253	1 240
Total, incl. Others	184 900	158 800	161 200	161 700

Sources: International Tin Council.
[1] Excludes countries with centrally planned economies, except Czechoslovakia, Poland and Hungary.
.. Not available; e estimate.

TABLE 7. MONTHLY AVERAGE TIN PRICES[1], 1984 AND 1985

	Canada Cdn. ¢/lb		Dealer NY U.S. ¢/lb		London Metals Exch. £ Sterling/tonne		Malaysia M$/Kilograms	
	1984	1985	1984	1985	1984	1985	1984	1985
January	791.01	772.89	569.05	508.14	8 605.9	9 821.5	29.150	29.150
February	794.44	772.52	574.81	502.89	8 527.4	10 011.0	29.163	29.150
March	807.69	795.58	581.68	526.62	8 519.8	9 959.4	29.153	29.163
April	817.15	806.32	584.19	548.41	8 755.1	9 536.1	29.150	29.209
May	839.03	821.95	586.00	545.95	9 052.9	9 538.9	29.150	28.856
June	842.28	832.46	588.33	559.75	9 192.7	9 666.5	29.229	29.562
July	845.83	LPS	574.81	581.04	9 419.7	9 236.2	29.154	30.757
August	828.78	LPS	565.94	580.09	9 365.3	9 136.4	29.150	30.741
September	823.50	LPS	555.68	558.50	9 621.3	9 032.9	29.150	30.182
October	807.87	LPS	540.05	538.23	9 626.2	8 714.6	29.150	29.912
November	815.73	LPS	553.00	449.21	9 674.2	..	29.188	..
December	803.15	LPS	540.00	411.90	9 881.2	..	29.150	..
Yearly average	818.04	-	567.80	525.90	9 186.8	9 465.4	29.161	29.668

Sources: Metals Week; Northern Miner.
[1] Prices are for Grade A (in the United States) or High Grade - 99.85 per cent tin or more - except the LME price which is for Standard Grade - 99.75 per cent tin or more.
.. Trading suspended; - Nil; LPS List price suspended.

Titanium and Titanium Dioxide

D.E.C. KING

CANADA

Canadian titanium-based industries include ilmenite mining and smelting, titanium oxide and pigment production, titanium metal fabrication to finished parts, coating of welding rods, and the manufacture of titanium carbide and nitride coated parts. Also, titanium-bearing master alloys are incorporated into special steel and aluminum alloys. The mining, smelting and pigment operations are carried out exclusively in Quebec, whereas the downstream activities are located in several provinces. Canada does not have any capacity for producing primary titanium (in the form of sponge or granules) or ferrotitanium. Capacity for vacuum melting of primary titanium to produce billets exists at Eldorado Nuclear Limited, Port Hope, Ontario and Atlas Steels division of Rio Algom Limited has facilities at Welland, Ontario, to custom forge and roll billets.

QIT-Fer et Titane Inc. (QIT) is the only company that mines titanium ore in Canada. Ilmenite, a mineral containing somewhat more iron than titanium, is mined at Havre St. Pierre, Quebec. The raw ore is shipped to Tracy, Quebec, where it is beneficiated, and the concentrate smelted to produce high quality pig iron and titania (TiO_2) slag (Sorelslag).

Because of the strong demand for titanium raw materials QIT produced at full capacity in 1985. Plant improvements and expansion begun before 1983, have enabled the company to produce richer (80 per cent TiO_2) slag. In 1986, QIT's production capacity will reach 850 000 tpy slag and 400 000 tpy of steel. The steel will be produced from part of its output of pig iron. Ivaco Inc. of Montreal has contracted to buy 200 000 tpy of the steel output from QIT. In a related development Quebec Metal Powders Limited, (QMP) began construction of a $45 million plant to produce up to 37 000 tpy of steel powder from molten steel that will be produced by its associated company QIT. QMP's present capacity is 51 000 tpy of iron powder.

Most of QIT's output of Sorelslag is exported to the United States and Europe, while approximately 10 to 15 per cent is sold in Canada to two pigment producers, NL Chem Canada, Inc. at Varennes and Tioxide Canada Inc., at Tracy, Quebec, respectively. Both pigment producers employ the sulphate process. QIT is sales agent for both its Tracy, output and that of Richards Bay Minerals of South Africa, which is 42 per cent owned by QIT.

In 1985, both Canadian pigment producers were operating at their full capacity of about 36 000 tpy of TiO_2 pigment each.

The total Canadian consumption of titania pigment of about 80 000 tpy, approximately matches the present total Canadian production capacity. However, some grades of pigment must be imported, the total amounting to about 13 000 to 16 000 tpy. The balance of Canadian production is exported, mainly to the United States.

In August, NL Chem Canada, Inc. announced a major expansion of its titanium dioxide pigment facility at Varennes, with construction beginning immediately. The new plant will use state of the art chloride process technology to produce about 36 000 tpy of pigment. It will cost about $68 million to construct and will create 130 new jobs. The new plant will enable the company to supply a complete range of pigments including pigment grades which are presently imported.

Chloride processes for producing pigment have been gradually replacing sulphate plants, mainly for environmental reasons. They produce less waste products because they recycle the chlorine reagent and have hitherto used the higher grade rutile and synthetic rutile feedstocks. The 80 per cent TiO_2 slags now produced by QIT at Tracy, may gain acceptance as feedstock for chloride process plants because slag containing 85 per cent TiO_2 from Richards Bay Minerals, South Africa has already been accepted by chloride plants.

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The negotiations by Tioxide Canada Inc. to construct a sulphate process pigment plant at Tracy, Quebec may possibly be discontinued in view of NL Chem Canada, Inc.'s active plans for a chloride plant of similar capacity.

A small number of Canadian companies make finished products from titanium forgings, castings, bar, pipe, tube, plate and sheet. Walbar of Canada Inc. of Toronto, Ontario and Pratt & Whitney Aircraft Services of Canada Limited of Longueuil, Quebec, machine forgings, investment castings, and bar stock to produce parts for turbine engines. The shop scrap is sold to U.S. producers of ferrotitanium and briquettes, which are made from titanium scrap and offgrade sponge. The total amount of titanium forgings, castings and bar stock consumed by these two companies in 1985 was in the order of 300 t.

Titanium Ltd. of St. Laurent, Quebec and Ellett Copper & Brass Co. Limited of Port Coquitlam, British Columbia custom produce titanium tanks, pressure vessels, heat exchangers, fans, and other equipment for pulp, chemical, petrochemical and metallurgical industries.

The aircraft companies The de Havilland Aircraft of Canada, Limited, Downsview, Ontario, Canadair Limited, Montreal, Quebec, and McDonnell Douglas Canada Ltd., Malton, Ontario, produce aircraft parts, such as firewalls, motor mounts, nacelles and wings. The quantities of titanium used in making chemical equipment and airframes in Canada vary widely, but appear to be in the order of 50 to 150 tpy for chemical equipment and 10 to 50 tpy for aircraft parts.

The quantities of titanium added as ferrotitanium and composite master alloys to specific grades of steels are small compared with other alloying elements. They nevertheless accounted for approximately 150 to 200 t of contained titanium in 1985. Used as an alloying agent, titanium is beneficial in controlling nitrogen and acts as a grain refiner in high-strength, low-alloy steel plate; it is also used as a carbide stabilizer in type 409 stainless steel. By comparison, the quantities of titanium added to aluminum alloys are of a much smaller order, possibly about 10 tpy of titanium in 5-10 per cent titanium-aluminum master alloys.

The quantities of titanium used by Canadian companies producing wear resistant parts for the mining and other industries are very small and are not separately reported in statistics. Titanium is used in mixed carbides with tungsten, and in titanium nitride coatings. Canadian companies producing carbides and nitrides include Kennametal Ltd. Canadian General Electric Company Limited, and Valenite-Modco Limited.

WORLD DEVELOPMENTS

Titanium Minerals

Ilmenite is the source for 90 per cent of the world supply of titanium dioxide pigment production. The more expensive rutile (TiO_2) is favoured by producers of primary titanium metal. Anatase (TiO_2) deposits in Brazil are also potentially important. Two other raw materials, titaniferous slag and synthetic rutile produced from ilmenite, are used extensively. The growing scarcity and high cost of rutile supplies are creating an increasing demand for beneficiated ilmenite, more commonly referred to as synthetic rutile. This provided the incentive during 1985 for announced plans to build new synthetic rutile plants. The world shortage of titanium raw material capacity continued throughout the year.

Australia: Two large synthetic rutile plants are to be built in Western Australia, both scheduled to begin production in 1987. Westralian Sands Ltd. has begun construction of a plant to produce 100 000 tpy at Capel, 200 km south of Perth, Western Australia. Westralian Sands Ltd. is 36 per cent owned by Tioxide Australia Pty Ltd and 15 per cent owned by Ishihara Sangyo Kaisha Ltd. (ISK) which supplies about one half of Japan's large titanium dioxide pigment market. In a later announcement Western Titanium Ltd., a subsidiary of Renison Goldfields Consolidated Ltd., disclosed its intentions to expand its existing 60 000 tpy synthetic rutile capacity at Capel, by building a new 112 000 tpy plant at Eneabba, 300 km north of Perth. The market for most of the output from the new plant is already secured by a 10-year sales contract with SCM Corporation. The decisions to go ahead with these Australian developments were reportedly influenced by the relatively static world natural rutile production capacity in relation to an approximately 2 per cent annual increase in demand, and the gradual replacement of sulphate plants by chloride process plants that require high-grade feedstocks.

The TiO_2 Corporation NL plans to mine the Cooljarlo and Jurien mineral sand deposits north of Perth. This operation is designed to process 4 million tpy of mineral sands. About 200 000 tpy of mineral concentrates will be produced, of which more than half would be ilmenite.

Sierra Leone: Sierra Rutile Ltd. was operating near its full capacity of 100 000 tpy of rutile and Sierra Leone has thereby become the world's second largest producer of natural rutile.

Brazil: A letter of interest was signed by International Minerals & Chemical Corporation (IMC) and the government of the Brazilian State of Goias for the building of a $US 200 million plant to produce titanium concentrate from anatase deposits owned by the state-owned company Metais Goias S.A. (METAGO). The plant would have a capacity of 300 000 tpy of anatase concentrate containing up to 90 per cent titanium dioxide.

E.I. du Pont de Nemours and Company (Du Pont) was reported to be considering a joint venture with Companhia Vale do Rio Doce (CVRD) to build a titanium dioxide pigment plant with a 60 000 tpy capacity, at a cost of $US 100 million. The new plant would operate with anatase concentrate feedstock from a $100 million concentration plant that CVRD was to begin building in 1985 in the state of Minas Gerais.

South Africa: Richards Bay Minerals (RBM) began a $US 68 million two-year project to expand its smelting capacity from 400 000 tpy to 600 000 tpy of 85 per cent TiO_2 slag, and to increase its production rate of ilmenite. Rutile production will remain unchanged at about 58 000 tpy.

Taiwan: Du Pont announced its intention to build a 60 000 tpy titanium dioxide (TiO_2) pigment plant based on its own chloride process technology.

United Kingdom: It was reported that SCM Corporation will increase its production capacity from about 80 000 to 116 000 tpy at its Stallingborough titanium dioxide pigment plant, at a cost of $US 30 million.

Saudi Arabia: IDI Ltd. was reportedly planning a titanium dioxide pigment plant at Al-Jubail on the Persian Gulf to produce 55 000 tpy using chloride technology. The capital cost would be about $US 140 million.

United States: RMI Co. of Ohio announced plans to begin building a $US 4 million welded tube mill in order to expand its share of sales of titanium mill products to the industrial markets. Initial capacity would be about 500 tpy of welded tubing.

Oregon Metallurgical Corporation which has the capacity to produce 4 500 tpy of titanium sponge was purchased from Armco, Inc. by Owens-Corning Fiberglas Corp.

Wyman-Gordon Co. gained management control over titanium sponge producer International Titanium Corp. (ITC).

NL Chem Canada, Inc. was unable to purchase the Savanna, Georgia, titanium dioxide pigment plants of American Cyanamid Company (Cyanamid) because its proposal was disallowed by the Federal Trade Commission. The company subsequently announced plans to increase capacity in Canada and West Germany. The Cyanamid plants were reportedly to be sold to Kemira Oy of Finland for $100 million, subject to approval by the United States and Finnish authorities.

Titanium Dioxide Pigment

As was the case for titanium raw materials in 1985, the demand for titanium dioxide pigment was strong throughout the year, with plants operating near full production capacity. This market strength is expected to continue well into 1986 in parallel with general economic trends. Increases in prices resulting from the strong demand and short supply have encouraged plans for capital investment in various countries, as outlined in the foregoing section.

Du Pont the largest producer of TiO_2 pigment in the world, has estimated that worldwide demand is growing at the rate of 1.5 per cent per year, while the Asian, Pacific and Latin American regions are growing at double this rate. The approximate global distribution of titanium pigment usage is 60 per cent in paint, 13 per cent in paper, and 15 per cent in plastics with the remainder spread more or less evenly between, rubber, ink, textiles and ceramics. North America's usage in paper (20 per cent) exceeds the average for the rest of the world by a substantial margin.

As a result of mergers and acquisitions over the last several years, there are now four major world pigment producers, namely Du Pont, Tioxide, NL Chemicals, and SCM Corporation. Concern over the large amounts of dilute sulphuric acid and ferrous sulphate waste generated by the sulphate process plants has prompted plants either to install expensive waste treatment facilities or, because of the consequent increase in operating costs, to close down. In the United States in particular, there have been a number of closures of sulphate plants, a tendency to replace the lost capacity with chloride process plants and projects to expand offshore operations.

In the chloride process the chlorine reagent is recycled and the economy so achieved enables the use of higher-grade feedstock than in the sulphate process.

On balance, production capacity has not kept pace with the increase in demand for pigment. Rising raw material costs and cost of capital investment, added to high energy costs, have meant marginal profits as long as pigment prices have remained relatively low. The major titanium dioxide pigment producers are integrated chemical producers and must choose between alternative areas to invest their available capital. The plans announced by pigment producers in 1985 will not result in additional capacity until 1987 so supply is expected to remain tight throughout 1986 and possibly beyond if demand remains firm.

The price increases necessary for the pigment industry will inevitably cause paint makers to pass on the increased costs or to find ways to reduce their usage of titanium dioxide pigments.

Operating costs in the chloride process are approximately in the proportions 40 per cent fixed costs, 40 per cent variable costs, 10 per cent laboratory and 10 per cent plant materials. The largest variable cost is in raw materials, but the biggest unit operating cost is in "finishing", which involve re-slurrying and re-drying in order to coat the pigment particles with compounds which reduce the absorption of ultraviolet light. The latter causes the deterioration of the organic paint base.

Apart from raw materials, a large component of sulphate process operating cost is sulphuric acid. Fossil fuel energy is the next largest cost component. While fuel costs are currently fairly stable, the price of acid is escalating, because of the weakness in base-metals production and the high cost of elemental sulphur.

Titanium Metal

Titanium metal comprises less than 6 per cent of total titanium ore demand. World consumption increased in the late-1970s and reached an all-time peak of 51 412 tpy in 1981. This rapid growth stimulated increases in production capacity, which in 1983 totalled about 68 000 tpy of primary titanium in the market economies. Global capacity includes about 33 400 tpy in the United States, 36 600 tpy in Japan where the greatest expansions took place, and 5 000 tpy in the United Kingdom. However, the U.S.S.R. has the world's largest production capacity, reported to be in the vicinity of 50 000 tpy. China's capacity has been estimated at 3 500 tpy.

The western world capacity for ingot melting amounted to a total of about 80 000 tpy in 1984, including 59 000 tpy in the United States, 13 000 tpy in Japan, 5 000 tpy in the United Kingdom, 2 000 tpy in West Germany and 1 000 tpy in France.

Western world consumption slumped after 1981 under the influence of the recession. Sponge consumption reached a low in the United States of 14 600 t in 1983 but recovered to an estimated 22 400 t in 1984. A reduction in the rate of consumption in the second and third quarters of 1985 indicated a probable overall 1985 consumption of 19 000 to 20 000 t. Capacity utilization had risen from a low of 30 per cent at the beginning of 1983 to 81 per cent by the end of 1984.

Ingot consumption in the United States rebounded from a low of 23 800 t in 1983 to 35 400 t in 1984. Preliminary data suggests that 1985 consumption was about 33 500 t. Capacity utilization of United States ingot production rose from about 40 per cent in 1983 to 60 per cent in 1984.

The distribution of usage for mill products in 1984 was estimated by the United States Bureau of Mines to be 75 per cent for aerospace and 25 per cent for industrial applications in the United States. This ratio is expected to continue for 1985. Japan's consumption depends far less on the volatile military market; less than 10 per cent is used in aerospace applications and more than 90 per cent in industrial applications. In western Europe, industrial applications account for 40 to 50 per cent of consumption.

Japan's sponge production rose from 10 500 t in 1983 to 15 400 t in 1984. Exports accounted for 6 500 t of which 4 000 t was shipped to the United States and 2 400 t to the European Community (EC). Charges of dumping, by RMI Co. of the United States, against Japanese suppliers of sponge to the General Services Administration (GSA) stockpile resulted in the imposition of 15 per cent and 30 per cent dumping duties.

Deeside Titanium Ltd. of the United Kingdom was also charged with dumping in its sale to the GSA, but the charge was not upheld. It was announced in 1985 that Billiton (UK) Ltd.'s 65 per cent share of Deeside Titanium Ltd. would be purchased by Rolls Royce Ltd. Deeside has been able to sell only small volumes of titanium sponge within the EC and its capacity utilization in 1985 was reportedly only 30 per cent. The 1 500 t of production in 1985 was essentially all purchased by IMI plc Billiton and Rolls Royce Ltd.

Charges of dumping by several European producers including IMI plc, were made against United States and Japanese mill products that were imported into Europe. These changes were not upheld by the EC.

Weak demand in 1982-83 was caused by a fall in consumption in the civilian and military aircraft industries. A recovery in the demand for civil aircraft and industrial products was the main element in market strength in 1984 and 1985. Overcapacity which followed the boom period of 1980-81 created intense competition during 1984-85, and it has tended to suppress prices during this period of strong demand. This price stability has provided a climate for increasing applications of various forms of the metal. At the same time, low prices have restricted profitability in the industry creating a climate for greater efforts to restore profitability through cost savings and improvements in technology.

Listed prices for sponge and mill products remained unchanged during 1985 and selling prices have also remained at a substantially lower level than the list prices.

If substantial price reductions could be achieved it would enable titanium to penetrate markets now filled by cheaper metals. There appears to be growing activity in the development of more efficient processes to produce and fabricate titanium metal. In the United States, Albany Titanium, Inc. was piloting a new process to produce titanium powder and sponge from ilmenite using sodium fluosilicate, with a view to installing a 5 000 tpy plant. In Italy, Elettrochimica Marco Ginatta was planning a 1 200 tpy plant to produce titanium based on an electrolytic fused salt process.

Other developments aimed at improving the marketability of titanium have been reported. For example, precision casting has become an important development for eliminating or minimizing the machining of forged shapes. Superplastic fusion and diffusion bonding are also becoming established, notably through the efforts of British Aerospace plc which is carrying out these operations on a commercial scale. Superplastic fusion and diffusion bonding are considered to be an important development in establishing new uses in areas where aluminum is conventionally applied. Inco Alloy Products Limited (IAPL) has entered the field of precision casting through the recent purchase of TiTech Europe S.A. and the formation of the new company Société Europeenne des Technologies du Titane et des Alliages Speciaux (SETTAS) in Belgium.

Advances have been made in the recycling of titanium turnings to allow these to meet American aerospace standards. In this field, Suisman Titanium Corp. is expanding recycling capacity in the United States by 500-600 per cent to 3 million lbs per year.

RMI announced that its Beta C titanium alloy has been listed in the National Association of Corrosion Engineers' Materials Requirement Standards. Superconductive alloys of titanium and niobium have been reported as having considerable potential in applications such as ship propulsion, levitation trains and cyclotrons. Aluminum Company of America (Alcoa) is reportedly developing ceramic titanium boride armour plate.

The participation of Nippon Kokan KK in International Light Metals Corporation of Torrance, California, has enabled the Japanese company to import mill products into the United States. Ingot produced in the Torrance plant, which meets U.S. aerospace requirements is milled in Japan and imported back into the United States.

In its first two years of operation the Titanium Development Association has been active in compiling information for its growing membership, and in promoting the development of markets and technology through publications, trade shows and conferences.

USES

Titanium metal usage is based on its relative abundance, unique physical properties and corrosion resistance. Initially, uses were found in military aircraft where cost was not the main factor, and its high-strength, lightness and high melting point could be utilized for engine and airframe applications. Greater availability and lower prices have led to expanding usage in commercial and private aircraft. Specifications for aircraft quality are high, and since titanium has a strong tendency to combine with oxygen and nitrogen, melting has to be carried out in vacuum, sometimes twice or three times before an ingot is produced for fabrication.

Commercial titanium that is unalloyed or produced to less demanding specifications is used in industrial applications. Titanium's high corrosion resistance lends itself to a wide range of uses in the chemical, metallurgical and paper industries, power plants and desalination plants. In these applications about 50 per cent of the total quantity of titanium consumed is used in heat transfer and seawater cooling applications, about 25 per cent in chemical process equipment, and about 20 per cent as electrodes in electrolytic plants. However, a vast number of minor applications are developing, such as spectacle eye frames, camera parts, yacht rigging, and prosthetic uses such as hip joints.

OUTLOOK

Environmental regulations will probably continue to favour the chloride process in new pigment plants. Although fluid-bed roasting is a standard way of oxidizing titanium chloride in the chloride process, plasma oxidation such as is used by Tioxide UK Limited might be favoured where electric power costs are low. Effluent treatment and disposal will require further development for both the chloride and sulphate processes.

In the production of titanium sponge, developments toward the use of less power is a trend exemplified by the new plant of Showa Titanium, Japan where power consumption is reportedly 15 000 to 18 000 kWh per ton instead of the 25 600 to 30 000 kWh per ton in other plants. Since existing sponge plants are based on batch operations, there are also considerable potential cost savings to be gained from the development of continuous processes such as the experimental process of Albany Titanium, Inc.

The development of semi-fabrication and precision casting to near-net-shape would eliminate much subsequent machining, particularly in the case of turbine blades which currently require the removal of up to 85 per cent of the initial forging weight. The U.S.S.R. is reportedly ahead of the west in welding technology which would account for its use of titanium in submarine construction. Improvements in welding, bonding and coating technologies may be anticipated through ongoing research and development.

Over the longer term industrial applications for the metal are expected to provide a greater share of the demand, particularly in the United States where military applications currently continue to provide the major demand base. Commercial aerospace has played an important role in the strong markets of 1984-85, which are expected to continue through 1986.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
32900-1	Titanium ore	free	free	free	free
34715-1	Sponge and sponge briquettes, ingots, blooms, slabs, billets, and castings in the rough, of titanium or titanium alloys for use in Canadian manufactures (expires June 30, 1986)	free	free	25	free
34735-1	Tubing of titanium or titanium alloys for use in Canadian manufactures (expires June 30, 1986)	free	free	25	free
34736-1	Sheet, strip or plate of titanium or titanium alloys, cold-rolled, not more than 0.2015 inch in thickness, for use in the manufacture of tubes (expires June 30, 1986)	free	free	25	free
34745-1	Bars, rods, plate, sheet, strip, foil, wire, coated or not; forgings and mesh of titanium or titanium alloys, for use in Canadian manufactures (expires June 30, 1986)	7.5	7.5	25	5
37506-1	Ferrotitanium	free	4.3	5	free
92825-1	Titanium oxides	free	10.6	25	free
93207-6	Titanium whites, not including pure titanium dioxide	free	10.6	25	free

MFN Reductions under GATT (effective January 1 of year given)	1985	1986	1987
		(%)	
37506-1	4.3	4.2	4.0
92825-1	10.6	10.3	10.0
93207-6	10.6	10.3	10.0

UNITED STATES (MFN)		1985	1986	1987
422.30	Titanium compounds	5.6	5.2	4.9
473.70	Titanium dioxide	6.4	6.2	6.0
601.51	Titanium ore	Remains free		
606.46	Ferrotitanium and ferro-silicon titanium	4.1	3.9	3.7
629.12	Titanium metal, waste and scrap	9.9	8.6	7.2
629.14	Titanium metal, unwrought	16.0	15.5	15.0
629.20	Titanium metal, wrought	16.0	15.5	15.0

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241.

TABLE 1. CANADA, TITANIUM PRODUCTION AND TRADE, 1983-85

	1983		1984		1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production (shipments)						
Titanium dioxide, slag	x	x	x	x		
Imports					(Jan.-Oct.)	
Titanium in ores and concentrates						
United States			1 596	1,005	1 213	870
Australia			2 092	869	206	84
South Africa			36	2	-	-
Total			3 724	1,876	1 419	954
Titanium dioxide, anatase						
United States	7 101	12,641	7 980	14,399	2 191	3,874
West Germany	2 797	3,990	2 660	3,676	3 655	4,736
Australia	592	1,181	691	1,392	800	1,458
France	790	1,155	909	1,273	783	1,199
Belgium-Luxembourg	584	798	492	685	236	330
United Kingdom	321	458	714	974	209	325
Spain	278	296	990	2,007	464	657
Other countries	505	666	1 752	2,516	1 634	2,127
Total	12 968	21,185	16 188	26,922	9 972	14,706
Titanium dioxide, rutile						
West Germany	2 599	2,955	4 987	6,164	1 985	2,543
United States	611	1,186	1 461	3,063	5 131	8,516
Belgium-Luxembourg	726	832	94	140	350	506
Spain	454	646	304	477	348	532
Other countries	1 410	2,122	2 522	3,633	2 023	3,125
Total	5 800	7,741	9 369	13,477	9 837	15,222
Titanium metal						
United States	227	8,903	267	7,342	340	10,834
Belgium-Luxembourg	5	624	5	480	7	703
United Kingdom	20	500	17	393	22	462
Japan	28	203	52	487	51	550
Other countries	5	413	14	1,330	3	190
Total	275	10,643	355	10,032	423	12,739
Ferrotitanium[1]						
United Kingdom	14	39	28	115	27	137
Belgium-Luxembourg	5	28	28	127	-	-
United States	298	1,045	232	837	252	1,014
Total	317	1,112	286	1,078	279	1,151
Exports[2] to the United States						
Titanium metal, unwrought including waste and scrap	415	2,342	178	384	71	171
Titanium metal, wrought	287	5,180	192	3,561	257	4,610
Titanium dioxide	23 190	27,396	23 779	29,391	14 799	18,397

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Total alloy weight. [2] U.S. Department of Commerce, U.S. General Imports, Report F.T. 135. Canadian export statistics do not provide separate categories.
P Preliminary; - Nil; x Confidential.

TABLE 2. CANADIAN TITANIUM PRODUCTION AND IMPORTS 1970, 1975 AND 1979-85

	Production		Imports		
	Ilmenite[1]	Titanium Dioxide Slag[2]	Titanium Dioxide Anatase	Titanium Dioxide Rutile[3]	Total Titanium Dioxide Pigments
			(tonnes)		
1970	1 892 290	766 300	2 523	7 415	9 938
1975	1 543 480	749 840	2 467	241	2 708
1979	1 004 260	477 030	9 815	1 515	11 330
1980	1 853 270	874 710	6 135	148	6 283
1981	2 008 117	759 191	6 986	314	7 300
1982	1 735 000	669 000	5 737	369	6 106
1983	x	x	12 968	5 555	18 523
1984	x	x	16 188	9 369	25 557
1985[3]	x	x	9 972	9 837	19 809

Sources: Energy, Mines and Resources Canada; Statistics Canada; Company reports.
[1] Ore treated at Sorel; from company reports. [2] Slag with 70 to 72 per cent TiO_2; from company reports. [3] Jan.-Oct. 1985.
x Confidential.

TABLE 3. PRODUCTION OF ILMENITE CONCENTRATE BY COUNTRIES, 1982-1984

	1982	1983p	1984e
		(000 tonnes)	
Australia	1 169	906	1 117
Canada[1]	669	635e	720
Norway	552	544	550
U.S.S.R.e	431	435	440
Republic of South Africa	381	417	417
United States	239	W	W
Indiae	153	150	150
Finland	168	163	167
China	136	140	140
Malaysia	101	223	195
Sri Lanka	68	82	80
Brazil	-	48	50
Other countries	15	-	-
Total	4 082	3 743	4 026

Sources: U.S. Bureau of Mines, Minerals Yearbook Preprint, 1983; U.S. Bureau of Mines, Mineral Commodity Summaries, 1984.
[1] Titanium slag containing 70-71 per cent TiO_2 to end of 1983; 80 per cent TiO_2 after 1983.
p Preliminary; e Estimated; - Nil;
W Withheld to avoid disclosing company proprietary data.

TABLE 4. PRODUCTION OF RUTILE BY COUNTRIES, 1982-1984

	1982	1983p	1984e
		(000 tonnes)	
Australia	221	163	182
Sierra Leone	48	72	91
Republic of South Africa	47	56	56
United States	W	W	W
Sri Lanka	7	9	8
U.S.S.R.e	10	10	10
Indiae	7	7	7
Brazil	--	1	1
Total	340	318	355

Sources: U.S. Bureau of Mines, Minerals Yearbook Preprint, 1982; U.S. Bureau of Mines, Mineral Commodity Summaries, 1984.
p Preliminary; e Estimated; -- Amount too small to be expressed; W Withheld to avoid disclosing company proprietary data.

TABLE 5. LISTED PRICES OF SELECTED TITANIUM COMMODITIES, 1984 and 1985

	1984	1985
Titanium ore, fob cars Atlantic and Great Lake ports		
Rutile, 96%, per short ton, delivered within 12 months	$A 400.00-420.00	$A 510.00-530.00
Ilmenite, 54%, per long ton, shiploads	$A 40.00-43.00	s
Titanium sponge, per lb	5.55-5.85	5.55-5.85
Mill products, per lb delivered		
Billet (Ti - 6AL-4V)	8.35	$US 8.35
Bar (Ti - 6AL-4V)	9.77	$US 9.77
Titanium dioxide, anatase[1],		
Bags, 20-ton lots, freight allowed, per lb	0.69-0.70	0.69-0.70
Titanium dioxide, rutile, regular grades, per lb	0.75	0.75

Source: Metals Week, December.
[1] Chemical Marketing Report, December.
fob - Free on board; s List price suspended.

Tungsten

D.R. PHILLIPS

The rebound of tungsten prices in the latter half of 1984 from their historical low in 1983 led to a temporary strengthening of the market in the first quarter of 1985. However, prices plummeted to a new low in the latter half of 1985 to $US 57-67 per t unit.

Canada's two producing tungsten mines, Canada Tungsten Mining Corporation Limited (Cantung) in the Northwest Territories, which is a subsidiary of AMAX Inc., and Mount Pleasant Tungsten mine in New Brunswick, both of which operated near capacity in 1984 were seriously affected by the continuing decline in prices. In July 1985, Mount Pleasant Tungsten mine was forced to close primarily because of depressed prices. For similar reasons, Cantung reduced its production to approximately 65 per cent of effective capacity in 1985.

CANADIAN DEVELOPMENTS

Canada ranked third among world producers of tungsten in 1984, with estimated production of 3 715 tonnes (t) of tungsten contained in ores and concentrates. Production in 1985 was estimated to decline about 20 per cent. Nevertheless, preliminary information suggest that Canada retained its rank in third place.

The decrease in production in 1985 was a result of the closure of Mount Pleasant Tungsten mine in July 1985 and reduced production by Cantung because of weak markets and continued low prices throughout the year.

Mount Pleasant Tungsten mine is a joint venture between Sullivan Mines Inc. (through its 89 per cent ownership of Brunswick Tin Mines Limited) and Billiton Canada Ltd. The mine, which operated at full capacity from January to October 1984 reduced its output to 50 per cent of capacity in November 1984.

Mount Pleasant was Canada's only producer of wolframite, one of the two tungsten-bearing minerals used for the commercial recovery of tungsten. Plans to produce and market molybdenite (MoS_2) as a coproduct were not initiated due to the low price of molybdenum and the company's initial plans to concentrate first on the production and marketing of tungsten.

If the present economic recovery fails to result in increased tungsten prices further reductions in operation at Cantung, or even closure could occur. The mine presently employs 210 people.

Cantung's revised estimate of ore reserves presently stand at four years. However, the company is prepared to bring on-stream the Mactung deposit through its parent's affiliate when the market rebounds. The evaluation of the Mactung property (scheelite deposit) on the Yukon and Northwest Territories boundary continued during 1985. Mactung reserves are reported to be the largest and highest ore grade of any tungsten deposit in the western world.

Dimac Resource Corp., which closed its 100 tpd mine/mill complex in British Columbia in 1982 because of poor market conditions and operational problems, did not reopen.

INTERNATIONAL DEVELOPMENTS

Canada's mine producers of tungsten have for some time been concerned with the oversupply of tungsten on world markets and, in this regard, have viewed research on potential new uses as one possible way that could significantly expand global consumption. This concern and perception evolved into a proposal for an International Tungsten Research Institute, which was formally presented by a representative of the Canadian industry at the Third Tungsten Symposium held in Madrid in May 1985. There was widespread support in principle for the proposal by both producer and consumer companies present at that meeting.

The main function of the International Institute would be to facilitate, undertake and sponsor research on new uses for

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tungsten. Participation in the proposed institute and financial support would likely have to come from a substantial portion of the industry as it is recognized that no one company is financially strong enough to undertake the necessary research on its own.

As a follow-up to the Madrid meeting, a more detailed proposal was presented at the Primary Tungsten Association annual meeting in September 1985, which was co-sponsored by the People's Republic of China in Beijing.

It was widely acknowledged by industry that the formation of the institute could be of benefit to all producers, in that it could provide a useful mechanism for the development of new and expanded uses for tungsten. However there were still many details on the structure and other aspects of the proposed institute that would have to be resolved before it could be a reality.

Bills were introduced in the United States Senate by Senator Grassley (R-Iowa, S1014) and in the House of Representatives by Congressman Flippo (D-Al, HR2360) for the suspension of the 17¢ per pound tariff on tungsten contained in imported tungsten concentrates. These bills form part of a miscellaneous package of tariff bills that will likely be considered for a decision before the end of 1986. The removal of the tariff would strengthen Canada's competitive position because it would result in developed market economy countries, such as Canada, achieving equal market access status in the United States with developing countries. The latter are currently exempt from a tariff under the General System of Preferences.

Reports at the Third Tungsten Symposium in Madrid cited the decrease in western world trade in tungsten ores and concentrates to be due to increased imports of ammonium paratungstate from China and South Korea.

The increase in the world production of tungsten ores and concentrates in 1984, and the subsequent decrease in 1985 by 2 per cent to 43 000 t of contained tungsten appeared to be shared equally in direct proportion to production capability by all major tungsten producers. This level of global production represents about 50 per cent of the world mine capacity.

Most of the major North American primary tungsten mines were closed at the end of 1985. A notable exception was the Cantung mine in Canada, and even its production was reduced to about 65 per cent of effective capacity due to continued low prices.

In the United States, the Strawberry mine, operated by Teledyne Wah Chang (TWCA), continued production on a regular basis throughout 1985. Union Carbide Corporation kept its Emerson mine closed throughout 1985 and operated its Pine Creek Bishop mine at approximately 50 per cent capacity on an intermittent basis. The Springer Mine, owned by the General Electric Company, remained closed throughout 1985.

The People's Republic of China (PRC) continued to be the world's largest producer of tungsten ore, followed closely by the U.S.S.R. Tungsten production in the PRC was reported to have decreased by 4 per cent in 1984 to an estimated 12 000 t, compared to a 7.7 per cent increase for the U.S.S.R. to 9 800 t. Production of ores in the U.S.S.R. and the PRC in 1985 was estimated to be equal to 1984 production.

Both major producers in Australia reduced production by about 50 per cent during 1985. All but one of the other six smaller Australian operations remained closed and will likely stay idle until the market situation improves.

Australian production of tungsten in 1984 was estimated at 2 000 t tungsten content, essentially unchanged from 1983 production of 2 060 t. Approximately 45 per cent of Australia's total production came from the King Island scheelite mine of Peko-Wallsend Ltd. and 42 per cent from the Mount Carbine wolframite mine of Wolfram Pty Ltd.

Tungsten producers in Thailand, Bolivia and South Korea all announced production cutbacks of about 30 per cent during 1983. Thailand and Bolivia's production in 1984 remained unchanged from 1983, but South Korea's increased to near capacity.

In compliance with limitations set by U.S. current legislation, the disposal of stockpile material was required to cease when revenue from these sales reached $250 million. This limit was reached by September 30, 1985 and the GSA did not offer tungsten for sale, during the rest of the year.

MARKET STABILIZATION

International discussions on stabilizing the tungsten market were held at the 17th Session of the United Nations Committee on Tungsten (COT) in Geneva on November 11-15, 1985. This session was also the first opportunity for a meeting of the Sessional Working Group (SWG).

The SWG recommended to the COT that the Secretariat undertake, inter alia, "studies with the assistance of the SWG to review the tungsten market situation with reference to exchange rate movements, trade in intermediate products, stocks and a comparison with other related primary metals as affected by the world economy".

PRICES

Tungsten prices which started to strengthen in the last quarter of 1984 continued to do so in the first quarter of 1985. However, continued weakening of the market reduced prices to a new low of $US 57-67 per t unit in November 1985.

Prices reported by the Metal Bulletin (MB) and as the International Tungsten Indicator (ITI) for the months February, July and November 1985 are summarized as follows.

	MB		ITI
	Wolframite	Scheelite	Tungsten Concentrate[1]
	$US/tu[2] WO_3	$US/tu[2] WO_3	$US/tu[2] WO_3
Feb.	68-76	79-82	76.65
July	58-69	69-75	66.77 - 71.85
Nov.	57-67	66-72	67.77 - 71.41

[1] Concentrate price based on an average WO_3 content related to monthly transactions.
[2] One tonne unit (tu) of WO_3 contains 7.93 kilograms of tungsten.

USES

Approximately 80 per cent of the western world tungsten consumption in 1984 and 1985 was accounted for in the manufacture of cemented carbide and tool steel products, the former amounting to approximately 50 per cent of total consumption. Tungsten metal, superalloys and miscellaneous end-uses accounted for the remaining 20 per cent.

Major consumers of tungsten include the oil and gas, mining, manufacturing and farm equipment industries. These industries consume intermediate tungsten products in the form of tungsten metal powder, ammonium paratungstate, tungsten carbide and ferrotungsten. These secondary products are produced from tungsten ores and concentrates.

Tungsten materials can be divided into several major classes, depending upon the product form and its use. The main product forms include tungsten carbide, tungsten-bearing steels, superalloys, mill products made essentially from pure metal, and chemicals.

Tungsten carbide (WC) is one of the hardest materials known and accordingly, has widespread applications where intense wear and abrasion are encountered. This product is the preferred metalworking material for the cutting edges of machine tools and as a metal surface in forming and shaping dies. It is produced by the chemical combination of tungsten metal powder and finely divided carbon. Tungsten carbide is compacted to the desired form, using cobalt as a binder, and sintered to produce cemented tungsten carbide. Cutting tools of cemented tungsten carbide are used for machining steel, cast iron and nonferrous metals, and for shaping in the woodworking and plastics industries. Cemented tungsten carbide is also used to make dies for wire and tube drawing, punches and dies for metal forming, and bits and tools for drilling equipment and wear-resistant parts. With the addition of tantalum, titanium and columbium carbides, the coefficient of friction of cemented tungsten carbides is lowered, thereby producing grades better suited to the machining of specific items, particularly steel products. Other uses of tungsten carbide are in tire studs, spikes for golf shoes, armour-piercing projectiles and welding electrodes.

As an alloy constituent, tungsten is used primarily in the production of high-speed steels, and tool and die steels. Tungsten is added to steels either as ferrotungsten (80 per cent tungsten), melting base (30-35 per cent tungsten), scheelite ($CaWO_4$) or as tungsten-bearing scrap. Tungsten-bearing steels are used for the same applications as carbides, especially where lower operating temperatures are encountered. Tungsten is also used in some stainless steels for applications in high-temperature environments.

Tungsten is an important constitutent in a wide variety of superalloys and nonferrous alloys. Tungsten-containing superalloys are being used increasingly in high-temperature applications and in highly corrosive environments because of their high-temperature strength and oxidation resistance. In making the alloys, tungsten is usually added in the form of metal powder, although scrap can be used to satisfy part of the requirements. Superalloys can be classified into three principal types: nickel base, iron base and cobalt base or "Sellite" superalloys. While only small amounts of tungsten are currently used in the nickel and iron base superalloys, several companies are developing new superalloys containing larger amounts of tungsten, a factor which could significantly expand the market for tungsten.

Mill products made from pure or nearly pure tungsten metal powder are used in significant quantities by the electrical industries. The relevant important properties of tungsten for electrical applications include its high-melting point, low-vapour pressure, hardness, good electrical conductivity and low coefficient of thermal expansion. Tungsten mill products such as rods, wire and flat products are made by compressing tungsten metal powder into the desired shape and then sintering.

Discs cut from tungsten rods are used as electrical contacts to improve resistance to heat deformation resulting from sparking and associated high temperatures. Pure tungsten contacts are used principally in ignition circuits of automobiles and aircraft. However, the trend to electronic ignition systems without tungsten contacts has resulted in a decline in its use for this application. Tungsten discs are also used as heat sinks in semiconductor applications and, in combination with other elements, as electrical contacts and breakers for industrial use.

Tungsten wire is used for filaments in incandescent lamps, and heating elements in both fluorescent lamps and vacuum tubes. The overall demand for tungsten wire is increasing in response to the upward trend in the manufacture of lamps and new uses such as de-icing and defogging elements in automobile glass.

Flat products are used for various parts of electron tubes and radiation shields as well as for very high-temperature applications in reducing or inert atmospheres.

Tungsten is used for counterweights and balances, especially by the aircraft industry, but it is being replaced by depleted uranium which has about the same density.

Minor amounts of tungsten are used to make chemicals and compounds for nonmetallurgical applications. Some of the end-uses include dyes, toners, phosphors, chemical reagents, corrosion inhibitors and catalysts.

OUTLOOK

The demand for tungsten, like most other minerals and metals, derives from the demand for goods (end-use products) in which tungsten in one of its many forms is a component. Hence, the growth in tungsten consumption is dictated by the level of economic activity in countries that are the principal users of such end-use products.

Currently, the world tungsten industry is characterized by a large amount of unutilized capacity. This situation is likely to continue in view of the forecast of only 2.0 per cent in the annual growth rate for tungsten consumption to the year 2000.

A relevant factor in this modest growth rate forecasted is the forecasted substitution of ceramics and coatings in cutting tool applications for tungsten carbide inserts. There is also substitution between tungsten products themselves, for example tungsten carbide for tungsten-alloyed high-speed tools in metal machining operations. Furthermore there are numerous other technological developments all in an early stage of development, aimed at substituting other materials for tungsten, in the future.

It is difficult to project the long-term effect of substitution. However, it should be recognized that new applications which emerge from ongoing tungsten research and development could expand the demand for tungsten more than enough to offset the substitution effect.

Developments in the recycling of scrap could have a major impact on the future consumption of tungsten ores and concentrates. Figures for scrap recycling are sparse and incomplete. However, it is estimated that of the total tungsten consumed in Canada in 1985, 20 per cent was recycled. Approximately 30 per cent of the total U.S. consumption was accounted for by recycled material in recent years. Secondary tungsten and its compounds are currently recovered from items with a high content of tungsten, such as tungsten carbide inserts.

The degree to which partial substitution for tungsten occurs in traditional uses and the extent to which different metals are substituted for tungsten carbide, either directly or as a coating, could make the recovery of tungsten from these items both technically difficult and costly. Accordingly, a smaller proportion of tungsten is likely to be sourced from scrap in the future and a correspondingly larger proportion from tungsten ores.

Due to the unused capacity in the world tungsten industry and given the fact that a significant portion of world supply is produced in a number of countries, the future market will remain, as it has been in the past decade, highly competitive.

Canada is well positioned with respect to tungsten resources and potential production capability. The Cantung mine has immediate capacity to substantially increase its current level of output, the Mount Pleasant Tungsten mine could be re-opened and the Mactung property could be developed on fairly short notice. Under favourable market conditions, Canadian production could be expanded to account for about 25 per cent of the world market, as compared to about 20 per cent of the market in recent years.

PRICES

	December 31, 1983	December 31, 1984
	($US)	
Tungsten ore, 65% minimum WO_3		
G.S.A. domestic, duty excluded, per short ton unit of WO_3	64.480	69.270
G.S.A. export, per short ton unit of WO_3	74.690	63.800
L.M.B. ore quoted by **London Metal Bulletin**, cif Europe, per metric tonne unit of WO_3	68.250-72.875	58.495-62.796
Ferrotungsten, per pound W, fob Niagara Falls, low-molybdenum	list price suspended	list price suspended
Tungsten metal, per pound, fob shipping point Hydrogen reduced: 99.5%, depending on Fisher No. range	13.100-13.720	13.100-13.720

Source: Metals Week.
cif Cost, insurance and freight; fob Free on board.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
32900-1	Tungsten ores and concentrates	free	free	free	free
34700-1	Tungsten metal in lumps, powder, ingots, blocks or bars and scrap of tungsten alloy metal, for alloying purposes	free	free	free	free
34710-1	Tungsten rod and tungsten wire	free	free	25	free
35120-1	Tungsten and alloys in powder, pellets, scrap, ingots, sheets, strips, plates, bars, rods, tubing, wire, for use in Canadian manufactures (expires June 30, 1986)	free	free	25	free
37506-1	Ferrotungsten	free	4.3	5	free
37520-1	Tungsten oxide in powder, lumps and briquettes, for use in the manufacture of iron and steel	free	free	5	free
82900-1	Tungsten carbide in metal tubes for use in Canadian manufactures	free	free	free	free

MFN Reductions under GATT (effective January 1 of year given)		1985	1986	1987
			(%)	
37506-1		4.3	4.2	4.0
UNITED STATES (MFN)				
601.54	Tungsten ore, per pound tungsten content	17¢		
422.40	Tungsten carbide, on tungsten content	11.5	11.0	10.5
422.42	Other tungsten compounds	10.5	10.2	10.0
606.48	Ferrotungsten and ferrosilicon tungsten, on tungsten content	6.9	6.2	5.6
629.25	Tungsten metal waste and scrap, not over 50% tungsten	5.6	5.2	4.9
629.26	Tungsten metal waste and scrap, over 50% tungsten	4.2	4.2	4.2
629.28	Tungsten metal, unwrought, other than alloys: lumps, grains and powders, on tungsten content	12.1	11.3	10.5
629.29	Tungsten metal, unwrought, other than alloys: ingots and shot	7.5	6.8	6.0
629.30	Other unwrought tungsten metal	8.6	7.6	6.6
629.32	Unwrought tungsten alloys, not over 50% tungsten	5.3	5.0	4.7
629.33	Unwrought tungsten alloys, over 50% tungsten	8.6	7.6	6.6
629.35	Wrought tungsten metal	8.0	7.3	6.5

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated 1985, USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241.

TABLE 1. CANADA, TUNGSTEN PRODUCTION, IMPORTS, 1983-85 AND CONSUMPTION 1982-84

	1983P		1984P		1985e	
	(kilograms)	($)	(kilograms)	($)	(kilograms)	($)
Production[1] (WO_3)	1 537 880	..	4 195 785	..	4 001 870	..
Imports						
Tungsten in ores and concentrates						
United States	9 000	121,000	7 000	108,000	10 000	161,000
Peoples Republic of China	3 000	15,000	-	-	1 000	18,660
Total	12 000	136,000	7 000	108,000	11 000	179,660
Ferrotungsten[2]						
United States	3 000	78,000	5 000	129,000	1 300	33,000
West Germany	-	-	-	-	-	-
Total	3 000	78,000	5 000	129,000	1 300	33,000
Tungsten carbide powder						
United States	197 000	5,170,000	351 885r	6,813,000	231 392	6,792,000
Other countries	23 000	618,000	30 119r	741,000	10 160	278,600
Total	220 000	5,788,000	382 004r	7,554,000	241 552	7,070,600
	(number)	($)	(number)	($)	(number)	($)
Tungsten carbide rotary rock drill bits						
United States	9 187	46,127,000	9 257	38,701,000	10 211	39,334,000
Other countries	560	1,825,000	1 174	5,189,000	1 064	4,678,000
Total	9 747	47,925,000	10 431	43,890,000	11 275	44,012,000
Tungsten carbide percussion rock drill bits						
Ireland	139 654	2,587,000	122 709	1,985,000	70 482	1,009,000
United States	42 114	1,467,000	51 660	1,725,000	62 495	2,051,000
Other countries	3 589	107,000	16 864	497,000	31 777	809,000
Total	185 357	4,161,000	191 233	4,107,000	164 754	3,869,000
Tungsten carbide tools for metal work						
United States	..	6,152,000	..	11,110,000	..	11,245,330
Other countries	..	2,722,000	..	3,565,000	..	3,310,600
Total	..	8,874,000	..	14,675,000	..	14,555,930
	1982		1983		1984	
	(kilograms)	($)	(kilograms)	($)	(kilograms)	($)
Consumption (W content)						
Tungsten metal and metal powder	466 672	..	487 463	..	643 730	..
Other tungsten products[3]	18 934r	..	16 188	..	15 935	..
Total	485 606	..	503 651	..	669 665	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments. [2] Gross weight. [3] Includes tungsten ore, tungsten carbide and tungsten wire.
P Preliminary; r Revised; e Estimated; - Nil; .. Not available.

TABLE 2. CANADA, TUNGSTEN PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975 AND 1979-85

	Production[1]	Imports: Tungsten Ore[2]	Imports: Ferrotungsten[3]	Consumption[2]
	(kilograms)			
1970	1 690 448	82 645	90 718	446 687
1975	1 477 731	1 000	45 359	451 336
1979	3 254 000	11 000	28 000	380 229
1980	4 007 000	6 000	7 000	290 479
1981	2 515 000	14 000	6 000	401 447[r]
1982	3 029 730	7 620	4 536	507 606
1983	1 537 880	12 000	3 000	503 651
1984[P]	4 195 785	7 000	5 000	659 665
1985[e]	4 001 870	11 000	1 300	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments of scheelite (WO_3 content); [2] W content; [3] Gross weight.
[P] Preliminary; [r] Revised; [e] Estimated; .. Not available.

TABLE 4. WESTERN WORLD AND SELECTED COUNTRIES, 1984 MINE CAPACITY AND PER CENT UTILIZATION, AND 1988 FORECASTED CAPACITY

	1984 Capacity[e]	1984 % Utilization[1]	1988 Capacity[e]
	(tonnes W content)		
Canada	5 200	71	6 440
United States	4 575	22	4 575
Bolivia	3 500	69	3 550
Brazil	1 280	81	1 280
Austria	1 600	80	1 600
France	840	95	840
Portugal	1 570	87	1 570
Spain	460	124	460
Sweden	400	96	400
United Kingdom	75	..	75
South Africa	420	..	1 130
Japan	700	68	2 800
South Korea	2 800	97	2 800
Thailand	1 750	42	1 750
Turkey	1 000	..	1 000
Australia	3 400	59	3 400

Sources: Chase Econometrics World Ferroalloy Report, January 1984 Update, Tungsten; USBM Mineral Commodity Summaries, 1985; Energy, Mines and Resources Canada.
[1] Per cent utilization calculated.
[e] Estimated; .. Not available.

TABLE 3. WORLD TUNGSTEN PRODUCTION IN ORES AND CONCENTRATES, 1982-84

	1982	1983[P]	1984[e]
	(tonnes of contained tungsten: W content)		
People's Republic of China	12 519	12 500	12 000
U.S.S.R.	8 981	9 100	9 800
Canada	2 403	358	3 715
Bolivia	2 534	2 400	2 600
Republic of Korea	2 233	2 293	2 400
Australia	2 588	2 060	2 000
Austria	1 406	1 200	1 400
Portugal	1 361	1 360	1 400
United States	1 521	1 016	1 300
Brazil	1 089	1 200	1 000
Thailand	856	700	800
Burma	844	500	1 000
Turkey	150	200	200
Mexico	99	100	150
Other central economy countries	550	300	600
Other market economy countries	3 465	2 500	3 200
World total	44 599	37 787	43 765

Sources: United States Bureau of Mines Minerals Yearbook Preprint 1984; USBM Mineral Commodity Summaries, 1985; Energy Mines and Resources Canada.
[P] Preliminary; [e] Estimated.

Uranium

R.T. WHILLANS

The outlook for the uranium market brightened considerably during 1985. Uranium production fell into line with reactor requirements for the first time since the start of the civilian nuclear power era. Overall supply and demand are now projected to come into balance before 1990. As demand increases, the high inventory levels that have troubled the uranium industry worldwide are being reduced. Additional requirements beyond 1990 will have to be met from new production, as output capability from current operations falls off.

Uranium will be produced increasingly from recently discovered deposits that will be developed in line with expanding markets. In Canada, this next generation of production centres certainly has sufficient proven resources to sustain required output levels well into the next century.

In Ontario, Rio Algom Limited and Denison Mines Limited will continue their efforts beyond 1985 to reduce costs and improve overall productivity; underground leaching is expected to contribute significantly toward achieving these objectives. In Saskatchewan, Eldorado Resources Limited is developing its Collins Bay 'B' orebody for production in 1986, Cluff Mining is proceeding with Phase II of the Cluff Lake operation, Key Lake Mining Corporation (KLMC) could commence development of the Deilmann orebody before the end of the decade, and Cigar Lake Mining Corporation (CLMC) is continuing the evaluation of the very promising Cigar Lake deposit.

PRODUCTION AND DEVELOPMENT

During 1985, Canada's five primary uranium producers, Denison, Rio Algom, Eldorado Resources, Cluff Mining and Key Lake Mining produced concentrates containing an estimated 10 870 tU.[1] With the phasing in of committed development plans in Saskatchewan, and recently completed projects in Ontario, annual production capability is expected to stabilize at about 12 000 tU through the late-1980s. As domestic requirements are small, some 15 per cent of current output, most of Canada's production will be exported. (See Table 1 for primary uranium production for the years 1982 to 1984, and Table 2 for a summary of the 1984 operating characteristics of Canada's existing uranium production centres).

Of Canada's total uranium shipments in 1985, some 55 per cent was attributable to the three Saskatchewan operations with the balance coming from the two Ontario producers at Elliot Lake (see Table 3).

A milling rate of about 8 000 tpd of ore is proving adequate at the Elliot Lake, Ontario, operations of Denison Mines Limited to meet production and delivery schedules required under long-term sales contracts. These approach 60 000 tU and extend to the year 2012. Installation of the new semi-autogenous grinding plant will help reduce milling costs, since the conventional crushing and grinding circuit will not be used regularly.

Denison's underground, in-place leaching tests continue to show favourable results. Together with better training, improved machinery and recoveries of high-grade pillars, the leaching program has become an increasingly important part of the company's efforts to reduce costs and enhance productivity. The leaching of uranium from low-grade ore is expected to have contributed over 10 per cent of the company's 1985 production and may account for up to 20 per cent of future production as more working areas become available.

As part of a plan implemented by Rio Algom Limited in late-1982 to match production more closely with deliveries made under existing contracts, combined ore output from the three Elliot Lake production centres (Quirke, Panel and Stanleigh) has been

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[1] tU = One metric ton (tonne) of elemental uranium (U), written as tU, is equivalent in terms of uranium content to 1.2999 short tons of uranium oxide (U_3O_8).

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established at about 12 000 tpd. This rate is adequate to meet deliveries under long-term sales contracts, which total some 42 000 tU through to the year 2020.

Rio Algom's intensive efforts to reduce or contain operating costs and increase productivity will continue. Although production costs in 1984 were held below those of 1982, uranium earnings and production to October 1985 were down slightly because of lower grades and higher costs at Quirke and Panel. The company's underground in-place leaching program is also of major importance as a cost control measure. Production from leaching could reach 20 per cent of total output in the future.

In late-1985, Eldorado Resources commenced mining at its Collins Bay 'B' orebody, some 9 km northeast of the Rabbit Lake mill. The northern Saskatchewan project includes modifications to the 1 500 tpd capacity Rabbit Lake mill to facilitate the processing of a wider range of complex uranium-bearing ores. Hydrogen peroxide will be used instead of ammonia in the precipitation of mill concentrates in order to meet stringent environmental criteria.

The completion of the Collins Bay 'B' expansion will return Eldorado's annual production capability to 2 000 tU. Ore stockpiled from the Rabbit Lake open-pit will provide feed into 1986, at which time production is expected to be solely from the 'B' deposit. The Rabbit Lake orebody was mined out in August 1984 and the company has prepared the depleted pit as a disposal facility for the tailings from the Collins Bay 'B' deposit. The reported cost of the project is $100 million.

In northwestern Saskatchewan, Cluff Mining - owned 80 per cent by Amok Ltd. and 20 per cent by Saskatchewan Mining Development Corporation (SMDC) - completed construction of its Phase II facilities two months ahead of schedule; production began in August 1984.

Phase II mining began in April 1984 from the exploitation of the 'O-P' underground and 'Claude' open-pit mines and was supplemented from the 'Dominique-Peter' underground mine in late-1985, as the 'O-P' deposit was depleted. The 'N40' underground and 'N' open-pit mines could be brought into production in the mid-1990s. The performance of the 'Claude' and 'O-P' mines surpassed expectations; total production for the first half of 1985 was approximately 480 tU.

Phase II facilities, designed to process ore of a more conventional grade than the very high-grade 'D' orebody exploited during Phase I of the operation, have the capability of mining and milling some 230 000 tpy of ore to produce between 850 and 1 270 tU annually.

Key Lake Mining Corporation (KLMC) - jointly owned by SMDC (one-half), Uranerz Exploration and Mining Limited (one-third), and Eldor Resources Limited, wholly-owned by Eldorado Nuclear Limited, (one-sixth) - became the world's largest uranium producer, with actual output of 4 000 tU in 1984 and an annual design capacity of 4 600 tU.

Overburden removal and drilling of the dewatering wells advanced on schedule at the Deilmann deposit, the second Key Lake orebody, in preparation for mining later this decade. Output from the Gaertner deposit in the first half of 1985 exceeded 2 000 tU.

Production goals are being met at the byproduct uranium recovery plant operated by Earth Sciences Extraction Company at Calgary, Alberta. The facility underwent major equipment modifications in 1982 to improve recoveries of uranium from phosphoric acid produced at an adjacent plant operated by Western Co-operative Fertilizers Limited. Testing of the modified circuits commenced in June 1983 and the plant has been operating close to its 40-60 tU/yr[1] design capacity. The facility is owned by a partnership of ESI Resources Limited, a wholly-owned subsidiary of Earth Sciences Inc. of Golden, Colorado, and Urangesellschaft Canada Limited, a subsidiary of Urangesellschaft mbH of Frankfurt, Federal Republic of Germany.

As shown in Table 4, the work force at Canada's producing uranium operations, as of January 1985, totalled some 5,800 employees. Of this total, over 2,500 worked in the mines, both open-pit and underground, and some 780 in the mills, with the balance described as general employees. Head-office and construction-related employment is not included.

1 Output from ESI is not included in Canadian production totals because the uranium is recovered from phosphate rock imported from the United States. This uranium is contracted to American utilities.

EXPLORATION

The Uranium Resource Appraisal Group (URAG) of Energy, Mines and Resources Canada, (EMR) completed its eleventh (1984) annual supply assessment and exploration survey during 1985. EMR reported[1] that overall uranium exploration activity in Canada declined in 1984 for the fourth consecutive year. Responses to the 1984 URAG questionnaire indicated the exploration activities of 45 companies or joint ventures representing essentially all the major participants active in uranium exploration in Canada. Total expenditures reached $35 million in 1984, distributed among some 84 active projects.

The 10 operators[2] with the largest exploration budgets in 1984 - accounting in aggregate for some 95 per cent of the $35 million total, were, in alphabetical order, AGIP Canada Ltd., Amok Ltd., Cogema Canada Limited, Eldor Resources Limited, Minatco Ltd., PNC Exploration (Canada) Co. Ltd., Saskatchewan Mining Development Corporation (SMDC), Uranerz Exploration and Mining Limited, Urangesellschaft Canada Limited and Westmin Resources Limited. Five of those companies were among the top 10 from 1979 to 1984, inclusive.

Seven of the above 10 operators are companies whose majority interests are held outside of Canada and which are supported, directly or indirectly, by their national governments in their uranium exploration efforts. Thus, in spite of low uranium prices and the poor short-term market outlook, Canada continues to attract foreign investment for uranium exploration.

Not all companies that responded to the 1984 URAG questionnaire had planned their exploration expenditures for 1985 at the time of the survey. However, from the preliminary estimate of $28 million, it appears that the decline in exploration expenditures may have started to level off. The preliminary estimates for 1985 also reveal that drilling activity will be in the order of 160 000 m, representing a decrease of some 20 per cent from the effort in 1984.

As in the previous four years, virtually all the surface development drilling in 1984 was associated with major programs in the Athabasca Basin of Saskatchewan. Essentially no exploration drilling was done outside Saskatchewan, the Northwest Territories and Quebec.

Figure 1 illustrates the responsiveness of uranium exploration expenditures in Canada to uranium price movements since the early-1970s. The decline in uranium exploration expenditures, in an apparent response to softening in the uranium market, has become increasingly evident with each successive survey since 1980.

Figure 2 shows the recent trend in corporate participation in Canadian uranium exploration. Of interest is the abrupt drop in exploration expenditures since 1981 by United States firms in Canada. They now account for less than one-tenth of the expenditures committed by either Canadian or non-United States foreign firms.

In January 1985, Cogema Canada Limited reported that the results of its continued drilling program had indicated that the Cigar Lake orebody contained an estimated 110 000 tU in ore grading 12 per cent U. Additional inferred resources in the western extension of the deposit were estimated at 40 000 tU in ore grading 4 per cent U. Expressed in terms of in-situ geological resources, the company's estimates do not reflect expected mining and ore processing losses.

As open-pit development is out of the question, the feasibility of alternative underground mining methods is currently being assessed by the Cigar Lake Mining Corporation (CLMC), formed on May 16, 1985 by the project partners. The high-grade ore means that relatively high levels of radiation will be encountered requiring special precautions to protect the health and safety of mine workers. In addition, specific attention must be given to the weakness of the groundrock surrounding the ore zone, which may prove to be a greater challenge than dealing with the high

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[1] Prepublication release of Uranium in Canada: 1984 Assessment of Supply and Requirements, Energy, Mines and Resources Canada, September 1985.

[2] An operator may incur expenditures on a project either alone or in a joint venture. In the latter case, the combined expenditure of all participants is attributed to the project operator; as such, contributions by other parties not responding directly to the URAG survey are accounted for in the total.

radiation levels. The anticipated cost for these pre-development studies is $4 million. Once project feasibility is demonstrated and environmental impact studies completed, construction will begin on a schedule established by the partners according to their individual marketing arrangements. The joint venture partners are SMDC (50.75 per cent), Cogema (37.375 per cent), and Idemitsu Uranium Exploration Canada Ltd. (11.875 per cent). Cogema acquired the minority interest share in Cigar Lake held by Reserve Oil and Minerals Corporation (3.75 per cent) in July 1984.

In February 1985, Canadian Occidental Petroleum Ltd. and Inco Limited announced the signing of an agreement with Minatco Ltd., a wholly-owned subsidiary of TOTAL Compagnie minière of France, granting Minatco an option to earn a one-third interest in their McClean and JEB deposits northeast of Cigar Lake. As operator, Minatco is to commit $23 million to extensive exploration and a feasibility study for commercial production. The first phase of the exploration program requires Minatco to spend $1 million during 1985 and another $4 million before 1989.

The continued exploration effort in the eastern part of Saskatchewan's Athabasca Basin has resulted in the discovery of significant new uranium mineralization associated with the known structural trends. These discoveries have not only confirmed URAG's previous appraisals, that indicated a high potential for uranium deposits in this area, but have also led to a more complete assessment of the Athabasca Basin in general.

In the Carswell Structure, a conceptual model of the genesis of mineralization that is not associated directly with the sub-Athabasca unconformity resulted in both the definition of new exploration targets and the delineation of additional uranium resources; the 1984 discovery by Amok Ltd. of the 'Dominique-Janine' deposit which is mineable by open-pit methods, has enhanced the resource base in that area.

In the Thelon Basin, Northwest Territories, the extrapolation of geological knowledge from studies of the Lone Gull deposits permitted the delineation of areas favourable for uranium mineralization. Urangesellschaft Canada Limited discovered two new zones in the vicinity of their Lone Gull property in the Baker Lake area.

The discovery in the United States of uranium resources in Virginia prompted renewed exploration interest in eastern Canada. Drilling efforts were also increased in Quebec as studies of uranium metallogeny point to the correlation of occurrences in various central and northern parts of the province.

In general, the efficiency of the Canadian uranium exploration effort has been increased through the application of advanced geological, geochemical and geophysical survey methods. The introduction of computerized data bases, improved exploration strategies using conceptual modelling for selecting exploration targets, and the combination of airborne and ground exploration methods have contributed to recent exploration successes.

URANIUM RESOURCES

The results of EMR's 1984 URAG uranium resource assessment, released in prepublication form in October 1985, are summarized in Table 6. For comparison, the results of the 1982 assessment[1] are also presented. To facilitate comparison of Canada's resource estimates with those of other countries, quantities are presented in terms of uranium **recoverable from** mineable ore instead of uranium **contained in** mineable ore. Uranium resource estimates are divided by URAG into separate resource categories that reflect different levels of confidence in the quantities reported. These categories are further subdivided into three levels of economic exploitability related to the price of uranium. For the 1984 assessment, the low price range (A) was assigned a uranium price limit of $100/kg U. The second price range (B) and third price range (C) spanned the $100-$150/kg U, and the $150-$300/kg U intervals, respectively. All quantities are reported in tonnes of elemental uranium, consistent with international practice. Prices are given in Canadian dollars/kg U[2].

The price of $100/kg U was chosen by URAG for its assessment to illustrate those resources that appeared to be of economic

[1] Uranium in Canada: 1982 Assessment of Supply and Requirements, Report EP 83-3, Energy, Mines and Resources Canada, September 1983.

[2] $1/lb U_3O_8 = $2.6 kg U.

interest to Canada in 1984, and served to define the upper limit of the A price category.

In comparing the 1984 revisions of Canada's uranium resource estimates with those of the 1982 resource assessment (see Table 6), the most significant change is the apparent shift in resources from the inferred to the indicated category, reflecting the continued delineation of recently discovered uranium deposits in Saskatchewan. At the same time, there has been a significant increase in resources assigned to the higher price categories, and a corresponding decline in resources of current economic interest (i.e., A price category). This shift in the economic distribution of Canada's known uranium resources is attributed to a number of factors including production of some 18 300 tU over the two-year assessment period, and the continuing upward pressure on production costs which necessitated the use of higher cut-off grades for assessing selected deposits. In addition, resources associated with certain of the more recently discovered Saskatchewan deposits have been assigned to the higher price categories as a reflection of current uncertainties associated with their costs of exploitation.

To provide an illustration of uranium availability in the short-term, a projection of Canadian production capability to 1996 was made, as illustrated in Figure 3. This scenario is an illustration of firm production capability. It is based on existing production centres only, and assumes levels of production that can be practically and realistically achieved, under current circumstances. Only resources in the measured, indicated and inferred categories, in the A plus B price range (i.e., recoverable at uranium prices of $150/kg U or less), were incorporated into the projection. The lives of these production centres could be extended, in certain cases, by the exploitation of associated higher-priced resources, or through additions of resources in the A plus B price range resulting from continued exploration and development work. No commitments have been made for the start-up of any production centres beyond those currently in production.

This production capability scenario is not intended to represent a projection of actual production. Rather, it is intended to illustrate a level of production that could be supported by known deposits, given favourable developments in the uranium market. Actual levels of production from these centres will depend on a number of operational variables, and could be different from the capabilities projected.

GOVERNMENT AFFAIRS

On June 30, 1985, the federal government passed the Investment Canada Act, designed to encourage investment in Canada that contributes to economic growth and employment opportunities. Replacing the Foreign Investment Review Act passed on December 12, 1973, the new Act should enhance the Canadian uranium industry's export opportunities and improve access to the world's uranium markets by encouraging foreign investment in new production projects. The federal government's policy on foreign ownership of uranium mines was under review at the end of 1985, and the result should be a simpler and more liberal regime than before.

During 1985, the federal government reviewed its policy that requires Canadian uranium to be processed to the maximum extent possible prior to export (i.e., to uranium hexafluoride). After consultation with the producers, Ministers concluded that the policy should be maintained, as long as Canadian facilities have the capacity and are generally competitive with other primary converters. However, the circumstances under which exemptions from further processing in Canada can be granted were defined more precisely than before. In his letter of October 18, 1985, Canada's Minister of State (Mines) informed the uranium producers of a new flexible approach to the further processing policy whereby exemptions can be obtained in certain situations where end-users have existing conversion contracts in place. Although the new approach responds to specific concerns of customers in the United States, the combination of uranium and further processing in Canada should remain highly attractive to all customers.

As a result of the protracted slump in the United States nuclear power program, high-cost U.S. uranium producers have been unable to compete with lower-priced imports and many have been forced to discontinue operations. Throughout 1985 the U.S. uranium industry exerted strong pressure to limit imports of uranium into the United States.

On September 26, 1985, the U.S. Secretary of Energy announced that he had determined the domestic uranium industry to be non-viable, thereby triggering an investigation by the U.S. Trade Representative (USTR) with a view to assessing the feasibility of imposing trade restrictions. Although, at year-end, the USTR recommended against taking any import restraint measures, it was anticipated that there will be continued effort on the part of the U.S. industry, probably through the legislative route, to impose restrictions on the import of foreign uranium. The Administration has strongly resisted efforts to protect the domestic uranium industry. Canada would be very concerned if actions were initiated to restrict imports of Canadian uranium, particularly in light of recent commitments to halt protectionism in cross-border trade in goods and services. Both countries benefit from substantial two-way trade.

MARKETS AND PRICES

Canadian uranium producers were encouraged in July, 1985 by the announcement of the first major sale to Japan since 1980. Key Lake partners Eldorado Nuclear Limited and SMDC will jointly provide a total of 2 300 tU to Kyushu Electric Power Co., over the period 1987-1999.

In general, Canadian producers continue to play an active role in the uranium market. During 1985, a significant number of new export contracts were reviewed and accepted by the federal government. As shown in Table 7, net additions resulting from new and revised contracts in 1985 brought to some 114 000 tU, the total amount of uranium under export contracts reviewed since September 5, 1974. The year-end 1985 total reflects scheduled deliveries under more than 130 contracts, over one-third of which remain active. As of December 1985, forward commitments under all active contracts were estimated at 63 000 tU. Forward domestic commitments exceed 75 000 tU.

Actual exports in 1984 exceeded 6 900 tU, and were primarily to Japan and the United States (see Table 8). Japan has been Canada's most important single customer, accounting for about 37 per cent of Canada's scheduled deliveries since the beginning of the commercial contract era. Most of the remaining exports have gone to the European Economic Community (31 per cent), the United States (18 per cent), and other countries in western Europe (13 per cent). The future importance of these Canadian markets can be illustrated in terms of scheduled deliveries as shown in Figure 4.

The average price of export deliveries made by Canadian producers in 1984 was $Cdn 90/kg U. The spot market had a significant impact on the average price, as more than 25 per cent of export deliveries in 1984 were under spot sales, compared with 10 per cent in 1983 and only 1.5 per cent in 1982.

By comparison, uranium spot market prices were significantly lower, as reflected by the Nuclear Exchange Corporation's[1] (Nuexco) monthly exchange value[2] (EV). The EV slid from $US 20.50/lb U_3O_8 in January 1984 to $US 15.25 in December. It hit an 11-year low of $US 14.25/lb U_3O_8 in April 1985 but rallied to $US 17/lb by year-end.

REFINING

Eldorado Resources Limited, operates Canada's only uranium refining/conversion facility. To keep pace with increasing domestic uranium concentrate production capability, expansions of the company's refining and conversion capacity have been under way during the past few years. These commitments were made in anticipation of greatly increased world requirements for uranium and for associated further processing services. Canada is now in a position to refine and convert the full output of its expanded uranium producing industry.

At the Blind River, Ontario, plant, uranium concentrates from mines in Canada and other countries are refined to high purity uranium trioxide (UO_3)[3]. The UO_3 is then converted at Port Hope, Ontario, into either uranium hexafluoride (UF_6)[4] for foreign utilities that operate light water reactors, or ceramic-grade uranium dioxide (UO_2) for CANDU-type heavy water reactors.

[1] A California-based uranium brokerage firm.
[2] Nuexco's judgement of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.
[3] Uranium trioxide is the initial refined product from which UO_2 or UF_6 is produced.
[4] Uranium hexafluoride is the required feed material for the uranium enrichment process.

Construction of the Blind River facility was completed in July 1983 and production reached commercial levels in early-1984. Start-up of this new facility permitted the closure of Eldorado's old refinery at Port Hope.

The refined UO_3 is transported from Blind River to Eldorado's conversion plants in Port Hope. There the new UF_6 facility, with an annual output capacity of 9 000 tU as UF_6, achieved commercial production levels in April 1985.

In total, Eldorado processed mine concentrates containing some 4 400 tU during 1984, a 20 per cent decrease from 1983.

NUCLEAR POWER DEVELOPMENTS

Despite the slow rate of new reactor orders in the world, the number of operating reactors will continue to grow steadily into the 1990s. The International Atomic Energy Agency (IAEA) reported that as of January 1, 1985, 345 nuclear power reactors, with a combined generating capacity of some 220 electrical gigawatts (GWe)[1], were on-line in national grids in 26 countries. Although nuclear programs in some countries are still small, in others the nuclear share in electricity production at times of low demand often exceeds 50 per cent.

A further 180 reactors with a combined capacity of 163 GWe were under construction at the beginning of 1985; the IAEA estimates that by 1990 the total world installed nuclear capacity will have reached 370 GWe.

In Canada, 16 CANDU reactors with an aggregate net output capacity of some 9 600 electrical megawatts (MWe) were in service (i.e., commercially operable) at year-end 1985 and a further 7 reactors with an additional capacity of some 5 700 MWe were either in the pre start-up phase or under construction (see Table 11). Nuclear generation in Canada exceeded 49 TWh[2] in 1984, an increase of some 7 per cent from 1983; it accounted for 12 per cent of total Canadian electricity generation. Canada's commitment to nuclear power remains firm.

Ontario Hydro's nuclear reactors maintained their standing among the world's best performers. To the end of 1984, 5 of Hydro's 11 in-service CANDU's were in the top 10 in terms of lifetime capacity factor[1] out of some 186 commercial power reactors, rated at 500 MWe or greater, in service around the world.

[1] GWe = 10^9 watts.
[2] Terawatts-hours = 10^{12} watt-hours.

Some 34 per cent of the total electrical energy generated by Ontario Hydro during 1984 came from nuclear-electric units; 34 per cent was also derived from hydro-electric sources and 32 per cent came from coal-fired plants.

At Ontario Hydro's four-reactor Pickering 'B' Nuclear Generating Station (NGS) east of Toronto, units 6 and 7 were declared in service on February 1, 1984 and January 1, 1985, respectively. Unit 8 is expected to be declared in service in early-1986.

Unit 6 of the Bruce 'B' NGS near Kincardine, was declared in service on September 14, 1984. Unit 5 achieved criticality on November 15, 1984 and was declared in service on March 1, 1985. The expected in-service dates for Units 7 and 8 are April 1, 1986 and January 1, 1987, respectively.

The rated capacity of the Bruce 'A' station was increased during 1985 and will reach 3 076 MWe in 1986; the Bruce 'B' station is also being upgraded and upon completion will be rated at 3 360 MWe.

At Ontario Hydro's Darlington NGS near Bowmanville, schedules are being maintained; 75 per cent of the engineering work and 40 per cent of the construction at the site was complete at year-end 1985. The most probable in-service dates for units 1 to 4 are February 1989, May 1988, November 1991 and August 1992, respectively.

In New Brunswick, Canada's first 600 MWe series CANDU reactor to go into commercial operation continues to operate exceptionally well. The Point Lepreau I unit, located some 40 km southwest of Saint John, achieved essentially full operating capacity throughout most of 1984 and 1985, except for required service inspections.

[1] Lifetime capacity factor is the ratio of electricity produced, from the in-service date of the reactor, relative to that which could have been produced had the reactor operated at 100 per cent power output for 100 per cent of the time.

Hydro-Quebec's Gentilly 2 Nuclear Power Station near Bécancour is Canada's second 600 MWe CANDU to go into service. The unit achieved an 87 per cent capacity factor during the 1984/85 demand peak.

OUTLOOK

In the years ahead, the requirements for Canadian uranium will depend upon the growth of nuclear power capacity in Canada and its trading partners. Nuclear energy is already making a significant and increasing contribution to electricity requirements in many countries. This installed and committed nuclear capacity will require increasing supplies of uranium well into the next century.

From data released by the IAEA it can be determined that total installed nuclear power capacity in the world grew by 17 per cent during 1984. Nuclear plants account for around 8 per cent of the world's total electrical generating capacity but, because they are generally used for base-load operation, nuclear units produce about 12 per cent of the world's electricity.

By the year 2000, Canada's total installed nuclear capacity is expected to have grown to between 15 and 20 GWe, requiring approximately 2 200 tU per year. By that time, nuclear energy will be providing about 18 per cent of Canada's electricity supply; the level in Ontario alone will be over 60 per cent.

Since 1959, Canada has ranked second behind the United States in terms of world[1] uranium production. In 1984, Canada replaced the United States as the leading world producer, accounting for about 30 per cent of total output, which was estimated at some 39 000 tU. Canada's position as the world's leading exporter of uranium is expected to be maintained for several years to come, despite a potential challenge from Australia.

Canada's annual uranium production capability will expand to some 12 000 tU within the next year, reflecting the phasing in of committed development plans in Saskatchewan. Because of the uncertain outlook for the uranium market over the next several years, it is unlikely that further new domestic production projects will be brought on-stream before the early-1990s. Actual production over the intervening period will depend on a variety of market factors such as the actual level of surplus consumer inventories and policies regarding their disposition, the growth in uncommitted demand, the uncertainties related to political developments, and the impact of such factors on uranium prices. It is quite possible that production over the next few years will not be maintained at Canada's full 12 000 tU per year capability.

However, recent estimates of world reactor requirements[1] confirm that the uranium market will improve in the longer term. Annual reactor-related requirements are expected to approach 55 000 tU by 1995 and over 60 000 tU by the turn of the century. More than 90 per cent of these uranium requirements occur in OECD countries. By 2025, requirements could grow to more than 250 000 tU per year, assuming a high rate of nuclear power growth.

Whatever the magnitude of future uranium requirements turns out to be, Canada has the capability to provide for its own needs while maintaining its place among the leading suppliers of uranium to world markets.

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[1] World, used in the context of uranium supply, excludes the U.S.S.R., Eastern Europe and the People's Republic of China.

[1] See "Nuclear Fuel Cycle Supply Capabilities - The Front End", a paper by R.M. Williams, Chairman of the NEA Uranium Group, delivered at the High Level Workshop on Nuclear Energy Prospects to 2000 and Beyond, Paris, November 5-7, 1985.

TABLE 1. URANIUM PRODUCTION IN CANADA, BY COMPANY, 1982-84

Company	Location	Production 1982	1983	1984
		(tonnes U[1])		
Cluff Mining (Amok Ltd./SMDC)	Cluff Lake, Sask.	1 469	682	642
Denison Mines Limited	Elliot Lake, Ont.	2 359	2 298	2 246
Eldorado Resources Limited	Eldorado, Sask.[2]	282	1[3]	-
	Rabbit Lake, Sask.	1 210[4]	1 244	1 361
Kerr Addison Mines Limited	Agnew Lake, Ont.	65	15	-
Key Lake Mining Corporation	Key Lake, Sask.	-	423[5]	4 003
Madawaska Mines Limited	Bancroft, Ont.	153	-	-
Rio Algom Limited - Quirke	Elliot Lake, Ont.	1 672[6]	1 446	1 372[6]
- Panel		865	831	841
- Stanleigh		-	203[7]	704
Total Canada[8]		8 075	7 143	11 169

Source: Company annual reports.
[1] One metric ton (tonne) of elemental uranium (U), written as tU, is equivalent in terms of uranium content to 1.2999 short tons of uranium oxide (U_3O_8). [2] Beaverlodge operation only. [3] Final clean-up of product from precipitation circuit. [4] Joint operation - Eldorado Resources Limited/Uranerz Canada Limited - acquired by Eldorado in October 1982. [5] Milling commenced in October 1983. [6] Does not include uranium recovered from Panel ore processed at Quirke, or from acid raffinate from Eldorado. [7] Milling commenced in July 1983. [8] Primary uranium production only: does not include uranium recovered from raffinates and sludges by Rio Algom Limited and Denison Mines Limited.
- Nil.

TABLE 2. OPERATIONAL CHARACTERISTICS OF CANADIAN URANIUM PRODUCTION CENTRES IN 1984

Company Name/ Production Centre	Nominal Mill Capacity/Actual Throughput	Total Ore Processed	Average Grade of Ore Processed	Overall Mill Recovery
	(tonnes/day)	(tonnes)	(kg U/t)	(%)
Amok Ltd.-SMDC/ Cluff Lake	800 in Phase II (100 in Phase I)	106 712	6.32	95
Denison Mines Limited/ Elliot Lake	13 610 / 9 398	3 132 500	0.78	93
Eldorado Resources Limited/Rabbit Lake	1 500 / 2 591	642 143	2.25	94
Key Lake Mining Corporation/Key Lake	500-700/ 475[e]	164 040	25.10	97
Rio Algom Limited/ Elliot Lake				
- Quirke	6 350 / 4 965	1 657 092	0.87	94
- Panel	2 990 / 3 029	994 881	0.89	95
- Stanleigh	4 540 / 3 636	1 214 550	0.64	90

Sources: Corporate Annual Reports and the Atomic Energy Control Board (AECB).
[e] Estimated.

TABLE 3. VALUE OF URANIUM SHIPMENTS[1] IN CANADA BY PROVINCE, 1983-85

	1983		1984		1985P	
	(t)	($000)	(t)	($000)	(t)	($000)
Ontario	4 767	546,306	4 552	544,779	4 485	519,479
Saskatchewan	2 056	121,366	5 720	356,794	5 544	438,181
Total	6 823	667,672	10 272	901,573	10 029	957,660

[1] Shipments of uranium (U) in concentrate from ore processing plants.
P Preliminary.

TABLE 4. WORK FORCE SUMMARY - CANADIAN URANIUM PRODUCING OPERATIONS

Company Name (Mine Name)	Total Number of Employees (Mine, Mill, General)	
	1/1/84	1/1/85
Cluff Mining (Cluff Lake)	272	309
Denison Mines Limited (Denison)	2,199	2,200
Eldorado Resources Limited (Rabbit Lake)	337	319
Key Lake Mining Corporation (Key Lake)	489	427
Rio Algom Limited (Quirke)	1,079	1,069
(Panel)	687	669
(Stanleigh)	789	818
Total all producers	5,845	5,811

TABLE 5. PRODUCTION OF URANIUM IN CONCENTRATES BY MAJOR PRODUCING COUNTRIES, 1975-84

	United States	Canada	South Africa	Namibia	France	Niger	Gabon	Australia	Other[1]	Total[2]
					(tonnes U)					
1975	8 900	3 560	2 490	-	1 730	1 310	800	-	330	19 120
1976	9 800	4 850	2 760	650	1 870	1 460	..	360	340	22 090
1977	11 500	5 790	3 360	2 340	2 100	1 610	910	355	385	28 350
1978	14 200	6 800	3 960	2 700	2 180	2 060	1 020	515	455	33 890
1979	14 400	6 820	4 800	3 840	2 360	3 620	1 100	705	465	38 110
1980	16 800	7 150	6 150	4 040	2 630	4 130	1 030	1 560	510	44 000
1981	14 800	7 720	6 130	3 970	2 560	4 360	1 020	2 920	670[3]	44 150
1982	10 330	8 080	5 820	3 780	2 860	4 260	970	4 420	970[3]	41 490
1983	8 140	7 140	6 060	3 720	3 270	3 470	1 040	3 210	900[3]	36 950
1984	5 720	11 170	5 740	3 690	3 170	3 400	1 000	4 390	950[4]	39 230

Sources: Data derived principally from "Uranium: Resources, Production and Demand, December 1983, a biennial report jointly produced by the Nuclear Energy Agency of the Organization for Economic Co-operation and Development, and the International Atomic Energy Agency, with supplements from the 1984 "MINEMET" report of IMETAL SA, and from miscellaneous sources, for 1982, 1983, and 1984. From 1980, country totals are rounded to the nearest 10 tU.

[1] Includes Argentina, Federal Republic of Germany, Japan, Portugal, Spain, and Sweden (1975 only). [2] Totals (rounded) are of listed figures only. [3] Includes Belgium, Brazil, India and Israel. [4] Includes Yugoslavia.
- Nil; .. Not available.

TABLE 6. ESTIMATES OF CANADA'S URANIUM RESOURCES RECOVERABLE FROM MINEABLE ORE[1], 1982 AND 1984

Price ranges within which mineable ore is assessed[2]	Reasonably Assured Resources: Measured 1984[3]	Measured 1982[4]	Indicated 1984[3]	Indicated 1982[4]	Estimated Additional Resources - Category I: Inferred 1984[3]	Inferred 1982[4]
(Canadian dollars)			('000 tonnes U)			
A	31	[32]	124	[144]	105	[181]
B	-	[1]	59	[8]	92	[48]
A + B	31	[33]	183	[152]	197	[229]
C	23	[26]	50	[43]	67	[58]
A + B + C	54	[59]	233	[195]	264	[287]

[1] Losses in mining recovery as well as ore processing have been accounted for. [2] The price figures reflect the price of a quantity of uranium concentrate containing 1 kg of elemental uranium. The prices were used in determining the cut-off grade at each deposit assessed, taking into account the mining method used and the processing losses expected. [3] For the 1984 assessment the price ranges were (A) $100/kg U or less, (B) between $100 and $150/kg U, and (C) between $150 and $300/kg U. [4] The [bracketed] figures are from the 1982 assessment in which price ranges were (A) 115/kg U or less, (B) between $115 and $170/kg U, and (C) between $170 and $340/kg U.
- Nil.

TABLE 7. URANIUM UNDER EXPORT CONTRACTS REVIEWED[1] SINCE SEPTEMBER 5, 1974

Country of buyer	1985
	(tonnes U)
Belgium	3 030
Finland	3 510
France	9 467
Italy	1 120
Japan	25 048
South Korea	5 140
Spain	3 556
Sweden	5 310
Switzerland	150
United Kingdom	7 700
United States	36 855
West Germany	13 236
Total	114 122

[1] Reviewed and accepted under Canadian uranium export policy. Totals adjusted to reflect new and amended contracts as of December 31, 1985.

TABLE 8. EXPORTS OF URANIUM OF CANADIAN ORIGIN

Country of Final Destination	1982	1983	1984
	Tonnes of contained uranium[1]		
Belgium	85	-	121
Finland	96[r]	179	137
France	-	435	525
Italy	143	-	50
Japan	718	663	2 436
South Korea	74	94	30
Spain	110	-	-
Sweden	889	613[r]	254
United Kingdom	379	675[r]	692
United States	4 852[2]	860[r]	2 397
West Germany	471	490	295
Total	7 817[r]	4 009[r]	6 937

Source: The Atomic Energy Control Board.
[1] Some of this uranium was first exported to intermediate countries, namely France, United States and U.S.S.R., for enrichment and then forwarded to the country of final destination. [2] The bulk of this material represents uranium exchanged by Eldorado in the purchase of the Rabbit Lake operation.
[r] Revised; - Nil.

TABLE 9. EXPORTS[1] OF RADIOACTIVE ORES AND CONCENTRATES[2] FROM CANADA, 1977-84

	United States[3]	U.S.S.R.	United Kingdom	Italy	West Germany	France	Nether-lands	Japan	Norway	South Korea	Total
						($000)					
1977	72,848	-	2,590	-	-	-	-	-	-	-	75,438
1978	163,911	-	39,106	3,348	-	-	-	791	-	-	207,156
1979	347,388	-	18,851	12,613	-	-	-	9	-	-	378,862
1980	218,013	-	10,319	-	-	1	-	-	-	2,329	230,662
1981	152,473	3,182	18,845	-	-	-	-	-	2,862	2,022	179,384
1982	346,891	-	11,690	-	-	-	-	-	-	-	358,581
1983	25,400	-	37,175	-	-	-	-	-	-	-	62,575
1984	295,686	-	28,188	2	6,149	36	167	3,475	-	-	333,703

Source: Statistics Canada.
[1] Material that cleared Canadian customs with destination as indicated. [2] Includes uranium in concentrates. [3] Prior to 1977, uranium almost entirely destined for transshipment, primarily to western Europe and Japan, following conversion and enrichment; for subsequent years, figures represent a mixture of sales to United States and others, primarily in western Europe and Japan.
- Nil.

TABLE 10. EXPORTS[1] OF RADIOACTIVE ELEMENTS[2] AND ISOTOPES FROM CANADA, 1977-84

	United States[3]	U.S.S.R.[4]	United Kingdom	West Germany	France	Belgium Luxembourg	Nether-lands	Finland	Argentina	Japan	South Korea	Other	Total
							($000)						
1977	151,869	6,133	356	384	685	75	-	10	287	288	-	1,078	161,165
1978	269,903	101,619	38,602	6,918	19,046	23	-	10	12,177	1,017	-	1,668	450,983
1979	293,577	170,500	5,147	26,159	1,762	221	629	5,493	94,038	1,101	87	3,363	602,077
1980	199,001	77,235	2,104	20,406	144,013	4,847	374	6,408	27,766	1,911	137,002	4,312	625,379
1981	382,418	20,192	2,081	40,092	213,051	339	7,506	-	248	1,577	67	2,915	670,486
1982	299,246	34,854	796	37,250	36,213	291	45r	199	214	19,617	123	5,185r	434,033
1983	261,168	8,148	2,303	32,208	39,037	232	1,517	11	315	12,371	3,057	7,248	367,615
1984	416,670	-	1,601	14,364	28,988	71	598	20,128	520	35,729	8,311	13,720	540,700

Source: Statistics Canada.
[1] Material that cleared Canadian customs with destination as indicated. [2] Includes uranium hexafluoride (UF_6) and radioisotopes for medical and industrial purposes. [3] Prior to 1977, UF_6 component destined for transshipment, primarily to western Europe and Japan, following enrichment; for subsequent years, figures would also include UF_6 sales to the U.S. market. [4] UF_6 component destined entirely for transshipment to western Europe, following enrichment.
- Nil; r Revised.

TABLE 11. NUCLEAR POWER PLANTS IN CANADA

Reactors	Owner	Net Output (MWe)	In-Service Dates (Expected)
Nuclear Power Demonstration	Atomic Energy of Canada Limited	22	1962
Pickering 1 to 4	Ontario Hydro	2 060	1971-73
Bruce 1 to 4	Ontario Hydro	3 076[r]	1977-79
Point Lepreau	New Brunswick Electric Power Commission	635	1983
Gentilly 2	Hydro-Quebec	638	1983
Pickering 5, 6 and 7	Ontario Hydro	1 548	1983-85
Pickering 8	Ontario Hydro	516	(1985)
Bruce 6 and 5	Ontario Hydro	1 660[r]	1984-85
Bruce 7 and 8	Ontario Hydro	1 660[r]	(1986-87)
Darlington 1 to 4	Ontario Hydro	3 524	(1988-92)
Total		15 339	

[r] Re-rated.

FIGURE 1

RESPONSIVENESS OF URANIUM EXPLORATION EXPENDITURES IN CANADA TO URANIUM PRICE MOVEMENTS, 1971-84

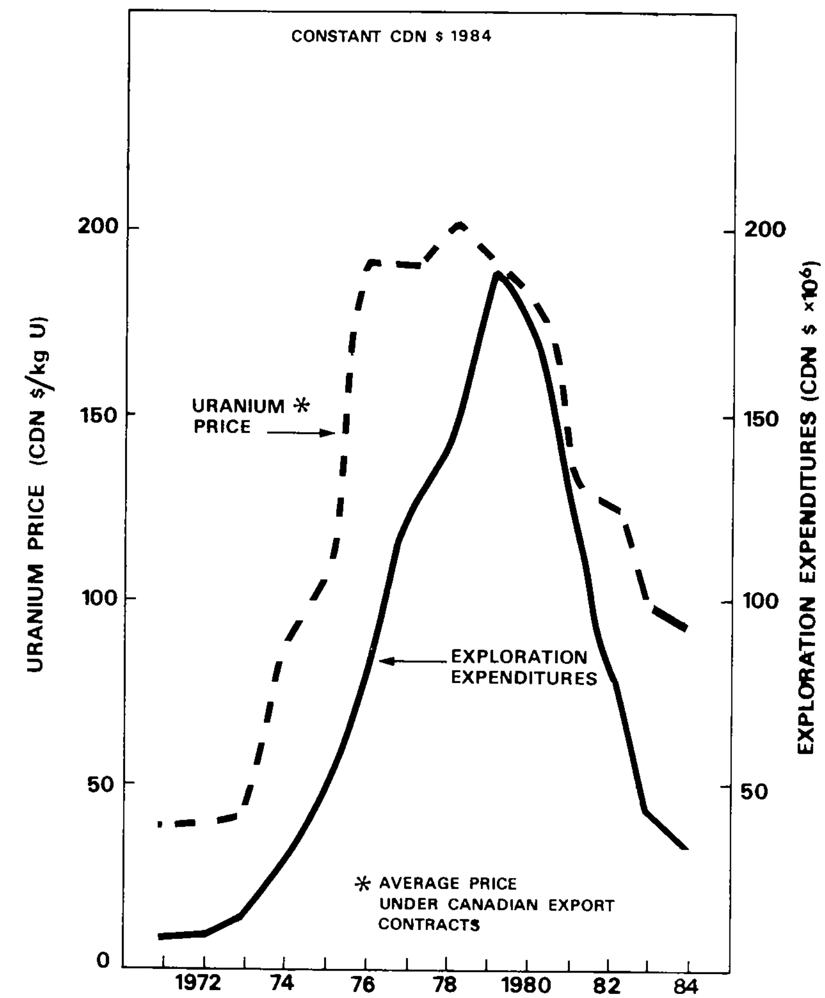


FIGURE 2

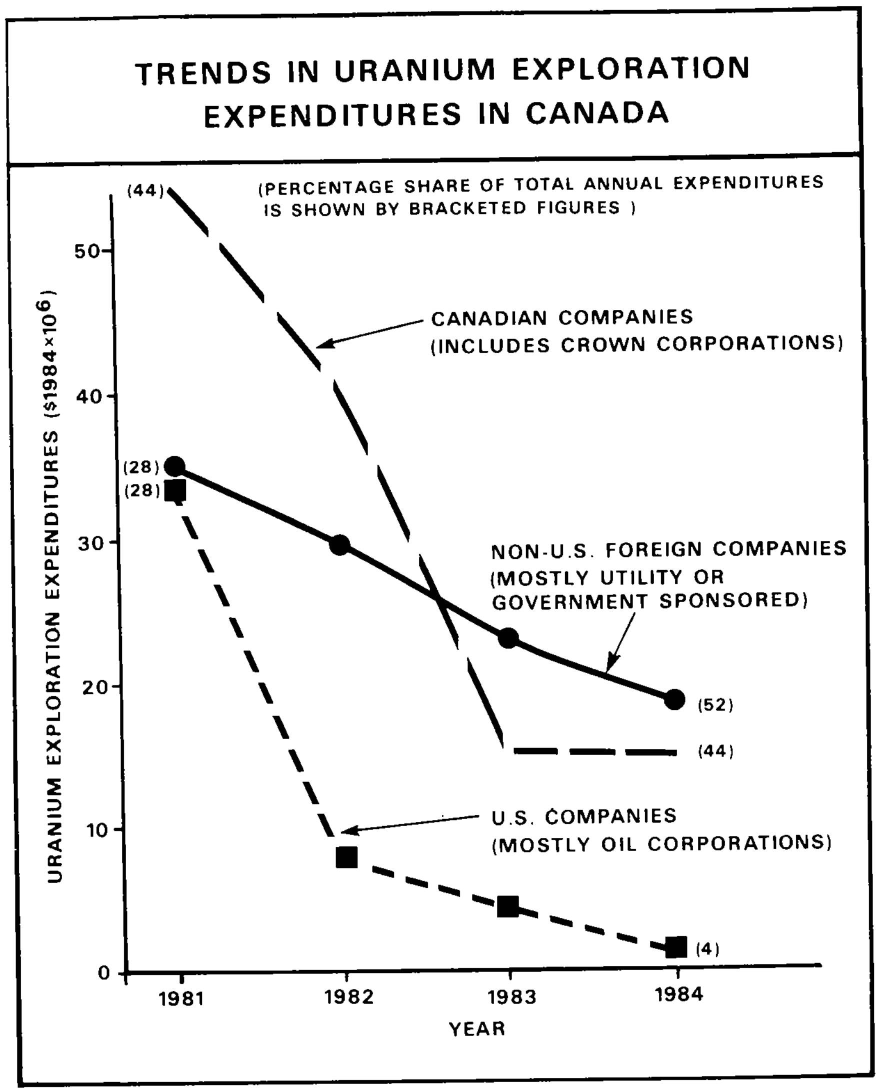

TRENDS IN URANIUM EXPLORATION EXPENDITURES IN CANADA
(PERCENTAGE SHARE OF TOTAL ANNUAL EXPENDITURES IS SHOWN BY BRACKETED FIGURES)
CANADIAN COMPANIES (INCLUDES CROWN CORPORATIONS)
NON-U.S. FOREIGN COMPANIES (MOSTLY UTILITY OR GOVERNMENT SPONSORED)
U.S. COMPANIES (MOSTLY OIL CORPORATIONS)
(44)
(28)
(28)
(52)
(44)
(4)
URANIUM EXPLORATION EXPENDITURES ($1984×10^6)
0
10
20
30
40
50
1981
1982
1983
1984
YEAR

FIGURE 3

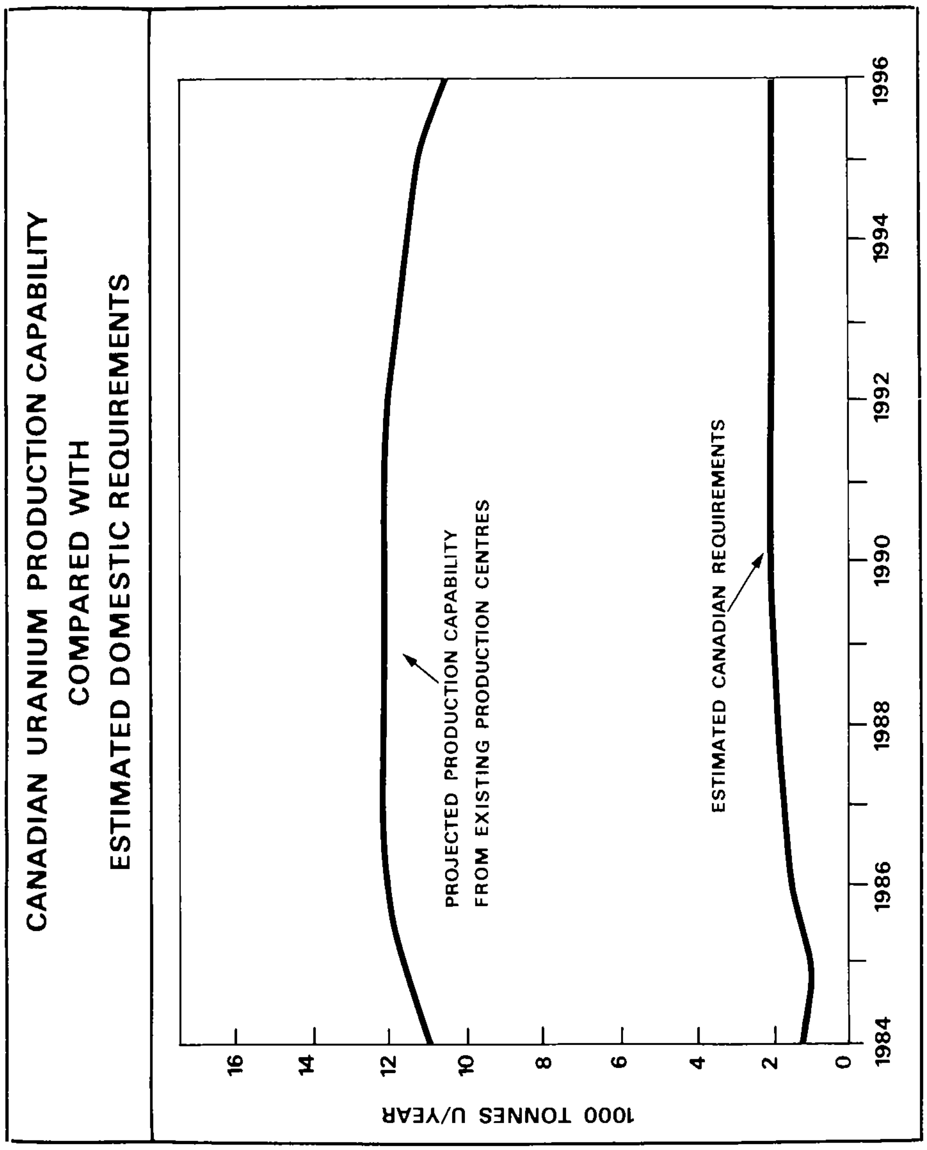
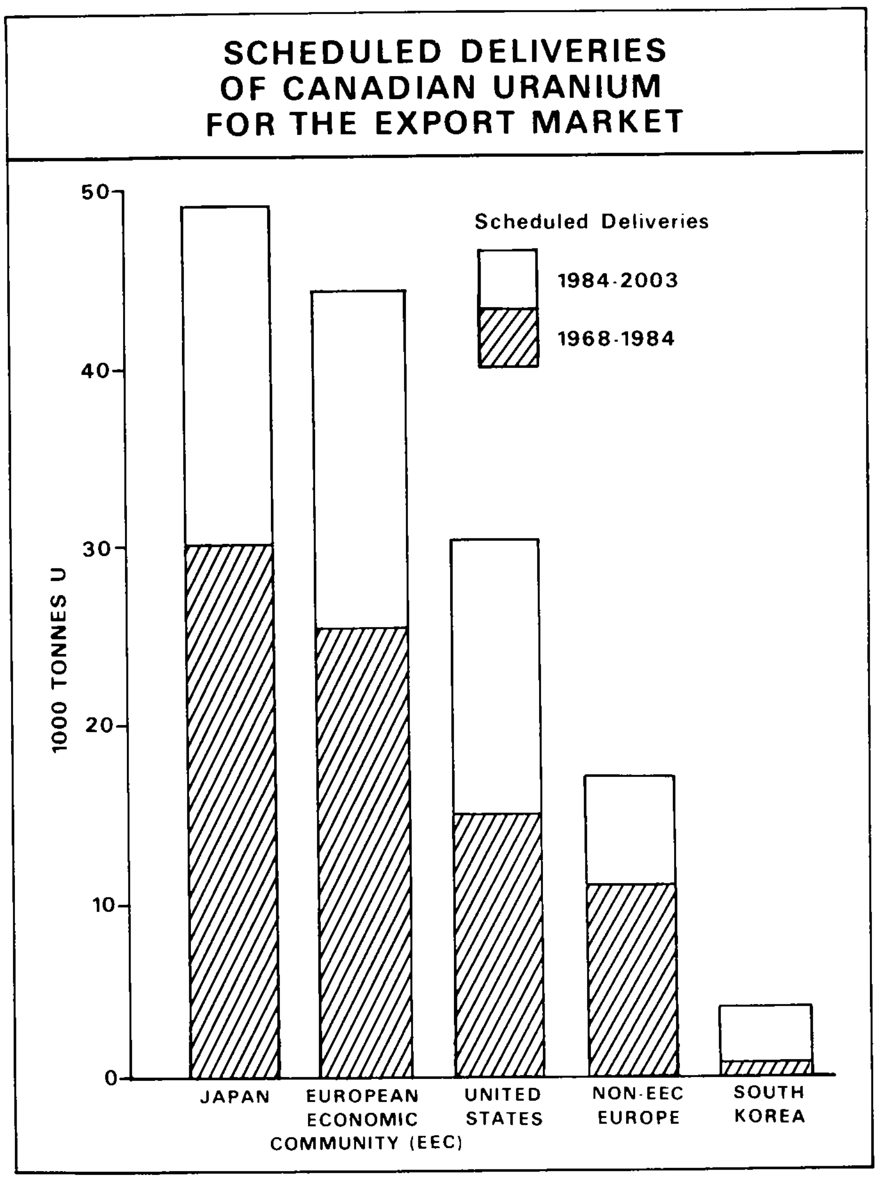

CANADIAN URANIUM PRODUCTION CAPABILITY
COMPARED WITH
ESTIMATED DOMESTIC REQUIREMENTS
1000 TONNES U/YEAR
0
2
4
6
8
10
12
14
16
1984
1986
1988
1990
1992
1994
1996
PROJECTED PRODUCTION CAPABILITY
FROM EXISTING PRODUCTION CENTRES
ESTIMATED CANADIAN REQUIREMENTS

FIGURE 4


SCHEDULED DELIVERIES
OF CANADIAN URANIUM
FOR THE EXPORT MARKET
Scheduled Deliveries
1984-2003
1968-1984
1000 TONNES U
50
40
30
20
10
0
JAPAN
EUROPEAN ECONOMIC COMMUNITY (EEC)
UNITED STATES
NON-EEC EUROPE
SOUTH KOREA

Vanadium

D. KING

Vanadium is derived from natural ores and from vanadium-containing residues such as byproducts from crude oil refining. The basic feedstock used to obtain all other vanadium products is vanadium pentoxide (V_2O_5), which is not currently produced in Canada. One domestic company, Masterloy Products Limited, produces ferrovanadium from imported vanadium pentoxide. Canada consumed about 750 t of ferrovanadium in 1984.

Following the economic recession of 1982 and 1983, the world vanadium industry went through a period of moderate recovery in 1984 which continued throughout 1985. Supply was relatively unaffected by the termination of output in Finland in 1985, but the possibility of further political deterioration in South Africa introduces some uncertainty for future supply from this very large source. Prices firmed in 1985 because of the improved demand from steel and titanium producers, coupled with the loss of Finnish output. The United States output of vanadium from the processing of uranium ores ceased in 1984, but Umetco Minerals Corporation (Umetco), the vanadium producing subsidiary of Union Carbide Corporation, resumed operations at its vanadiferous clay mine in Arkansas. A further degree of uncertainty regarding vanadium supply was introduced when Umetco was put up for sale in late-1984.

In 1985, the United States government purchased vanadium materials for the National Defence Stockpile for the first time in 23 years.

Non-communist world demand is generally expected to remain firm during 1986 in line with steel and titanium consumption.

CANADIAN DEVELOPMENTS

Vanadium occurrences are widespread throughout Canada. The most common type of occurrence is vanadium contained in titaniferous magnetites. While the grade of the best deposits, at 0.6 per cent V_2O_5, is comparable to the grade of some deposits now being worked in other countries, it is only about one-third the grade of titaniferous magnetites being mined for vanadium in the Republic of South Africa. However, milling tests on material from the large titaniferous magnetite deposit at Lac Doré in Quebec yielded a magnetic concentrate containing about 1.4 per cent V_2O_5, which is almost comparable with ore grades at Highveld Steel and Vanadium Corporation Limited in South Africa. The non-magnetic fraction offers some potential as a titanium concentrate although recoveries would be low. Due to its large size, the deposit could support a scale of output of vanadium which would be limited only by market demand.

Vanadium associated with uranium ores in Canada is too low in grade to warrant economic recovery. There are a few known occurrences in Canada of vanadium minerals dispersed in beds of sandstone, limestone or shale. However, the grade is less than 0.3 per cent V_2O_5, which is less than one-third the grade of a primary vanadium deposit now being worked in the United States.

The most immediate prospect for commercial recovery of vanadium in Canada is the vanadium associated with the bitumen of the Alberta Tar Sands. The bitumen itself contains only 0.02 to 0.05 per cent V_2O_5. However, the fly ash generated when some of the bitumen throughput is burnt during processing, contains 4 to 5 per cent V_2O_5 after removal of the associated carbon. The Oil Sands Group division of Suncor Inc.'s operation produces an estimated 33 000 tpy of carbon-free fly ash would contain 4 to 5 per cent V_2O_5 or 1 500 tpy V_2O_5. Due to the different process employed at Syncrude Canada Ltd. (Syncrude), the grade of its approximately 50 000 tpy "carbon free" fly ash is only about 0.8 per cent V_2O_5. After carbon removal the residual 7 200 tpy of ash would contain about 5.4 per cent V_2O_5 for a potential recovery of less than 400 tpy of V_2O_5. In Syncrude's process, much of the vanadium

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reports in some 1 300 tpy of spent catalyst that contains about 20 per cent V_2O_5 or 260 tpy of V_2O_5.

The production of byproduct vanadium from tar sand would be limited by the scale of bitumen production, but exploitation would be facilitated by the existence of infrastructure, labour and energy in the vicinity of the tar sand operations.

For mineralogical reasons, fly ash is not amenable to efficient treatment by the Petrofina acid leaching process. Salt roast leaching and alkaline leaching treatments have recently been investigated but no details are available.

Presently, no vanadium pentoxide is being produced in Canada. However, Masterloy Products Limited (Masterloy) imports vanadium pentoxide for the production of ferrovanadium at its Ottawa plant, which has a capacity of approximately 1 400 tpy.

Masterloy supplies the major share of the Canadian demand for ferrovanadium in competition with imports which come mainly from the United States. Approximately one fifth to one third of its output of ferrovanadium is exported to the United States and elsewhere.

The principal consumers of ferrovanadium in Canada are: Stelco Inc.; The Algoma Steel Corporation, Limited; Dofasco Inc.; IPSCO Inc.; Atlas Steels division of Rio Algom Limited; and Sydney Steel Corporation. Apart from ferrovanadium, vanadium salts are used in substantial amounts in oxidation catalysts for the manufacture of sulphuric acid.

WORLD DEVELOPMENTS

The world consumption of vanadium, led by the United States, increased by about 12 per cent in 1984 from its depressed levels of 1983, and in 1985 was estimated to have risen by a further 2 to 3 per cent. The steel industry accounted for about 85 per cent of total consumption, with titanium alloys and catalysts comprising the remaining 15 per cent of the market. The overall growth in consumption was moderate, but strengthened by the relatively faster growth of the titanium industry.

Over the last three years, lower sales to the world market by the People's Republic of China, the cessation of production in Finland in 1985 and the reduction in primary vanadium production in the United States narrowed the gap between supply and demand, and caused inventories to be reduced.

In 1985, countries which depended on vanadium imports had to evaluate the possibility of supply disruptions from South Africa as a result of political pressures from outside and within that country. The possible sale of Umetco to South African interests further heightened this concern. However, observers have concluded that the South African government would not voluntarily restrict supplies of vanadium.

Republic of South Africa. The Republic of South Africa is the non-communist world's leading producer and exporter of vanadium. It supplied about 64 per cent of the vanadium pentoxide consumed in Canada and 44 per cent of that consumed in the United States in 1984. Three companies, Highveld Steel and Vanadium Corporation Limited (Highveld), Umetco Minerals Corporation (Umetco) and Transvaal Alloys (Pty) Limited mine vanadium-bearing ore in the Transvaal. Highveld and Umetco also produce ferrovanadium.

In 1985, East Rand Consolidated plc established a new company, Rhodium Reefs Ltd., to develop a mine in eastern Transvaal. The mine was to be on-stream by the end of 1985 but vanadium from it was not expected to reach the market for two years. The new operation will have a capacity of about 3 600 tpy V_2O_5, with ore reserves sufficient for 15-20 years. The decision to open the mine was largely based on the cessation of output from Finland.

United States. The United States consumed about 9 100 t of V_2O_5 in 1984, an increase of 33 per cent over 1983. The consumption increased further to 9 500 t in 1985. United States vanadium pentoxide production in 1984 was about 6 000 t.

However, the coproduction of vanadium from the uranium-vanadium carnotite ores of the Colorado plateau has suffered from the curtailment of uranium production due to the depressed state of the uranium industry and competition from high-grade uranium ores, notably in Canada. Some vanadium was produced as a byproduct of ferrophosphorus operations and about 900 t was produced in 1984 from the resumption of primary production by Umetco at the Hot Springs, Arkansas mine which has a capacity of about 6 800 tpy from vanadiferous micaceous clays.

Fly ash, petroleum residues and spent catalysts have been treated to an increasing extent for vanadium recovery. In 1984, production amounted to nearly 3 000 t V_2O_5, an increase of 86 per cent over 1983.

As a result of production shrinkage, the United States will probably become more dependent on supplies from South Africa and China, especially if demand recovers to the levels of the 1970s.

Finland. Rautaruukki Oy closed down production from its Otanmaki and Mustavaara mines, thereby removing about 5 400 t V_2O_5 from world supply.

Other Producing Countries. Norway, Japan and Australia produced about 5.5 per cent of the world supply during 1984, while sales from China declined from about 11 per cent to less than 3 per cent.

The latest estimates suggest that the U.S.S.R. now exceeds South Africa in production capacity and has become the world's largest producer. Most of its production is consumed internally and an additional amount is imported.

MINERALS, PRODUCTS, AND PROCESSES

Vanadium is found in most parts of the world, but rarely occurs as the sole component of economic interest. The principal economic minerals are:

Carnotite - $K_2O.2U_2O_3.V_2O_5.3H_2O$
Roscoelite - $2K_2O.2Al_2O_3(Mg,Fe)O.3V_2O_5.10SiO_2.4H_2O$
Descloizite - $4(Cu,Pb,Zn)O.V_2O_5.H_2O$
Titaniferous Magnetite - $FeO.TiO_2.FeO(Fe,V)O_3$ and V_2O_5 in solid solution
Phosphate Rock - $Ca_5(PO_4)_3$ (F,Cl,OH) with VO_4 replacing some PO_4 ions

Vanadium is sold in three basic forms: as an oxide concentrate, as technical grade vanadium pentoxide, and as fused vanadium pentoxide.

The extraction of vanadium from mineral sources invariably requires hydrometallurgical processing but some raw materials are given a prior pyrometallurgical treatment to yield an intermediate product amenable to leaching. Titaniferous magnetite is the predominant mineral. It accounts for essentially all of South African and Soviet production and is generally smelted to produce iron and a vanadium rich slag. The slag can then be leached to extract vanadium, which is normally recovered as vanadium pentoxide.

The phosphate ores of Idaho are also pre-treated pyrometallurgically. In this case the intermediate product is vanadium-bearing ferrophosphorus, which is then leached.

Other intermediate products are produced incidentally during the processing and burning of petroleum. These include vanadium-bearing fly ash, boiler residues, and refinery residues or coke. The vanadium from these are then recovered by a process incorporating hydrometallurgy.

Direct hydrometallurgical treatment is applied to some ores, including the vanadiferous clays of Arkansas and to fine fractions of titaniferous magnetite at Highveld which are directly treated at its Vantra plant. In previous years, lead vanadate ores at Kabwe, Zambia were acid leached. The uranium vanadium carnotite ores of Colorado were also directly leached with acid.

In the Highveld operation, titaniferous magnetite containing 1.5 to 1.8 per cent V_2O_5, from the open cast mine at Mapochs, is pre-reduced in kilns and then smelted electrically to produce slag containing about 25 per cent V_2O_5 and steel. Most of the slag is exported and treated elsewhere. At Highveld's Vantra division, titaniferous magnetite fines are partially concentrated by magnetic separation and then mixed and roasted with sodium sulphate and/or sodium carbonate. The sodium vanadate so formed is leached with water. A precipitate of ammonium metavanadate (AMV) is obtained by adding an excess of ammonium chloride to the sodium vanadate solution. The AMV is heated to remove the ammonia, leaving vanadium pentoxide which is melted and solidified into flakes of oxide. Ammonia from the AMV and from evaporation of the barren solution, is recycled.

Commercially pure vanadium pentoxide forms the basic raw material for much of the production of ferrovanadium and other alloying agents. A reduction of the oxides of vanadium and iron by aluminum powder, enables the production of ferrovanadium containing 80 per cent vanadium with low carbon content. Hydrocarbon or carbon reduction of vanadium pentoxide is used to produce the proprietary alloys Carvan, ferrovanadium carbide and Nitrovan, which each contain about 10 per cent carbon with vanadium contents from 70 to 86 per cent depending on the particular product. Ferrosilicon is also used as a reductant in the production of Ferovan which contains about 42 per cent vanadium, 7 per cent silicon and 4.5 per cent manganese. Vanadiferous slag can be reduced directly to produce ferrovanadium containing 25 to 50 per cent vanadium.

In 1984, Umetco announced the availability of an additional product called Vanox, which is essentially vanadium trioxide produced by partial reduction of vanadium pentoxide. This product can be added directly to an argon oxidation decarburization (AOD) steelmaking vessel. Its high melting point enables it to become dispersed in the steel melt where the particles become reduced within two minutes.

Vanadium aluminum master alloys are produced by aluminothermic reduction of vanadium pentoxide, and are used in the production of nonferrous alloys.

USES

The steel industry accounts for about 85 per cent of total vanadium consumption as an alloying agent in various grades of steel. Vanadium is also an essential alloying element in titanium alloys and it is a major component of catalysts in sulphuric acid production. Base-metal alloys consume about 9 per cent, chemicals catalysts and ceramics about 3 per cent and cast irons 1 per cent of all vanadium consumed.

Additions to steel are made in the form of ferrovanadium or one of the proprietary alloys containing iron and vanadium. Improvements to the strength, hardness and wear resistance of steels are due to vanadium's chemical and crystallographic behaviour which produces several effects. Vanadium forms carbides and nitrides within the iron matrix which limit grain growth and the resulting grain refinement increases the toughness and strength of the steel. Vanadium also stabilizes the ferrite phase and suppresses the formation of bainite and pearlite structures within the steel, thereby improving hardenability and weldability.

The most widespread usage of vanadium occurs in high-strength-low-alloy (HSLA) steels and full alloy steels, accounting for about 35 per cent and 25 per cent, respectively, of the total vanadium used in ferrous alloys. HSLA steels have replaced carbon steels in many instances where the higher intrinsic strength of the steel permits a lower design weight, which can offset the somewhat higher per-unit-weight cost. The lighter weight also results in savings in transportation costs, and further cost savings are obtained through improved weldability. The major uses of HSLA steels are in pipelines, concrete reinforcing bars, structural shapes and automobile components.

Vanadium is used in HSLA steels in combination with other alloying elements, including niobium and molybdenum. The ratios of these elements can be varied to some degree without adverse effects and this is sometimes done to accommodate price changes or the availability of respective elements. The percentage contents of niobium and vanadium are low, ranging between 0.03 per cent and 0.08 per cent and these two metals are largely interchangeable. Molybdenum can vary between 0.15 and 0.3 per cent, chromium 0.15 to 0.25 per cent and nickel 0.0 to 0.35 per cent. Vanadium is essential in Arctic pipelines where it imparts toughness at cold temperatures making the steel less prone to cold embrittlement. Large quantities of vanadium-bearing HSLA steels have been manufactured and used in the United States, West Germany and the United Kingdom for petroleum products and natural gas pipelines. Vanadium has also been used in pipeline steels designed to operate in extreme environments, such as the Arctic.

In recent years, yield-strength requirements for concrete reinforcing bars have risen and this trend is expected to continue in the future. While these higher yield strengths can be achieved with the addition of more carbon and manganese, the two traditional steelmaking additives, the resulting loss in weldability makes this practice undesirable. HSLA steels are finding increased application in structures such as bridges, elevated roadways, and in transportation equipment such as rail cars and automobiles.

The earliest use of vanadium in steel was as an addition to tool steels, used for high-speed machining. Vanadium inhibits grain growth and enables the steels to maintain their hardness and therefore their cutting edge at the high temperatures generated in the tool tip from high-speed machining. This remains an important application for the metal. Vanadium at concentrations of 1 to 5 per cent, is used in both the high-tungsten tool steels that were first developed and in the later generation of molybdenum-tungsten tool steels.

Vanadium is also used in making high-temperature steels such as those employed in steam power plants for steam pipes and headers. Other areas where vanadium is used in the iron and steel industry include: heavy iron and steel castings; forged parts, such as crankshafts; automobile parts, such as gears and axles; springs, ball bearings, hammers and dies. Vanadium is also used in iron-base superalloys employed in jet engines and turbine blades where high-temperature strength is essential.

The most commonly used titanium alloy for applications utilizing titanium's high strength is an alpha beta alloy containing 6 per cent aluminum and 4 per cent vanadium. Beta grade alloys contain 7.5 to 8.5 per cent vanadium. Commercially pure titanium that is used primarily in industrial applications requiring high corrosion resistance but not necessarily high strength, contains no vanadium. Aerospace presently provides the major market for fabricated, forged and cast titanium alloys and there is essentially no substitute for vanadium as a strengthening element in these alloys.

Vanadium is added to copper-base alloys to control gas content and refine the microstructure, and a small amount is added to aluminum alloys for internal combustion engine pistons to improve high-temperature operating properties.

A potential use for high vanadium alloys is as a cladding material in fast-breeder nuclear reactors. Vanadium has a low neutron capture cross-section (i.e., permits relatively free movement of neutrons within the reactor core), good resistance to corrosion by liquid sodium (the reactor coolant), and good high-temperature operating properties.

Vanadium is used in making vanadium carbide, employed as coatings in the manufacture of both hand and machine tools, and in the production of various chemical salts. Compounds of vanadium are used in the chemical industry as a catalyst in the production of sulphuric acids and the cracking of petroleum products. Other uses in the chemical industry include pigments in glass and ceramics, driers in paints and varnishes, and in the processing of colour film.

PRICES

Market prices of vanadium products were influenced by fluctuations in the availability of material from China in 1984. Spot prices increased from \$2.05-\$2.15 per lb V_2O_5 in January 1984, to \$2.50-\$2.60 per lb in July, and then receded to \$2.25-\$2.30 per lb at year-end with the resumption of Chinese sales. Ferrovanadium prices also weakened under the pressure of competition from European converters. The same market forces affected selling prices in 1985: the price of vanadium pentoxide over the first six months of 1985 was about 12 per cent higher than the average for 1984 while the price of ferrovanadium during the first 10 months of 1985 was about 10 per cent higher than the 1984 average.

Whenever the markets were weaker, Highveld was reported to have offered discounts to the quoted price, which reached \$1.40 per lb for vanadium pentoxide. Highveld estimated that a stable market for producers and consumers could be achieved if the world industry operated at about 80 per cent capacity utilization.

OUTLOOK

Vanadium consumption in steel in 1986 is expected to remain at about the same level as in 1985, or slightly higher due to marginally more demand for HSLA steels. Titanium consumption is expected to be somewhat firmer than 1985, which would add to the demand for vanadium. Vanadium catalyst consumption will depend to some extent on the possible addition of new sulphuric acid plants that would be constructed largely for environmental purposes.

The long-term growth of vanadium demand is estimated to be about 2 per cent per year in the United States and about 3 per cent per year in the rest of the non-communist world.

Supply could be adversely affected by political forces affecting South Africa, although it has been reported that the government there would not willingly curtail exports because of its priority for export earnings.

PRICES

United States vanadium prices published in "Metals Week".

	December 1982	December 1983	December 1984	December 1985
		($US)		
Vanadium pentoxide, per pound of V_2O_5, fob mine or mill				
Chemical	4.10 - 4.94	4.10 - 4.94	4.10 - 4.94	4.10 - 4.94
Metallurgical	3.35 - 3.65	3.35 - 3.65	3.35 - 3.65	3.35 - 3.65
Ferrovanadium, per pound of V packed, fob shipping point				
U.S. Producer, 80% V	8.50	6.00	6.50	5.00
Caravan	7.36	5.50	6.00	5.00
Ferovan	7.50	5.50	6.25	5.00

fob Free on board.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
32900-1	Vanadium ores and concentrates	free	free	free	free
35101-1	Vanadium metal, not including alloys	free	4.3	25	free
37506-1	Ferrovanadium	free	4.3	5	free
37520-1	Vanadium oxide	free	free	5	free

MFN Reductions under GATT (effective January 1 of year given)	1985	1986	1987
		(%)	
35101-1	4.3	4.1	4.0
37506-1	4.3	4.2	4.0

UNITED STATES (MFN)

422.60	Vanadium pentoxide (anhydride)	16
422.62	Other vanadium compounds	16
427.22	Vanadium salts	9.6
601.60	Vanadium ores	free

		1985	1986	1987
			(%)	
422.58	Vanadium carbide	4.7	4.4	4.2
606.50	Ferrovanadium	4.8	4.5	4.2
632.58	Vanadium metal, unwrought, waste and scrap	4.0	3.9	3.7
632.68	Vanadium alloys, unwrought	4.1	3.6	3.0
633.00	Vanadium metal, wrought	6.4	5.9	5.5

Sources: The Customs Tariff 1985, Revenue Canada, Customs & Excise; Tariff Schedules of the United States Annotated (1985), USITC Publication 1610; U.S. Federal Register, Vol. 44, No. 241.

TABLE 1. CANADA, VANADIUM IMPORTS AND EXPORTS, 1982-85

	1982	1983	1984	1985[1]
	(tonnes)			
Imports				
Vanadium oxides				
United Kingdom	7	2	6	-
Belgium/Luxembourg	-	-	302	-
Finland	324	1 036	360	198
West Germany	-	-	3	-
South Africa	659	454	1 231	201
United States	51	64	9	-
Brazil	-	-	-	2
China, People's Republic	-	-	-	16
Total	1 041	1 556	1 911	417
				1985[2]
Ferrovanadium				
Austria	-	17	17	-
Belgium/Luxembourg	44	32	-	-
South Africa	16	-	-	-
United States	181	123	228	155
Total	241	172	245	155
Exports				
Ferrovanadium				
United States	226	473	516	-

Source: Statistics Canada; USBM Import Statistics.
[1] January-June 1985 Vanadium Oxides Imports. [2] January-October 1985 Ferrovanadium Imports.

TABLE 2. CANADA, VANADIUM CONSUMPTION, 1981-84

	1981		1982		1983		1984	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Consumption								
Ferrovanadium								
Gross weight	674	..	551	..	447	..	754	..
Vanadium content	543	..	447	..	200	..	589	..

.. Not available.

TABLE 3. WORLD, VANADIUM OXIDE PRODUCTION CAPACITY, 1983-84 AND 1990

	1983	1984	1990
		(tonnes contained V)	
Primary capacity[1] (from ores, concentrates and slags)			
United States	9 000	9 000	10 300
Chile	1 100	1 100	1 100
Finland	3 800	3 800	-
South Africa (RSA)	17 200	17 200	27 000
Australia	900	900	3 000
New Zealand	-	-	2 300
China, People's Republic (PRC)	6 000	6 500	8 000
U.S.S.R.	18 000	21 000	28 000
Total	57 500	61 000	81 200
Secondary capacity[2] (from petroleum ash, residues, spent catalysts)			
United States	6 400	6 800	10 000
Canada	-	-	1 500
Japan	1 100	1 100	1 500
Total	7 500	7 900	13 000

Source: USBM Mineral Facts and Problems No. 675, 1985 edition.
[1] Production credited to country of origin of vanadiferous material. [2] Production credited to country where vanadium is extracted.
- Nil.

TABLE 4. ESTIMATED NON-COMMUNIST WORLD CONSUMPTION AND PRODUCTION OF V_2O_5 EQUIVALENT, 1981-85

	1981	1982	1983	1984	1985
			(tonnes)		
Consumption					
Western Europe	15 500	13 700	12 700	13 600	13 600
United States	13 500	6 800	6 800	9 100	9 500
Japan	6 500	6 500	5 000	5 900	5 900
Eastern Europe	4 600	3 900	3 600	3 600	4 100
Other countries	4 400	3 900	5 400	5 400	5 400
Total	44 500	34 800	33 500	37 600	38 500
Production					
South Africa	21 000	19 500	14 500	20 400	..
United States	13 900	10 100	3 600	6 000	..
Finland	5 200	4 800	5 000	4 500	..
China, People's Republic	4 500	4 500	4 500	900	..
Other countries[1]	1 800	1 200	900	1 800	..
Total	46 400	40 100	28 500	33 600	34 600[e]

Sources: Umetco minerals data in EMJ March 1985.
[1] Other countries includes Norway, Japan, Australia and Venezuela.
[e] Estimate; .. Not available.

Zinc

M.J. GAUVIN

The world economy grew at a much slower rate in 1985, than 1984, and this resulted in a decrease in zinc consumption to an estimated 4.6 million t from 4.7 million t in 1984. Metal production increased to 4.94 million t from 4.88 million t resulting in increased inventories. Prices fell during the year, and producers were forced to re-evaluate their production decisions. During the latter half of the year some production cutbacks were made and further cutbacks were announced for 1986.

The outlook for the next year or two is for a continuation of oversupply and depressed prices.

CANADIAN DEVELOPMENTS

Canadian zinc mine production in 1985 is estimated at 1 197 000 t compared to 1 207 098 t produced in 1984.

Newfoundland Zinc Mines Limited, at Daniel's Harbour, Newfoundland - the only remaining zinc producer in the province - continued the development and mining of its new T zone. Brunswick Mining and Smelting Corporation Limited experienced near normal production at its No. 12 mine near Bathurst, New Brunswick. However, in the last quarter of the year, in response to severely depressed markets for zinc, the company announced a two-week shutdown of all operations for late December. Further production cuts will also be taken in 1986. Heath Steele Mines Limited and ASARCO Incorporated have closed indefinitely their Little River Joint Venture located near Newcastle, New Brunswick. Underground production has been suspended since May 1983. Rio Algom Limited brought its tin mine near East Kemptville, Nova Scotia into production late in the year. The mine will also produce a zinc concentrate containing some 2 000 t of zinc.

In Quebec, exploration work by Noranda Inc. adjacent to its Mattagami Lake mine, resulted in the discovery of significant base-metal mineralization which could extend the life of the Mattagami mine. BP Canada Inc. has started work to bring the Al-Zone of Les Mines Selbaie near Joutel into production in late 1986 at a cost of $125 million. Mill capacity will be increased to 6 500 tpd and annual production of zinc from the new open-pit mine is expected to be 30 000 t of zinc in concentrates. Abcourt Mines Inc. brought its zinc-silver, Vendome mine near Barraute, Quebec into production with an annual capacity of 12 000 t of zinc in concentrates. The ore is processed at the Matagami mill of Noranda Inc.

At Kidd Creek Mines Ltd.'s, Timmins, Ontario operation, improved grade control and further mechanization contributed to increased production. Kidd Creek plans substantial zinc mine production cutbacks for 1986. Also, Cominco Ltd. and Noranda Inc. cut mine and metal production about 10 per cent during the second half of 1985 and announced further cutbacks for all of 1986.

In early November, Corporation Falconbridge Copper put on hold the development of its Winston Lake zinc deposit in northern Ontario, after announcing in September that it would spend $52.5 million to bring the deposit into production by late 1986. Annual production had been planned at 50 000 t of zinc in concentrates. Ore reserves at the property are estimated at 2.2 million t grading 18 per cent zinc, 1.1 per cent copper and significant precious metal values. Production at Mattabi Mines Limited, which is 60 per cent owned by Noranda Inc., and at the Lynn Lake division of Noranda was halted by a strike that lasted more than two months. Sherritt Gordon Mines Limited permanently closed its Fox mine in Manitoba because of exhaustion of ore reserves.

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In British Columbia, Westmin Resources Limited completed the development of its new H-W orebody and construction of its new 2 700 tpd concentrator. Capacity has been increased by 30 000 tpy of zinc in concentrates.

Dome Petroleum Limited has agreed to sell Cyprus Anvil Mining Corporation to Curragh Resources Corporation for an undisclosed sum. Cyprus closed its Faro, Yukon mine in June 1982 because of heavy cash losses. Curragh feels that it can turn the mine into a viable operation and expects to start production in the near future.

Refined zinc production in Canada - estimated at 690 000 t - is at an all-time high, up somewhat from the 683 156 t produced in 1984. Kidd Creek Mines is in the process of increasing its capacity from 127 000 tpy to 133 000 tpy. This is expected to be in operation in early 1986.

WORLD DEVELOPMENTS

Mining

Non-socialist world zinc mine production in 1985 is estimated at 5.19 million t, a 1.5 per cent increase from the 5.11 million t produced in 1984. The small increase in production was accounted for mainly by higher output in Australia which more than offset small decreases in Canada and the United States. During 1985, eleven zinc mines were opened or expanded which increased capacity by 139 000 t. Most of the increase was accounted for by mines in Australia, Spain and Canada. Three mine closures were reported, the largest being the Teutonic Bore mine in Australia.

Mine production in the United States fell by some 30 000 t during 1985 mainly as the result of labour disputes at mines of St. Joe Resources Company at Balmat and Pierrepont, New York. Cominco American Incorporated, in partnership with the Nana Regional Corp. (an Alaskan native company), is planning the development of the Red Dog mine in Alaska. Located some 100 km from the Chukchi Sea, ore reserves are estimated at 85 million t with grades of 17.1 per cent zinc, 5.0 per cent lead and 82 g/t of silver. It will be operated and financed by Cominco, but after the investment is recovered the partners will eventually share proceeds on a 50:50 basis. The Alaskan Legislature has passed a bill for the Alaska Industrial Development Authority to issue bonds up to $175 million for construction of a road and port for the project. At the earliest, the Red Dog mine could begin operating in 1989. Also in Alaska, Noranda is continuing exploration of its zinc-lead-silver-gold, Green's Creek deposit on Admiralty Island in the Alexander Archipelago of Alaska's panhandle. Production may start near the end of the decade. ASARCO Incorporated completed development and began production at its West Fork, Missouri, mine during the year. Capacity of the new mine is 7 000 tpy of zinc in concentrates and 46 000 tpy of lead.

Mexico increased its zinc production to an estimated 31 300 t in 1985. Industrial Mineral Mexico S.A. continued with an expansion of its Charcas mine which will result in capacity increased from 1 500 tpy to 3 300 tpy of zinc in concentrates. In Peru, two new mines with a total capacity of 18 000 tpy of zinc started production during 1985, while expansions at three other mines will see their zinc mine capacity increase by 29 000 tpy during 1986.

Bula Ltd. continued development of its Navan, Ireland zinc-lead deposit. The company plans to bring the mine into production in 1987 with capacity of 55 000 tpy of zinc in concentrates. In Italy, SAMIM S.p.A. is in the process of expanding its Monteponi lead-zinc mine which will increase the mine's zinc capacity by 42 000 t in early 1986. Asturiana de Zinc S.A. has completed the expansion of its Reocin, Spain, lead-zinc mine and increased its zinc capacity by 20 000 t to 70 000 tpy.

The main developments in Australia were the opening of two mines and the closing of one large mine. The Woodcutters open-pit mine in Northern Territory opened in late 1985 with a capacity of 2 300 tpy zinc, and EZ Industries Ltd. re-opened its 13 000 tpy Beltana zinc-lead open-pit mine which had been closed since 1975. The 30 000 tpy Teutonic Bore mine in Western Australia ceased production in late 1985. Australian zinc mine production increased some 85 000 t in 1985 to 720 000 t from the strike-plagued 1984 level. Exploration and development work are proceeding on several large zinc-lead deposits which could lead to decisions to bring them into production by the end of the decade. Hindustan Zinc Ltd. is considering bringing the large Rampura-Agucha zinc deposit into production with a capacity of 70 000 tpy of zinc in concentrates. With this additional mine tonnage and new smelter capacity, India will become almost self-sufficient in zinc by 1990.

Smelting and Refining

Non-socialist world zinc metal production was estimated at 4.94 million t in 1985 up marginally from the 4.88 million t produced in 1984. Output from new capacity in Thailand and higher production in Canada and Europe offset declines in Japan and the United States. During the second half of the year smelters in Canada, Japan and the United States announced production cutbacks because of sagging zinc markets.

In March, ASARCO Incorporated, indefinitely closed its 104 000 tpy smelter and refinery at Corpus Christi, Texas due to the unfavourable conditions created by excess world smelting capacity. The plant had been closed from October, 1982 to February 1984. After the re-opening it had operated at about one half the plant's capacity.

In Italy, SAMIM S.p.A. completed the construction of its new 83 000 tpy electrolytic plant at Porto Vesme, Sardinia. Norzink A/S is in the process of increasing by 20 000 t the capacity of its Odda, Norway plant. The expansion is expected to be completed in 1986. In Yugoslavia, Trepca S.O.U.R. at year-end added 40 000 t capacity to its Kosovska Mitrovica electrolytic plant. Asturienne-France SA will increase the capacity of its Auby, France electrolytic plant by 100 000 t to 200 000 tpy in 1988, but this will be balanced by the closure of its 110 000 tpy plant at Viviez, France.

The Sulphide Corporation Pty. Limited completed a 5 000 t expansion of its I.S.F. plant at Cockle Creek, Australia. Young Poong Mining Co., Ltd. added 16 000 t capacity to its electrolytic plant in the Republic of Korea. Korea Zinc Co. Ltd. is in the process of more than doubling its Onsan electrolytic plant from 70 000 t to 150 000 tpy. In India, Cominco Binani Zinc Limited is building a new 20 000 tpy electrolytic plant for completion in 1987, to replace its existing 14 000 t plant.

The purchase of zinc concentrates and metal by socialist countries continues to be an important factor in zinc. In recent years, large purchases by the People's Republic of China have proven to be the balancing factor in the slab zinc market. However Chinese purchases in 1985 dropped off in the second quarter as China curbed its imports. China has announced plans to double its metal output in the next five years and expects to be a net exporter of zinc in the 1990s.

CONSUMPTION

World zinc metal consumption in 1985 was estimated at 4.6 million t down 2.2 per cent from the 4.72 million t consumed in 1984. Peak consumption in the non-socialist world was 4.88 million t in 1973.

PRICES

At the beginning of 1985, the price of high grade zinc was 45 cents (U.S.) in the United States and 59 cents (Cdn.) in Canada, while the European Producer Price (EPP) was $US 900 a t. Prices declined in January, then increased to the year's high in March of 47 cents for the U.S. producer price and 64 cents in Canada. The E.P.P. reached its year's high of $US 960 in early April. Afterwards there was a steady decline in prices until, in November, the E.P.P. was a $670 a t, the U.S. producer price for high-grade zinc was 35 cents a pound and the price in Canada was 48 cents a pound. In late December the E.P.P. was raised to $US 700 a t.

USES

Zinc is a widely used metal and its uses are based upon its low melting point which facilitates shaping by casting; its high electrochemical activity which provides cathodic corrosion and contact protection (galvanizing) for iron and steel products; and its ability to alloy readily with copper to make brass. About 40 per cent of zinc is used in galvanizing. Galvanized products such as main structural components, roofing, siding and reinforcing bars are used in construction. Brass and bronze, as used in products such as plumbing fittings and the heating industry, account for about 20 per cent of zinc consumption. Some 15 per cent of zinc consumption is in the diecasting industry for products such as builders' hardware and fittings on automobiles. The balance is used for such items as zinc semi-manufactures, chemicals and dust.

The average car currently manufactured in North America contains about 10.5 kg of zinc. The strong demand for a better rust-resistant automobile and concerns by automobile manufacturers about perforation warranties, will increase the amount of zinc in galvanized coating alone to as much as 6.8 kilos per car. The automakers will use galvanized sheet on all outer body parts except the roof. Also, it is expected that within the decade, all those parts will be made from two-sided electro-galvanized. Some estimates indicate that increased use of zinc in this application will reach 150 000 t by 1990. Zinc has also started to win back some applications in automobiles that had been lost to plastic.

The new Surface Transportation Assistance Act came into effect in the United States in April 1983. The law increases the federal taxes on gasoline sold in the United States to fund the revitalization of U.S. highways and mass transit systems. It has been estimated that up to $1 billion would be funnelled into the hot-dip galvanizing sector for bridge framework and guardrails. Galvanizers report they are now seeing the first effect of this legislation.

The first copper-plated zinc penny was struck by the U.S. Mint in November 1981 and placed in circulation in January 1982. The penny blanks are made of an alloy containing 99.2 per cent SHG zinc and 0.8 per cent copper; the total penny including plating is 97.6 per cent zinc and 2.4 per cent copper. This new usage for zinc now consumes about 40 000 tpy of zinc. Other countries are considering converting to this form of coinage. The regular tenders conducted by the Mint are looked upon by many merchants and producers as a barometer of the zinc market.

Galfan, a new and improved galvanizing alloy developed by the International Lead Zinc Research Organization Inc. (ILZRO) was first used commercially in 1983 in Japan. The alloy contains about 95 per cent zinc, 5 per cent aluminum and a small but significant amount of rare earth metals. The new alloy outperforms conventional galvanizing and Galvalume in corrosion resistance and several other characteristics. Another advantage is that only minor modifications are necessary to adapt existing galvanizing lines compared with the major cost of converting a line for Galvalume. Galvalume, a 55 per cent aluminum, 43.4 per cent zinc and 1.6 per cent silicon alloy, developed by Bethlehem Steel Corporation was introduced to the U.S. market in 1976 and is being used in specialized applications.

These alloys are complementary to galvanizing and increase the potential market for zinc.

OUTLOOK

Overcapacity and overproduction continue to plague the industry. Prices dropped substantially in 1985 and by year-end were at levels such that few producers were able to record a profit, yet discounting from the current low prices continued. As the industry becomes more disciplined, the market may return to a close balance between supply and demand and prices will return closer to historical levels. The current slow recovery in world economic activity will lengthen the period that will be required to work off overcapacity in all sectors of the industry. It is estimated this will require at least five years.

Zinc consumption in the western world is projected to grow at 1.6 per cent per annum to the end of the century which is much lower than historical growth rates. The overall factors underlying this relatively low forecast growth are the maturing of zinc markets in industrialized countries and the expected slowdown in world economic growth.

Canadian mine production is expected to drop some 5 per cent during 1986, but the actual amount of the reduction will depend on when and at what rate the Faro deposit of Cyprus Anvil is brought back into production. Canadian metal production is expected to be a little lower than that of 1985. Meanwhile, industry must continue to reduce costs and maintain a low level of inventories.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(% unless otherwise specified)		
CANADA					
32900-1	Zinc in ores and concentrates	free	free	free	free
34500-1	Zinc dross and zinc scrap for remelting, or for processing into zinc dust	free	free	10	free
34505-1	Zinc spelter, zinc and zinc alloys containing not more than 10% by weight of other metal or metals, in the form of pigs, slabs, blocks, dust or granules	free	free	2¢/lb	free
35800-1	Zinc anodes	free	free	10	free
UNITED STATES (MFN)					
626.04	Zinc, unwrought, alloyed		19.0%		

		1985	1986	1987
		(% unless otherwise specified)		
602.20	Zinc in ores and concentrates	0.39¢/lb	0.35¢/lb	0.30¢/lb
626.02	Zinc, unwrought, unalloyed	1.6	1.6	1.5
626.10	Zinc, waste and scrap (duty temporarily suspended)	2.9	2.5	2.1

EUROPEAN ECONOMIC COMMUNITY (MFN)

		1985	Base Rate	Concession Rate
			(% unless otherwise specified)	
26.01	Zinc, ores and concentrates	free	free	free
79.01	Zinc, unwrought	3.5	3.5	3.5
	Zinc, waste and scrap	free	free	free

JAPAN (MFN)

		1985	Base Rate	Concession Rate
			(% unless otherwise specified)	
26.01	Zinc, ores and concentrates	free	free	free
79.01	Zinc, unwrought, unalloyed	2.2	2.5	2.1
	Zinc, unwrought, alloyed	7.2 yen/kg	10 yen/kg	7 yen/kg
	Zinc, waste and scrap	1.9	2.5	1.9

Sources: The Customs Tariff, 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated 1985, USITC Publication 1610; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, Vol. 27, No. L 320, 1985; Customs Tariff Schedules of Japan, 1985.

TABLE 1. CANADA, ZINC PRODUCTION AND TRADE, 1983-85 AND CONSUMPTION 1983-84

	1983		1984		1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production						
All forms[1]						
Ontario	288 528	331,605	303 425	426,920	269 497	341,722
New Brunswick	225 054	258,655	232 792	327,539	230 974	292,874
Northwest Territories	234 883	269,951	274 920	386,813	269 655	341,923
British Columbia	95 289	109,516	95 508	134,379	106 815	135,441
Manitoba	49 007	56,324	48 854	68,737	63 372	80,356
Quebec	53 688	61,703	58 249	81,968	64 330	81,571
Newfoundland	35 358	40,637	42 620	59,967	29 686	37,642
Saskatchewan	5 879	6,757	6 160	8,666	4 143	5,253
Yukon	27	31	173	244	32	41
Total	987 713	1,135,179	1 062 701	1,495,233	1 038 504	1,316,823
Mine output[2]	1 069 709	..	1 207 098		1 197 000	
Refined[3]	617 033	..	683 156		690 000	
					(Jan.-Sept. 1985)	
Exports						
Zinc blocks, pigs and slabs						
United States	309 490	328,684	331 120	443,520	273 360	341,625
People's Republic of China	54 244	45,255	44 785	47,738	27 312	28,923
United Kingdom	25 697	23,454	39 466	47,127	32 090	35,775
Taiwan	16 231	13,791	12 918	14,680	8 613	9,631
West Germany	6 197	5,751	9 125	10,735	4 509	5,269
New Zealand	5 560	4,960	8 863	10,208	4 319	4,527
Philippines	9 396	7,760	5 306	5,904	2 586	2,876
Thailand	4 804	4,267	7 708	9,457	2 953	3,386
India	2 589	2,254	7 681	9,192	9 644	11,083
Hong Kong	8 486	7,404	7 589	9,319	5 070	6,220
Indonesia	6 422	5,393	5 701	6,818	4 725	5,428
Italy	5 059	4,301	7 202	7,334	2 963	3,103
Japan	2 800	2,413	5 692	6,253	6 024	6,984
Singapore	6 092	5,096	4 661	5,105	836	957
Other countries	47 574	41,709	31 842	35,030	31 082	32,554
Total	500 448	493,558	529 659	668,420	420 086	498,341
Zinc contained in ores and concentrates						
Belgium-Luxembourg	344 672	139,853	306 285	149,564	91 404	54,014
Japan	47 817	21,403	63 432	35,116	13 472	8,695
Netherlands	8 299	4,652	39 400	11,073	-	-
West Germany	79 084	29,506	30 022	12,451	16 884	8,407
United States	8 939	6,639	28 373	20,148	27 244	17,009
France	30 191	14,934	27 772	17,916	17 950	11,145
United Kingdom	17 600	8,497	16 816	9,217	16 328	8,193
Italy	23 355	15,190	8 061	4,577	15 519	8,051
Algeria	5 768	5,001	3 528	2,587	3 322	2,348
Spain	-	-	3 495	2,906	-	-
Bulgaria	3 413	1,907	3 305	2,490	-	-
Other countries	56 980	23,855	9 144	5,373	6 280	3,529
Total	626 178	271,437	539 633	273,418	208 403	121,391
Zinc alloy scrap, dross and ash[4]						
United States	12 541	6,003	8 699	6,689	5 366	3,951
West Germany	1 610	310	7 027	3,133	4 826	2,225
United Kingdom	2 549	858	1 322	503	391	200
Italy	-	-	624	563	36	34
Belgium-Luxembourg	194	85	374	269	125	77
Japan	392	204	239	157	303	156
Other countries	643	273	1 180	944	1 261	889
Total	17 929	7,733	19 465	12,258	12 308	7,532
Zinc dust and granules						
United States	4 090	4,602	3 258	5,115	3 225	4,929
Venezuela	-	-	62	119	114	204
West Germany	-	-	92	47	93	62
United Kingdom	128	90	16	8	56	26
Other countries	197	327	104	127	155	214
Total	4 415	5,019	3 532	5,416	3 743	5,435

TABLE 1. (cont'd.)

	1983		1984		1985P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Zinc fabricated material, nes						
United States	1 726	3,734	992	3,079	1 088	3,188
United Kingdom	3	18	19	73	8	26
Other countries	262	285	136	546	26	46
Total	1 991	4,037	1 147	3,698	1 122	3,260
Imports					(Jan.-Sept. 1985)	
In ores, concentrates and scrap	78 325	37,645	41 867	26,482	12 486	6,922
Dust and granules	445	669	845	1,485	649	1,161
Slabs, blocks, pigs and anodes	9 964	10,845	6 757	8,850	995	1,219
Bars, rods, plates, strip and sheet	575	1,226	386	1,057	360	999
Slugs, discs and shells	58	48	21	18	-	-
Zinc oxide	1 257	1,313	1 350	1,479	976	1,084
Zinc sulphate	1 688	771	2 296	1,199	1 218	727
Zinc fabricated materials, nes	859	2,139	682	2,147	369	1,363
Total	93 171	54,656	54 204	42,717	17 053	7,175

	1983			1984		
	Primary	Secondary	Total	Primary	Secondary	Total
	(tonnes)					
Consumption[5]						
Zinc used for, or in the manufacture of:						
Copper alloys (brass, bronze, etc.)	9 467)			13 118)		
Galvanizing: electro	2 289)	1 054	75 405	2 888)	1 094	109 157
hot dip	62 595)			92 057)		
Zinc die-cast alloy	15 102	X	X	15 292	X	X
Other products (including rolled and ribbon zinc, zinc oxide)	22 804	X	X	24 072		
Total	112 257	4 000	116 257	147 427	3 101	150 528
Consumer stocks, year-end	14 255	416	14 671	17 959	360	18 319

Sources: Energy, Mines and Resources Canada; 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. [4] Gross weight. [5] Consumer survey does not represent 100 per cent of Canadian consumption and is therefore consistently less than apparent consumption.
P Preliminary; r Revised; - Nil; .. Not available; nes Not elsewhere specified; X Confidential.

TABLE 2. CANADA, ZINC MINE OUTPUT, 1983-85

	1983	1984	Jan.-Sept. 1985P
		(tonnes)	
Newfoundland	40 905	47 604	29 299
New Brunswick	258 731	258 049	190 643
Quebec	52 061	58 199	54 347
Ontario	317 438	337 799	220 993
Manitoba-Saskatchewan	58 816	60 927	56 864
British Columbia	83 730	107 150	81 603
Northwest Territories	258 028	337 370	266 278
Total	1 069 709	1 207 098	900 027

P Preliminary.

TABLE 3. CANADA, ZINC PRODUCTION, EXPORTS AND DOMESTIC SHIPMENTS, 1970, 1975, 1980-85

	Production		Exports		
	All Forms[1]	Refined[2]	In Ores and Concentrates	Refined	Total
			(tonnes)		
1970	1 135 714	417 906	809 248	318 834	1 128 082
1975	1 055 151	426 902	705 088	247 474	952 562
1980	883 697	591 565	434 178	471 949	906 127
1981	911 178	618 650	516 210	453 526	969 736
1982	965 607	511 870	457 751	470 390	928 141
1983	987 713	617 033	626 178	500 448	1126 626
1984	1 062 701	683 156	539 633	529 659	1 069 292
1985P	1 038 504	690 000	..	..	..

Sources: Energy, Mines and Resources Canada; 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.
P Preliminary; .. Not available.

TABLE 4. WESTERN WORLD, PRIMARY ZINC STATISTICS, 1982-85

	1982	1983	1984	1985e
		(000 tonnes)		
Mine Production (Zinc Content)	4 804	4 793	5 110	5 190
Metal Production	4 318	4 643	4 879	4 940
Metal Consumption	4 240	4 583	4 721	4 610

Source: International Lead and Zinc Study Group.
e Estimated by Energy, Mines and Resources Canada.

TABLE 5. CANADA, ZINC-BEARING DEPOSITS CONSIDERED MOST PROMISING FOR FUTURE PRODUCTION

Company and Province	Deposit Name	Indicated Tonnage (000 tonnes)	Per Cent Zinc	Zinc Content (000 tonnes)
New Brunswick				
Billiton Canada Ltd. and Gowganda Resources Inc.	Restigouche	2 900	6.55	190.0
Caribou-Chaleur Bay Mines Ltd.	Caribou	44 800	4.48	2 007.0
Cominco Ltd.	Stratmat 61	2 040	6.29	128.3
Key Anacon Mines Limited	Middle Landing	1 690	7.43	125.6
Kidd Creek Mines Ltd. and Bay Copper Mines Limited	Halfmile Lake	10 160	7.51	763.0
		61 590	5.22	3 213.9
Quebec				
Noranda Inc.	Magusi	2 130	3.55	75.9
Noranda Inc.	La Gauchetière	1 709	4.50	76.9
Phelps Dodge Corporation BP Canada Inc.	A-2 Zone	5 000	1.33	66.5
		8 839	2.48	219.3
Ontario				
Corporation Falconbridge Copper	Winston Lake	2 950	17.8	525.1
British Columbia				
Cyprus Anvil Mining Corporation	Cirque	39 920	7.80	3 113.8
Regional Resources Ltd./ Canamax Resources Inc./ Procan Exploration Company	Midway	4 300	11.0[e]	473.0
Esso Minerals Canada	Kutcho Creek	6 614	4.33	286.4
		50 834	7.62	3 873.2
Yukon Territory				
Cyprus Anvil Mining Corporation	DY zone	14 700	6.90	1 014.3
	Swim Lake	4 540	5.50	249.7
Hudson Bay Mining and Smelting Co., Limited	Tom	7 840	8.40	658.6
Aberford Resources Ltd. and Ogilvie Joint Venture	Jason	11 790	6.57	774.6
Placer Development Limited and United States Steel Corporation	Howard's Pass	120 000	5.40	6 480.0
Sulpetro Minerals Limited and Sovereign Metals Corporation	MEL	4 780	5.10	243.8
		163 600	5.76	9 421.0
Northwest Territories				
Cominco Ltd. and Bathurst Norsemines Ltd.	Seven deposits	19 050	4.98	948.7
Cadillac Explorations Limited	Prairie Creek	1 800	17.16	308.9
Kidd Creek Mines Ltd.	Izok Lake	11 020	13.77	1 517.5
Westmin Resources Limited,	X-25	3 450	9.10	314.0
Du Pont Canada Inc. and Philipp Brothers (Canada) Ltd.	R-190	1 270	11.90	151.1
		36 590	8.89	3 240.2
Canada		324 403	6.32	20 492.7

Source: MR 201 Canadian Reserves, Gold, Silver, Lead, Zinc, Copper, Nickel, Molybdenum, as of January 1, 1983; Energy, Mines and Resources Canada 1984.
[e] Estimated.

TABLE 6. WESTERN WORLD ZINC INDUSTRY, PRODUCTION AND CONSUMPTION, 1984

	Mine Production	Metal Production	Metal Consumption
	(000 tonnes)		
Europe			
Austria	21	24	31
Belgium	-	271	156
Denmark[1]	71	-	10
Finland	60	159	22
France	36	259	282
Germany F.R.	113	356	425
Greece	23	-	12
Ireland	206	-	1
Italy	42	167	210
Netherlands	-	210	60
Norway	29	94	20
Portugal	-	6	11
Spain	228	212	101
Sweden	207	-	37
Switzerland	-	-	21
United Kingdom	7	85	185
Yugoslavia	86	93	92
Total	1 129	1 936	1 676
Africa			
Algeria	15	35	14
Egypt	-	-	20
Morocco	11	-	2
Nigeria	-	-	15
South Africa[2]	134	90	91
Tunisia	7	-	1
Zaire	75	66	-
Zambia	41	29	1
Others	-	-	22
Total	283	220	166
Americas			
Argentina	35	29	31
Bolivia	38	-	-
Brazil	79	107	113
Canada	1 207	683	146
Chile	19	-	-
Colombia	-	-	17
Honduras	42	-	-
Mexico	290	185	101
Peru	568	149	31
United States	278	331	980
Venezuela	-	-	18
Others	-	-	25
Total	2 556	1 484	1 462
Asia			
Hong Kong	-	-	19
India	44	55	124
Indonesia	-	-	50
Iran	30	-	-
Japan	253	754	774
Korea, Rep.	54	109	121
Philippines	2	-	18
Taiwan	-	-	42
Thailand	41	4	36
Turkey	51	20	38
Others	3	-	78
Total	478	942	1 300
Oceania			
Australia	621	306	82
New Zealand	-	-	20
Total	621	306	102
Total non-socialist world	5 067	4 888	4 706

Source: International Lead and Zinc Study Group.
[1] Includes Greenland. [2] Includes Namibia.
- Nil.

TABLE 7. CANADA, PRIMARY ZINC METAL CAPACITY, 1985

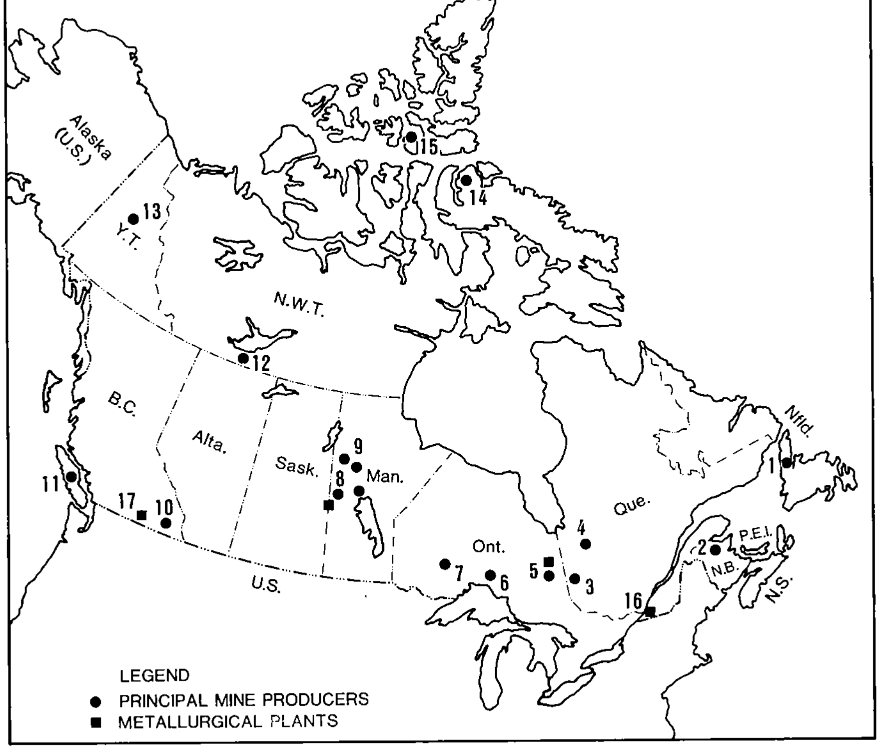
Company and Location	Annual Rated Capacity
	(tonnes of slab zinc)
Canadian Electrolytic Zinc Limited (CEZ) Valleyfield, Quebec	227 000
Kidd Creek Mines Ltd. Timmins, Ontario	127 000
Hudson Bay Mining and Smelting Co., Limited Flin Flon, Manitoba	73 000
Cominco Ltd. Trail, British Columbia	272 000
Canada total	699 000

TABLE 8. MONTHLY AVERAGE ZINC PRICES

	Overseas[1] Producer ($US/tonne)	U.S.[1] Producer (¢US/lb)	Canadian[1] Producer (¢Cdn./lb)	LME[2] Settlement (£/tonne)
1984				
January	990.91	49.2	62.9	680.4
February	1 048.10	50.6	63.5	692.6
March	1 051.82	51.1	66.0	714.8
April	1 090.00	51.9	67.0	706.6
May	1 090.00	52.8	67.0	720.6
June	1 080.48	52.5	66.6	683.7
July	1 010.45	49.5	65.5	646.7
August	990.00	47.8	63.4	635.1
September	957.50	46.4	61.5	611.4
October	906.97	44.2	59.3	623.3
November	900.00	43.6	59.3	635.6
December	900.00	43.6	59.3	669.2
Year Average	1 001.24	48.6	63.4	668.3
1985				
January	900.00	42.9	58.2	769.3
February	900.00	42.6	58.2	811.0
March	922.62	43.2	61.8	818.4
April	958.33	44.9	64.0	752.4
May	952.17	45.1	64.0	706.0
June	907.50	43.7	62.5	630.9
July	847.39	41.4	57.0	555.4
August	830.00	39.8	55.5	531.1
September	815.71	38.0	54.6	505.4
October	753.91	35.9	52.0	444.5
November	672.86	33.3	48.0	415.0
December	684.71	33.6	48.0	474.3
Year Average	845.43	40.4	57.0	617.8

Source: Metals Week, ILZSG, Northern Miner.
[1] High grade zinc. [2] G.O.B. zinc for 1984, high grade for 1985.

ZINC PRODUCERS IN CANADA 1985



Principal Producers
(numbers refer to numbers on map above)

1. Newfoundland Zinc Mines Limited
2. Brunswick Mining and Smelting Corporation Limited
3. Corporation Falconbridge Copper Lake Dufault Division
   Noranda Inc. and Les Mines Gallen Limitée (Gallen Mine)
4. Noranda Inc. Matagami Division
5. Kidd Creek Mines Ltd.
6. Noranda Inc. (Geco Division)
7. Mattabi Mines Limited
   Noranda Inc. (Lyon Lake)
8. Hudson Bay Mining and Smelting Co., Limited (Chisel Lake, Osborne Lake, Stall Lake, Ghost Lake, Anderson Lake, Westarm, Flin Flon, White Lake, Centennial, Trout Lake, Spruce Point)
9. Sherritt Gordon Mines Limited (Fox Lake mine and Ruttan mine)
10. Cominco Ltd. (Sullivan mine)
    Teck Corporation (Beaverdell mine)
    Dickenson Mines Limited (Silmonac mine)
11. Westmin Resources Limited
12. Pine Point Mines Limited
13. United Keno Hill Mines Limited
14. Nanisivik Mines Ltd.
15. Cominco Ltd. (Polaris mine)

Metallurgical Plants

5. Kidd Creek Mines Ltd., Timmins
8. Hudson Bay Mining and Smelting Co., Limited, Flin Flon
16. Canadian Electrolytic Zinc Limited, Valleyfield
17. Cominco Ltd., Trail

Zirconium

D.E.C. KING

Canada imports all of its zirconium needs. In terms of tonnage, zircon sand and flour are the most important. Imports fell to nearly 7 000 t in 1983 following highs in excess of 22 000 t in 1981 and 1980, but recovered in 1984 and 1985 to about 15 000 t. Australia was the source for about 80 per cent of global supply in 1985. However, South Africa's importance has increased and its share over the past two years was 10 to 14 per cent. Somewhat less than 10 per cent of Canadian zircon imports were re-exported to the United States.

In terms of value, zirconium metal and alloys represented the major imports, valued between $16 and $20 million. Most of these products came from the United States and the remaining were imported from France.

Canada also imports small quantities (less than 1 000 tpy each) of zirconium oxide, zirconium silicate, ferrozirconium, and zirconia-alumina-silica bricks.

The mineral baddeleyite, a naturally occurring zirconium oxide (ZrO_2), is used in the manufacture of alumina-zirconia abrasives in Canada. Baddeleyite sand is imported from South Africa, the largest commercial source. This mineral constitutes about 13 per cent of south African production.

Candu nuclear reactors utilize zirconium alloys for pressure tubing and for fuel rod sheathing. Canadian firms import tube hollows from the United States and further process them to produce finished materials for the reactors.

Zirconium is an essential element in magnesium alloys, used in precision castings for the aerospace industry. Such alloys are imported and cast in Canada.

CANADIAN DEVELOPMENTS

In 1985, The Iron Ore Company of Canada (IOC) suspended evaluation studies and research on its zirconium-rare earth property at Strange Lake, Labrador/Quebec, as a result of its market research. The deposit, some 300 km northeast of Schefferville, Quebec, occurs in a granite complex of pre-cambrian age and could be mined by open-pit. This is reported to be one of the world's largest high-grade deposits of yttrium and zirconium. The deposit also contains significant values of beryllium, niobium and rare earths. Measured reserves are large and these could be increased when required. The zirconium is in the form of gittinsite, an acid-soluble mineral from which the metals can be separated by solvent extraction.

The Athabasca tar sands of Alberta are a potential source of ilmenite, rutile, and zircon. These heavy minerals tend to become concentrated in a fraction called Scroll tailings during the bitumen extraction process. A Syncrude Canada Ltd. study carried out in 1976 showed that zircon minerals of marketable quality could be separated from the other heavy minerals and that a 135 000 bbl/d Syncrude oil plant could potentially produce about 41 000 tpy of zircon and 94 000 tpy of titanium minerals. The tar sand operation of Suncor Inc. has about 40 per cent of the oil capacity of Syncrude and might represent a further potential centre for zircon production, although no estimates of potential heavy mineral recovery at Suncor are available.

The Canadian nuclear reactors planned prior to 1982 have remained on schedule. The initial inventory of zirconium alloy tubing for sheathing the fuel rods, in Ontario Hydro's Bruce 7 and 8 reactors and Darlington 1 to 4 reactors, is estimated at about 200 t in finished weight. Fuel replacement in 1985 required about 140 t of zirconium alloy tubes as fuel sheathing. The annual requirement of sheathing alloy is expected to increase to about 230 t in 1987 with virtually no growth after that. The re-tubing of Pickering 1 and 2 reactors is still under way.

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WORLD PRODUCTION AND DEVELOPMENTS

Zircon is a natural zirconium-hafnium silicate occurring widely in beach sand formations in various countries. It is by far the most important zirconium mineral. Australia is the dominant supplier of zircon concentrates but its share of world production has declined over the past several years while South Africa's share has increased as the output of Richards Bay Minerals (RBM) has expanded since it began production in late-1977. The United States is also a major producer but it has not released production statistics in recent years.

During 1985 and to some extent 1984, the market was favourable for all heavy minerals which include ilmenite, rutile, zircon and monazite, and which tend to occur together in mineral sands. Without this unusual coincidence of demand there normally would be an oversupply of one or more of the coproducts with corresponding downward pressure on their prices. The past two years have therefore been favourable for consideration of plant expansions.

Australia

The main volume of mineral sand production has transferred from the east coast to Western Australia over the past several years, mainly due to environmental and preservation restrictions on the eastern sites. However, Australia remains the world's largest zircon producer with about 75 per cent of its zircon output now coming from Western Australia.

In 1984, Allied Eneabba Ltd., the largest Western Australian mineral sand producer operated near full capacity, although its output was restricted by an equipment shutdown. It was reported in 1985 that E.I. du Pont de Nemours and Company (Du Pont) would sell its 50 per cent share of Allied Eneabba to Renison Goldfields Consolidated Ltd. (RGC), subject to the approval of regulatory authorities and shareholders. RGC wanted the acquisition in order to rationalize its own and Allied Eneabba's adjacent mining and plant operations.

Allied Eneabba produced 161 000 t and Associated Minerals Consolidated Ltd. (AMC) 127 000 t of zircon in Western Australia in 1984. AMC sold its eastern operation (14 000 t zircon in 1984) to Consolidated Rutile Ltd. (CRL) which has completed an expansion on North Stradbrooke Island (east coast) for the purpose of adding approximately 30 000 t to its zircon output.

TiO_2 Corporation NL in 1985 purchased the Cooljarloo and Jurien deposits in Western Australia and expects to start production within 2 years. Planned production capacity would yield 200 000 tpy of heavy minerals containing about 37 000 t of zircon.

Australia is also moving toward the production of zirconia and zirconium chemicals. In a joint venture between ICI Australia Ltd. and Commonwealth Scientific and Industrial Research Organization (CSIRO) a pilot plant was built and operated in 1985. In late-1985, ICI announced that it would build a high temperature reactor and hydrometallurgical zirconia production plant at Kwinana, Western Australia, with planned start-up within three years at an annual capacity of 2 500 to 3 000 t of zirconia. Z-Tech Ltd., a joint venture of ICI and CSIRO, was established to market special grades of zirconia and pre-blends of zirconia ceramic powders.

South Africa

Richards Bay Minerals operated close to its capacity of 135 000 tpy of zircon during 1984 and 1985. Baddeleyite production from Palabora Mining Co. Ltd. (PMC) and the Phosphate Development Corp. Ltd. (Foskor) totalled about 12 000 t in 1984. The completion of a plant expansion at Palabora will approximately double its present production capacity of 5 000 tpy of baddeleyite.

France

In response to a strong demand, Cezus, a subsidiary of Pechiney, announced in 1985 that it would expand its zirconium sponge production capacity by 20 per cent to 1 800 tpy by early 1986 and also increase its forging capacities for zirconium and titanium.

OTHER DEVELOPMENTS

The development of advanced ceramic materials continued to be the subject of considerable industrial research and development, particularly in Japan and the United States. The United Kingdom and other western Europe countries were pioneers in this field in the 1950s and 1960s, but allowed their lead to slip away and are now attempting to recover lost ground. Special zirconia ceramics are a group of materials now undergoing rapid growth in demand.

USES

Foundry sands, refractories and ceramics account for about 84 per cent of all world zirconium mineral demand, although the consumption patterns vary from region to region. The predominant usage in Japan is in refractories, whereas foundries are the major users in the United States and ceramics account for most of the zirconium consumption in Europe.

Foundry applications, in sand form or as mould washes, take advantage of zircon's low reactivity, high thermal conductivity and its chemical stability in the presence of molten metals. However, substitution by other materials tends to occur whenever there is a significant increase in the price of zircon. The extensive use of zircon-based refractories developed chiefly in Japan where these refractories are used in the lining of steel ladles, furnaces and crucibles. Zircon is used in general ceramic applications as an opacifier.

The three major areas of usage provide a stable demand base with steady growth. Other uses involving fused zirconia from baddeleyite and high purity zirconia manufactured from natural minerals, presently represent minor volumes but could undergo rapid growth.

The total world consumption of zirconia including baddeleyite was estimated to have been 18 000 to 20 000 t, including 6 000 to 8 000 t as manufactured zirconia. The uses for baddeleyite are in the manufacture of zirconium oxide and alumina-zirconia (AZ) abrasives, refractories and ceramic colours. North America is the principle source of AZ abrasives.

Zirconia refractories are stabilized with calcium oxide and/or magnesia. The consumption of zirconia refractories in North America and Europe is presently considerably less than in Japan, but this may accelerate with increasing production of continuously cast steel in the former continents.

In general, while fused baddeleyite is sufficiently pure to be used in such applications as the manufacture of abrasives, there is a growing market for manufactured zirconia. These applications require much higher purity and relatively small amounts of material involving very high added value for the zirconia and its manufactured products. Its uses include oxygen sensors for exhaust systems and other industrial applications, lead zirconate titanates (PZT) for peizo-electric materials for electronics, and wear resistant coatings. Other uses for which long-term growth has been predicted include partially stabilized zirconia in engines. The future for the latter application is uncertain but could conceivably involve large volumes. More immediately, investigations reveal a potential for zirconia coatings on metal parts for wear resistance, and thermal and corrosion protection.

PRICES

The weaker Australian dollar coupled with zircon's tight supply caused the market price of Australian zircon to rise significantly during 1984 and 1985. However, zirconium sponge and mill product list prices were not increased because of the surplus capacity which exists in the industry.

OUTLOOK

The current tightness of zircon supply will be eased by capacity expansions presently underway. Research and development should continue to develop new applications for zircon, with high technology uses showing the highest rate of growth and becoming increasingly important in terms of value. Although the construction of nuclear power stations has declined there will continue to be a fairly constant demand for zirconium sheathing alloys that are used in fuel bundle replacement.

The overall world growth in demand until the end of the decade is estimated at 3 to 4 per cent per year.

The excessive production capacity for zirconium metal that developed in 1981 and 1982 is expected to continue for several years, assuming there is no dramatic increase in the demand growth of electricity from nuclear powered stations.

PRICES

Zircon prices quoted in Metals Week and American Metal Market at the end of 1985.

	Price per kg ($US)
Zirconium ore	
Australia	0.36
United States	0.38
Sponge	26.456 - 37.479
Sheet, strip, bar	44.09 - 88.185
Powder	165 - 330

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
				(%)	
CANADA					
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 June 30, 1986)	free	free	25	free
34730-1	Bars, rods, plate, sheet, strip, wire, forgings, castings, foils and tubes, seamless or welded, of zirconium or zirconium alloys for use in the manufacture of nuclear power reactors, including fuels components (expires June 30, 1986)	free	free	25	free
33508-1	Zirconium oxide	free	4.3	15	free
92845-4	Zirconium silicate	free	free	free	free

MFN Reductions under GATT (effective January 1 of year given)	1985	1986	1987
		(%)	
33508-1	4.3	4.1	4.0

UNITED STATES

601.63	Zirconium ore, (including zirconium sand)	free		

		1985	1986	1987
			(%)	
629.60	Zirconium metal, unwrought, waste other than alloys	4.7	4.4	4.2
629.62	Zirconium, unwrought alloys	5.6	5.2	4.9
629.65	Zirconium metal, wrought	6.4	5.9	5.5
422.80	Zirconium oxide	4.0	3.9	3.7
422.82	Other zirconium compounds	4.0	3.9	3.7

EUROPEAN ECONOMIC COMMUNITY		1985	Base Rate	Concession Rate
			(%)	
26.01	Zirconium and hafnium ores	free		
28.28	Zirconium oxide	7.3	8.0	7.0
28.45	Zirconium silicates	6.5	8.8	5.7
73.02	Ferrozirconium	5.3	7.0	4.9
81.04	Zirconium metal			
	Unwrought; waste and scrap	5.3	6.0	5.0
	Wrought	9.3	10.0	9.0

Sources: The Customs Tariff, January 1985, Revenue Canada, Customs and Excise; Tariff Schedules of the United States Annotated 1985, USITC Publication 1410; U.S. Federal Register, Vol. 44, No. 241; Official Journal of the European Communities, Vol. 27, No. 320, 1985.

TABLE 1. WORLD ZIRCONIUM RESERVES

	Thousand tonnes Zr content Reserves[1]
United States	3 600
Brazil	200
Republic of South Africa	3 000
Sierra Leone	450
Madagascar	100
India	1 600
Malaysia/ Thailand	100
Sri Lanka	900
Australia	7 900
U.S.S.R.	2 700
Peoples Republic of China	350
World Total (Rounded)	21 000

Source: USBM Mineral Facts and Problems 1985 Bulletin 675.
[1] Estimates include currently economic demonstrated resources.

TABLE 2. AUSTRALIA, ZIRCON PRODUCTION, 1970, 1975 AND 1978-84

	Zircon concentrate	Zircon (ZrO_2 SiO_2 content)
	(tonnes)	
1970	395 351	390 294
1975	382 217	375 548
1978	391 606	386 724
1979	446 980	440 119
1980	491 547	413 603
1981	424 688	332 524
1982	462 476	..
1983	382 005	..
1984[r]	454 591	..

Sources: Australian Mineral Industry Quarterly, March Quarter (1985).
[r] Revised; .. Not available.

TABLE 3. WORLD PRODUCTION OF ZIRCON CONCENTRATES, 1981-84

	1981	1982	1983[p]	1984[e]
	(tonnes)			
United States	W	W	W	W
Australia	434 249	462 480	382 309	417 309
Republic of South Africa	99 790	127 007	127 007	127 007
U.S.S.R.[e]	72 575	81 674	81 674	81 674
India	12 400	11 793	11 793	11 793
China[e]	14 968	14 968	14 968	14 968
Brazil	6 000	4 996	13 790	12 973
Sri Lanka	3 265	5 789	5 720	5 987
Malaysia	1 307	2 147	2 548	2 540
Thailand	104	196	199	200
Total[1]	633 847	549 710	640 008	674 451

Sources: United States Bureau of Mines Minerals Yearbook Preprint, Zirconium and Hafnium, 1984; Australian Mineral Industry Annual Review Preliminary Summary 1982.
[1] Excludes United States production which is withheld.
[p] Preliminary; [e] Estimated; W Withheld.

TABLE 4. CANADA, ZIRCONIUM IMPORTS BY COUNTRY, 1982-85

	1982		1983		1984		1985[1]	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Zircon sand and flour								
South Africa	-	-	-	-	2 007	281	1 500	228
Australia	14 781	2,021	5 687	733	10 508	1,470	12 365	1,533
United States	660	249	1 701	565	1 157	534	953	690
Total	15 441	2,270	7 388	1,299	13 672	2,285	14 820	2,451
Zirconium oxides								
United States	18	137	44	204	33	251	22	201
France	3	21	12	89	11	85	-	-
Total	21	158	56	293	44	336	22	201
Zirconium silicate								
United States	866	569	767	524	815	579	758	510
Australia	10	8	20	15	21	18	11	7
Total	876	577	777	539	836	597	769	517
Ferrozirconium alloys								
France	282	551	-	-	-	-	227	387
United States	191	412	442	940	440	1,036	710	1,610
Total	473	963	442	940	440	1,036	937	1,997
	(kg)		(kg)		(kg)		(kg)	
Zirconium, primary forms and fabricated material								
United States	49 106	2,814	60 876	2,066	16 225	1,629	36 198	1,253
West Germany	9 230	1,389	16 657	2,370	1 375	174	8 596	1,233
Belgium-Luxembourg	998	20	-	-	-	-		
South Africa	-	-	40 007	74	80 010	141	57 992	106
France	-	-	-	-	14 752	745	-	-
Total	59 334	4,223	117 539	4,511	122 308	4,003	102 786	2,591
Zirconium alloys								
United States	190 271	15,755	144 323	12,460	196 820	15,345	137 718	10,942
West Germany	8 757	1,478	3 046	303	-	-	3 036	396
France	24 046	1,198	43 143	2,053	30 118	1,621	72 244	4,098
United Kingdom	19 449	95	-	-	-	-	-	-
Sweden	44	3	-	-	121	21	-	-
Japan	-	-	28	2	-	-	-	-
Total	242 567	18,529	190 540	14,817	227 059	16,987	212 998	15,436

Source: Statistics Canada.
[1] Jan. to Oct.
- Nil.

TABLE 5. CANDU PRESSURIZED HEAVY WATER ELECTRIC GENERATING STATIONS IN OPERATION, UNDER CONSTRUCTION OR PROPOSED IN CANADA OR ABROAD

Generating Station	Location	Net Power (MW(e))	In-Service Dates (Expected)
NPD 2	Ontario	22	1962
Douglas Point	"	206	1968
Pickering 1 to 4	"	2 060	1971-73
Bruce 1 to 4	"	2 960	1977-79
Gentilly 2	Quebec	635	1983
Point Lepreau	New Brunswick	630	1983
Pickering 5 and 6	Ontario	1 032	1983-84
Pickering 7 and 8	"	1 032	1985
Bruce 6	"	830	1984
Bruce 5	"	830	1985
Bruce 7 and 8	"	1 660	1986-87
Darlington 1 to 4	"	3 524	1988-92
Wolsung 1	Korea	630	1983

Sources: Energy, Mines and Resources Canada, Zirconium MR 202, 1983, and "Uranium" Preprint 1983-84; Ontario Hydro, Staff.

TABLE 6. WORLD PRODUCERS OF ZIRCONIUM SPONGE

Company	Plant Location	Annual Production Capacity 1978	1980	1983
			(tonnes)	
Teledyne Wah Chang (TWCA)	Albany, Oregon, U.S.A.	3 500	3 500	3 600
Cezus (a subsidiary of Pechiney)	Jarrie, France	1 000	1 600	1 600
Western Zirconium Co.	Ogden, Utah, U.S.A.	-	1 400	1 350
Nippon Mining Co. Ltd.	Toda, Japan	50	300	150
Zirconium Industry Co.	Hiratsuka, Japan	250	300	-
Total		4 800	7 100	6 700

Source: Teledyne Wah Chang.
- Nil.

TABLE 7. CHEMICAL AND SIZE ANALYSIS OF ZIRCON CONCENTRATES OF TYPICAL PRODUCERS

	Australia (East Coast)		United States (Florida)		South Africa		
					Zircon		Baddeleyite
	Standard	Premium	Standard	Premium	Standard	Premium	
Chemical Guarantee							
% ZrO_2 Mn	65.5	66.0	65.0	66.0	65.0	66.0	95-97
% Fe_2O_3 Mx	0.05	0.05	0.1	0.04	0.3	0.05	0.4-1.0
% TiO_2 Mx	0.3	0.1	0.35	0.2	0.3	0.1	0.5-1.0
% Al_2O_3 Mx	0.4	0.3	2.0	0.5	0.25	0.08	0.1
Typical Screen Sizings microns (% cumulative)							
250	0	1	-	-	0.5	0.5	
180	1	6	5	-	0.7	0.7	
125	12	45	41	Traces	29.8	29.8	
90	67	95	84	56	80.0	80.0	
63	99	100	100	93	100.0	100.0	
53	100	-	-	100	-	-	

Source: Producers' Published Specifications.
Mn Minimum; Mx Maximum; - Nil.

TABLE 8. WORLD ZIRCON CONSUMPTION - ESTIMATED DISTRIBUTION BY USE AND REGION, 1983

	Foundry	Refractory	Ceramics	Zirconia	Other[1]	Total
			(000 tonnes)			
Western Europe	50	50	100	15	30	245
North America	60	40	10	20	25	155
Japan	30	130	10	5	5	180
Other countries[2]	15	15	25	-	5	60
Total	155	245	145	40	65	640
Per Cent	24	38	22	6	10	100

Source: Industrial Minerals, December 1983.
[1] Includes metal, chemicals, etc; [2] Not including the U.S.S.R. and China.
- Nil.

TABLE 9. MAJOR CONSUMERS AND PROCESSORS OF ZIRCONIUM PRODUCTS IN CANADA

Product	Major Consumers
Zircon sand and flour	Dofasco Inc. Haley Industries Limited Abex Industries Ltd. Sidbec Foseco Canada Inc.
Zirconium oxide	Norton Company
Ferrozirconium	Dofasco Inc. Atlas Steels division of Rio Algom Limited Esco Limited
Zirconia-alumina-silica bricks	Consumers Glass Company Limited Domglas Inc.
Zirconium metal and alloys	Ontario Hydro Haley Industries Limited Nu-Tech Precision Metals Inc. Westinghouse Canada Inc. Noranda Metal Industries Limited Canadian General Electric Company Limited Eldorado Nuclear Limited Hydro-Quebec New Brunswick Electric Power Commission Combustion Engineering-Superheater Ltd. Bristol Aerospace Limited

TABLE 10. CANADA, FORECAST DEMAND FOR REPLACEMENT ZIRCONIUM ALLOY MILL PRODUCTS FOR CANDU NUCLEAR POWER REACTORS, 1985-1990

Year	Tonnes
1985	142
1986	189
1987	232
1988	234
1989	236
1990	272

Source: Ontario Hydro, February 1986.

Principal Canadian Nonferrous

and

Precious Metal Mine Production in 1984,

with Highlights for 1985

PRINCIPAL CANADIAN NONFERROUS AND PRECIOUS METAL MINE PRODUCTION IN 1984, WITH HIGHLIGHTS FOR 1985

Company and Mine/Mill Location	Capacity	Grades of Ore Milled: Cu	Ni	Pb	Zn	Ag	Au	Ore Milled	Metal Contained in All Concentrates Produced: Copper	Nickel	Zinc	Lead	Silver	Gold	Highlights
	(tonnes per day)	%	%	%	%	(g/tonne)		(tonnes)			(tonnes)		(kilograms)		
NEWFOUNDLAND															
ASARCO Incorporated Buchans	1 089	2.11	-	6.95	10.79	115.2	0.75	92 533	1 590	-	8 325	4 718	76 788	516	Mine closed permanently, September 1984.
Newfoundland Zinc Mines Limited Daniel's Harbour	1 497	-	-	-	8.20	-	-	498 952	-	-	40 349	-	-	-	
NEW BRUNSWICK															
Brunswick Mining and Smelting Corporation Limited, No. 12 mine Bathurst	10 500	0.32	-	3.54	8.87	99.09	-	3 560 206	8 748	-	271 094	96 430	2 036	-	
Heath Steele Mines Limited Newcastle	3 630	-	-	-	-	198.34	4.63	130 666	-	-	-	-	14 550	463.4	Underground production suspended May 1983. Surface gossan treated in special circuit.
QUEBEC															
Agnico-Eagle Mines Limited Joutel	1 090	-	-	-	-	0.96	6.17	332 720	-	-	-	-	288	1 862	
Aiguebelle Resources Inc.	1 000	-	-	-	-	1.23	3.49	226 824	-	-	-	-	247	753	
Bachelor Lake Gold Mines Inc. Desmaraisville	450	-	-	-	-	0.48	4.80	141 599	-	-	-	-	65	625	
Barrick Resources Corporation Camflo Division	1 130	-	-	-	-	0.38	4.15	431 687	-	-	-	-	96	1 690	
Belmoral Mines Ltd. Ferderber and Dumont mines Val d'Or	1 360	-	-	-	-	0.86	8.23	200 159	-	-	-	-	164	1 556	

BP Resources Canada Limited (Selco Division) Joutel	1 500	3.15	-	-	0.69	31.3	1.27	551 259	16 638	-	3 576	-	15 349	1 609	Company started development work to bring its A1-Zone into production in 1986. Exploration work on A2-Zone began in late 1985.
Campbell Resources Inc. Chibougamau	3 175	1.08	-	-	-	7.20	2.95	334 768	3 486	-	-	-	1 446	837	
Corporation Falconbridge Copper															
Lake Dufault Division Millenbach and Corbet mines	1 542	2.98	-	-	2.73	24.69	1.03	489 245	13 976	-	10 755	-	7 732	447	
Lake Shortt Division Noranda	750	-	-	-	-	0.29	3.81	60 300	-	-	-	-	9	208	
Opemiska Division Perry, Springer & Cooke mines, Chapais	2 722	1.18	-	-	-	9.94	2.85	622 345	6 996	-	-	-	4 909	1 597	
Kiena Gold Mines Limited	1 250	-	-	-	-	1.10	5.73	91 856	-	-	-	-	78	449	
Lac Minerals Ltd. Doyon Division	1 090	-	-	-	-	0.58	5.70	519 884	-	-	-	-	289	2 839	
Est-Malartic Division	1 630	-	-	-	-	0.34	4.53	622 526	-	-	-	-	202	2 643	
Terraine Aurifères Division	1 800	-	-	-	-	1.62	6.84	525 060	-	-	-	-	790	3 349	
Muscocho Explorations Limited Montauban Mine	230	-	-	-	-	5.83	4.77	123 294	-	-	-	-	649	531	
Noranda Inc.															
Gaspé Division Copper Mountain and Needle Mountain mines Murdochville	3 719	1.48	-	-	-	7.65	.09	355 481	5 106	-	-	-	2 039	7	Development of E-32 Zone continued. Copper Mountain open pit remains closed.
Horne Division															
Chadbourne Circuit	3 447	-	-	-	-	2.23	3.74	26 685	-	-	-	-	587	863	
Les Mines Gallen	-	-	-	-	5.03	20.85	1.30	84 242	-	-	3 305	-	660	55	
Mattagami Division	3 950	1.21	-	-	5.04	20.37	0.45	1 067 356	11 421	-	48 451	-	11 181	194	Exploration outlining possible orebody.
Northgate Patino Mines Inc.															
Copper Rand and Portage mines	2 939	1.59	-	-	-	9.81	4.11	671 689	10 398	-	-	-	4 102	2 409	

Principal Canadian Nonferrous and Precious Metal Mine Production in 1984, with Highlights for 1985 (cont'd)

Company and Mine/Mill Location	Capacity (tonnes per day)	Grades of Ore Milled Cu %	Ni %	Pb %	Zn %	Ag (g/tonne)	Au (g/tonne)	Ore Milled (tonnes)	Metal Contained in All Concentrates Produced Copper (tonnes)	Nickel (tonnes)	Zinc (tonnes)	Lead (tonnes)	Silver (kilograms)	Gold (kilograms)	Highlights
QUEBEC (cont'd)															
Sigma Mines (Quebec) Limited Val d'Or	1 270	-	-	-	-	0.75	4.25	433 824	-	-	-	-	328	1 772	
Société québécoise d'exploration minière (SOQUEM)	544	-	-	-	-	1.37	3.74	75 296	-	-	-	-	103	262	The Chimo mine, a major mill feed source was closed from January to August 1985.
Teck Corporation Lamaque Division (including custom milled ore) Val d'Or	1 900	-	-	-	-	0.88	4.87	570 810	-	-	-	-	507	2 627	Lamaque Mine shut down during 1985. Drilling program to redefine reserves continued.
ONTARIO															
Agnico-Eagle Mines Limited Silver Division Cobalt	360	-	-	-	-	967.20	0.0	52 880	-	-	-	-	49 840	-	
Campbell Red Lake Mines Limited Red Lake	975	-	-	-	-	2.06	19.65	358 365	-	-	-	-	665	6 654	
Detour Joint Venture James Bay	2 500	-	-	-	-	0.65	3.33	794 561	-	-	-	-	469	2 456	Open pit mine scheduled to close in Sept. 86. Decision on underground to follow within 18 months.
Consolidated Louanna Gold Mines Limited Nakina	181	-	-	-	-	2.57	7.03	53 303	-	-	-	-	109	352	
Dickenson-Sullivan Joint Venture Red Lake	910	-	-	-	-	1.37	11.66	187 672	-	-	-	-	218	1 890	
Dome Mines, Limited South Porcupine	2 720	-	-	-	-	0.79	4.87	780 179	-	-	-	-	585	3 685	
Falconbridge Limited (6 mines) Sudbury district	10 340	1.16	1.29	-	-	6.86	0.14	2 882 000	31 543	30 940	-	-	1 276	1 981	
Gail Resources Inc. Timmins	450	-	-	-	-	6.86	7.89	68 039	-	-	-	-	440	506	Production intermittent.

Inco Limited (10 mines, Sudbury area and Shebandowan)	49 440	1.23	1.30	-	-	5.14	0.17	10 870 000	125 512	115 850	-	-	43 610	11 372	
Queenston-Inco Exploration Joint Venture	450	-	-	-	-	0.21	2.61	114 882	-	-	-	-	22	280	
Kerr Addison Mines Limited Virginiatown	1 225	-	-	-	-	0.17	3.98	346 835	-	-	-	-	55	1 346	
Kidd Creek Mines Ltd. Timmins	12 250	2.76	-	0.32	6.30	105.63	3.77	4 512 613	120 166	-	256 552	9 612	393 836	174	Gold from 61 595 t treated in gold circuit.
Lac Minerals Ltd. Macassa Division Kirkland Lake	454	-	-	-	-	2.06	18.17	152 949	-	-	-	-	302	2 689	
Mattabi Mines Limited Mattabi and Lyon Lake mines	2 700	0.96	-	0.91	8.33	130.97	0.45	843 655	7 353	-	65 837	6 420	96 308	264	
Noranda Inc. Geco Division Manitouwadge	3 850	1.79	-	0.14	3.13	50.06	0.14	1 253 855	21 563	-	36 644	1 165	48 390	89	
Pamour Porcupine Mines, Limited Pamour Division Timmins	2 720	-	-	-	-	0.69	2.54	877 078	-	-	-	-	373	1 967	Sold to Jimberlana Resources during 1985.
Schumacher Division	2 720	0.04	-	-	-	3.22	3.29	758 363	157	-	-	-	1 557	2 113	
Royex Gold Mining Corporation Goldlund Mine Sioux Lookout	180	-	-	-	-	-	4.46	56 152	-	-	-	-	-	215	
Royex Gold Mining Corporation Barrick Resources Corporation Renabie Mine	450	-	-	-	-	1.78	4.94	110 497	-	-	-	-	194	507	
Sulpetro Minerals Limited Canadaka Division	270	-	-	-	-	105.26	-	47 633	-	-	-	-	3 378	-	
Teck Corporation Pan Empire Cobalt	180	-	-	-	-	0.17	3.43	47 554	-	-	-	-	3	62	
Westfield Minerals Limited Scadding Twp.	180	-	-	-	-	-	6.82	20 562	-	-	-	-	-	110	

Principal Canadian Nonferrous and Precious Metal Mine Production in 1984, with Highlights for 1985 (cont'd)

Company and Mine/Mill Location	Capacity	Grades of Ore Milled Cu	Ni	Pb	Zn	Ag	Au	Ore Milled	Metal Contained in All Concentrates Produced Copper	Nickel	Zinc	Lead	Silver	Gold	Highlights
	(tonnes per day)	%	%	%	%	(g/tonne)		(tonnes)			(tonnes)		(kilograms)		
MANITOBA															
Hudson Bay Mining and Smelting Co., Limited (9 mines), Flin Flon concentrators & Snow Lake concentrators)	10 500	2.47	-	0.12	2.65	18.80	1.51	1 905 813	43 375	-	42 143	1 464	26 676	1 838	
Inco Limited Thompson underground and open pit mines Thompson district	12 700	0.14	1.88	-	-	5.14	0.10	2 518 900	2 969	42 000	-	-	10 105	158	Some stockpiled ore from the Pipe open pit, which was closed in 1984, was also processed in 1985. Production from the Thompson open pit commenced in October.
Sherritt Gordon Mines Limited															
Fox mine Lynn Lake district	2 725	1.62	-	-	2.20	14.06	0.58	663 164	9 762	-	12 552	-	5 325	207	Mine closed November 28, 1985 due to exhaustion of reserves.
Ruttan mine Leaf Rapids	9 070	1.47	-	-	0.91	10.63	0.34	1 413 317	19 569	-	10 807	-	8 582	296	Production commenced from deepening project.
BRITISH COLUMBIA															
Brenda Mines Ltd. Peachland	27 220	0.15	-	-	-	1.47	0.03	6 109 067	7 826	-	-	-	4 486	79	Mine reopened September 15, 1985.
Broken Hill Proprietary Company Limited, The Utah Division Island Copper mine	37 200	0.43	-	-	-	1.61	0.21	16 360 918	59 443	-	-	-	13 143	1 781	In-pit crusher and conveyor completed. Mine also recovers molybdenum and rhenium.
Carolin Mines Ltd. Hope	1 360	-	-	-	-	0.31	3.36	236 581	-	-	-	-	19	488	
Cominco Ltd. Copper Division Valley Copper Mine	18 145	0.50	-	-	-	3.43	0.03	8 452 682	37 850	-	-	-	14 442	121	
Sullivan Mine Kimberley	9 070	-	-	5.10	4.02	58.29	-	2 472 236	-	-	93 080	116 576	126 606	-	
Dickenson Mines Limited Silvana Division Silmonac mine New Denver	110	-	-	10.40	6.17	733.71	-	7 382	-	-	427	765	5 275	-	

Equity Silver Mines Limited	5 300	0.59	-	-	-	122.80	1.17	2 089 710	9 021	-	-	-	143 837	748	
Erickson Gold Mines Ltd. Cassiar	180	-	-	-	-	7.89	10.63	83 153	-	-	-	-	476	780	
Esso Resources Canada Limited Esso Minerals Canada Division Granduc Mine	7 260	1.58	-	-	-	12.69	0.20	278 278	4 206	-	-	-	2 909	42	
Gibraltar Mines Limited McLeese Lake	36 290	0.31	-	-	-	0.82	-	13 142 194	33 920	-	-	-	5 476	-	Decision made to install 5 000 tpy copper leaching, solvent extraction, electrowinning operation in 1986.
Lornex Mining Corporation Ltd. Lornex mine Highland Valley	72 575	0.35	-	-	-	1.78	0.00	28 162 932	86 389	-	-	-	25 087	-	
Mosquito Creek Gold Mining Company Limited, The Cariboo	90	-	-	-	-	7.20	23.66	2 113	-	-	-	-	13	42	
Newmont Mines Limited Similkameen Division Princeton	19 960	0.39	-	-	-	1.92	0.17	6 516 308	21 677	-	-	-	6 250	525	
Noranda Inc.															
Bell Copper mine Granisle mine Babine Lake															Bell mine reopened September 9, 1985.
Goldstream Division	1 360	3.36	-	-	2.19	19.20	-	138 799	4 131	-	1 259	-	1 339	-	Mine did not operate in 1985.
Scottie Gold Mines Ltd. Summit Lake	180	-	-	-	-	7.20	16.18	43 685	-	-	-	-	307	623	
Teck Corporation															
Afton Operating Corporation	6 805	0.68	-	-	-	4.46	0.46	2 639 082	30 189	-	-	-	7 644	945	
Highmont Operating Corporation Highland Valley	22 680	0.22	-	-	-	-	-	6 049 857	11 775	-	-	-	-	-	Mine remained closed through 1985.
Beaverdell mine Beaverdell	110	-	-	0.20	0.40	322.63	-	36 795	-	-	109	61	10 394	-	

Principal Canadian Nonferrous and Precious Metal Mine Production in 1984, with Highlights for 1985 (cont'd)

Company and Mine/Mill Location	Capacity	Grades of Ore Milled						Ore Milled	Metal Contained in All Concentrates Produced						Highlights
		Cu	Ni	Pb	Zn	Ag	Au		Copper	Nickel	Zinc	Lead	Silver	Gold	
	(tonnes per day)	%	%	%	%	(g/tonne)		(tonnes)	(tonnes)				(kilograms)		
BRITISH COLUMBIA (cont'd)															
Westmin Resources Limited Lynx, Myra and Price mines Buttle Lake	907	1.02	-	1.03	7.42	105.60	2.26	203 636	1 947	-	14 057	1 979	19 014	405	H.W. orebody brought into production and mill capacity increased to 2 700 tpd. Price mine on standby in 1985.
YUKON TERRITORY															
United Keno Hill Mines Limited Elsa, Husky, No Cash, Keno mines Elsa	450	-	-	2.38	0.32	675.43	-	65 688	-	-	112	1 045	38 713	-	
NORTHWEST TERRITORIES															
Cominco Ltd. Con and Rycon mines Yellowknife	590	-	-	-	-	3.77	13.71	221 479	-	-	-	-	763	2 772	
Polaris Mine Little Cornwallis Island	2 050	-	-	3.82	13.71	-	-	819 063	-	-	108 333	30 283	-	-	
Echo Bay Mines Ltd. Lupin mine Contwoyto Lake	1 090	-	-	-	-	1.71	12.03	493 078	-	-	-	-	832	5 646	
Giant Yellowknife Mines Limited															
Yellowknife Division Giant Mine Yellowknife	1 090	-	-	-	-	1.54	7.82	295 333	-	-	-	-	310	1 884	
Salmita Division	160	-	-	-	-	4.90	26.19	55 069	-	-	-	-	257	1 381	
Nanisivik Mines Ltd. Nanisivik	1 500	-	-	1.14	10.20	47.73	-	692 900	-	-	67 558	7 473	27 653	-	
Pine Point Mines Limited Pine Point mine	10 000	-	-	2.30	7.60	-	-	2 278 873	-	-	163 485	51 089	-	-	
Royex Gold Mining Corporation Cullaton Lake Division Cullaton	300	-	-	-	-	0.62	7.89	128 629	-	-	-	-	50	908	
Terra Mines Ltd. Smallwood and Norex Mines Camsell River	360	-	-	0.15	0.10	1229.49	-	20 274	-	-	12	-	24 376	-	

Statistical Report

The statistical material contained in this summary was principally derived from surveys conducted by the Information Systems Division of the Mineral Policy Sector of Energy, Mines and Resources Canada.

The statistical survey program of Energy, Mines and Resources Canada is conducted jointly with the provincial governments and Statistics Canada. This joint program is intended to minimize the reporting burden on the mineral companies. The cooperation of the companies that provide information is greatly appreciated. Without this cooperation, a statistical report of this nature would not be possible. International mineral statistics contained in this summary are derived from the U.S. Bureau of Mines, The American Bureau of Metal Statistics, The World Bureau of Metal Statistics, **Metals Week, Engineering and Mining Journal,** The United Nations and the Organization for Economic Co-operation and Development (OECD).

This statistical summary of the mineral industry in Canada for the year 1985 was prepared by J.T. Brennan and staff, Statistics Section, Mineral Policy Sector, Energy, Mines and Resources Canada, Ottawa. Telephone (613) 995-9466.

STATISTICAL TABLES

Table No.

CANADA, GENERAL ECONOMIC INDICATORS, 1970-84

		1970	1971	1972	1973	1974
Gross national product, current dollars	$ million	85,685	94,450	105,234	123,560	147,528
Gross national product, constant dollars (1971 = 100)	"	88,390	94,450	100,248	107,812	111,678
Value of manufacturing industry shipments	"	46,381	50,276	56,191	66,674	82,455
Value of mineral production	"	5,722	5,963	6,408	8,370	11,754
Merchandise exports	"	16,401	17,397	19,671	24,838	31,739
Merchandise imports	"	13,952	15,618	18,669	23,325	31,722
Balance of payments, current account	"	+1,106	+431	-386	+108	-1,460
Corporation profits before taxes	"	7,699	8,681	10,799	15,417	20,062
Capital investment current dollars	"	18,015	20,800	23,051	27,848	34,260
Capital investment, constant dollars (1971 = 100)	"	18,904	20,800	21,955	24,384	25,694
Population	000's	21,297	21,568	21,802	22,043	22,364
Labour force	"	8,395	8,639	8,897	9,276	9,639
Employed	"	7,919	8,104	8,344	8,761	9,125
Unemployed	"	476	535	553	515	514
Unemployment rate	per cent	5.7	6.2	6.2	5.5	5.3
Labour income	$ million	46,706	51,528	57,570	66,501	79,846
Index industrial production	1971=100	94.9	100.0	107.6	119.0	122.8
Index manufacturing production	"	94.5	100.0	107.7	119.1	123.4
Index mining production	"	98.7	100.0	104.4	117.8	114.0
Index gross domestic product	"	94.4	100.0	105.2	114.1	119.3
Consumer price index	1981=100	41.0	42.2	44.2	47.6	52.8

[p] Preliminary; [r] Revised.

1975	1976	1977	1978	1979	1980	1981[r]	1982[r]	1983	1984[p]
165,343	191,857	210,189	232,211	264,279	297,556	339,797	358,302	390,340	420,819
113,005	119,612	121,988	126,347	130,362	131,765	136,108	130,065	134,353	140,614
88,427	98,076	109,747	129,019	152,133	165,985	188,212	183,432	200,247	226,096
13,347	15,693	18,473	20,319	26,135	31,926	32,420	33,831	38,534	43,071
32,587	37,651	43,685	52,259	64,317	74,446	81,203	84,540	90,825	112,510
34,716	37,494	42,363	50,108	62,871	69,274	79,129	66,726	73,120	91,680
-4,757	-3,842	-4,301	-4,935	-4,962	-1,096	-5,346	2,665	1,686	1,955
19,663	19,985	21,090	25,360	34,884	36,456	32,638	21,110	32,684	39,654
40,044	44,927	48,376	52,482	60,921	69,196	82,058	79,330	77,647	79,696
26,661	27,731	27,606	27,585	29,448	30,461	32,401	29,265	27,844	28,004
22,697	22,993	23,258	23,476	23,671	23,936	24,342	24,634	24,886	25,128
9,974	10,203	10,500	10,895	11,231	11,573	11,904	11,958	12,183	12,399
9,284	9,477	9,651	9,987	10,395	10,708	11,006	10,644	10,734	11,000
690	726	849	908	836	865	898	1,314	1,448	1,399
6.9	7.1	8.1	8.3	7.4	7.5	7.5	11.0	11.9	11.3
93,299	109,053	120,508	131,702	148,256	167,936	194,074	207,594	218,963	232,421
115.5	122.6	125.7	129.9	137.9	135.9	136.5	123.0	129.7	140.8
116.2	123.1	125.5	131.9	138.1	133.7	137.8	121.3	128.6	139.3
100.9	103.1	106.1	97.8	107.1	109.6	104.6	92.7	96.2	108.1
120.4	126.4	130.1	134.4	139.3	139.8	145.5	139.2	142.9	149.7
58.5	62.9	67.9	73.9	80.7	88.9	100.0	110.8	117.2	122.3

TABLE 1. **MINERAL PRODUCTION OF CANADA, 1983 AND 1984, AND AVERAGE 1980-84**

	Unit of Measure	1983		1984P		Average 1980-84	
		(Quantity)	($000)	(Quantity)	($000)	(Quantity)	($000)
Metals							
Antimony	t	385	2,093	510	3,014	948	3,548
Bismuth	t	253	1,267	220	2,596	195	1,411
Cadmium	t	1 193	3,657	1 602	7,820	1 110	5,170
Cesium, pollucite, rubidium	t	..	(1)	..	(1)	59	142
Calcium	t	..	(1)	..	(1)	456	3,587
Cobalt	t	1 410	23,563	2 325	66,805	1 841	74,447
Columbium (Cb_2O_5)	t	1 745	12,133	2 500	17,500	2 507	16,875
Copper	000 t	653	1,364,397	712	1,351,373	677	1,460,052
Gold	kg	73 512	1,230,886	81 316	1,227,847	64 444	1,102,850
Ilmenite	t	..	(1)	..	(1)	187 568	4,560
Indium	kg	..	(1)	..	(1)	1 291	1,070
Iron ore	000 t	32 959	1,269,924	41 065	1,470,910	41 168	1,478,223
Iron remelt	000 t	..	108,549	..	121,000	501 993	113,056
Lead	000 t	272	160,512	259	190,842	265	217,209
Lithium, lepidolite, spodumene	t	..	(1)	..	(1)	9	67
Magnesium	t	..	(1)	..	(1)	7 866	28,264
Molybdenum	t	10 194	87,710	10 865	108,916	11 952	188,713
Nickel	000 t	125	781,458	174	1,165,191	147	1,056,589
Platinum group	kg	6 965	..	10 831	..	9 916	118,888
Rhenium	kg	..	(1)	..	(1)	779	1,823
Selenium	t	266	2,687	354	9,129	275	6,311
Silver	t	1 197	544,723	1 149	401,744	1 172	529,728
Strontium	t	..	(1)	..	(1)	47	1,147
Tantalum (Ta_2O_5)	t	-	-	-	-	56	10,443
Tellurium	t	18	520	20	567	20	702
Tin	t	140	2,013	217	2,998	195	3,157
Tungsten (WO_3)	t	1 126	..	4 328	..	3 000	52,505
Uranium (U)	t	6 823	667,672	9 693	916,294	7 681	783,537
Zinc	000 t	988	1,135,179	1 022	1,438,030	954	1,111,416
Total metals			7,398,944		8,510,094		8,375,490
Nonmetals							
Arsenious trioxide	t	..	(1)	..	(1)	1 531	256,496
Asbestos	000 t	858	391,294	836	412,978	995	467,193
Barite	000 t	..	4,878	..	7,450	58	5,098
Bentonite	000 t	..	(1)	..	(1)	33	1,981
Diatomite	t	..	(1)	..	(1)	2 261	124
Gemstone	t	..	641	..	377	202	638
Graphite	t	..	(1)	..	(1)	1 598	786
Gypsum	000 t	7 507	59,297	8 725	69,154	7 316	52,291

Magnesitic dolomite and brucite	000 t	..	7,825	..	7,590	64	9,102
Marl	000 t	..	(1)	..	(1)	11	141
Mica	000 t	..	(1)	..	(1)	11	2,895
Nepheline syenite	000 t	523	18,131	485	17,671	549	17,166
Peat	000 t	529	47,810	499	56,225	489	49,981
Potash (K_2O)	000 t	6 294	645,767	6 972	759,270	6 465	809,344
Pumice	t	..	(1)	.	(1)	268	6
Pyrite, pyrrhotite	000 t	-	-	-	-	5	135
Quartz	000 t	2 303	38,467	2 624	41,863	2 224	35,215
Salt	000 t	8 602	172,787	10 294	214,866	8 370	160,329
Serpentine	t	..	(1)	..	(1)	3 745	438
Soapstone, talc & pyrophyllite	000 t	97	7,996	126	10,530	94	6,386
Sodium sulphate	000 t	454	42,636	387	37,076	481	39,409
Sulphur in smelter gas	000 t	678	42,322	848	63,300	766	44,791
Sulphur, elemental	000 t	6 631	427,358	7 700	574,177	7 390	532,642
Titanium dioxide	000 t	..	(1)	..	(1)	618	124,307
Total nonmetals			1,907,210		2,272,528		2,360,656
Fuels							
Coal	000 t	44 787	1,303,944	56 800	1,814,000	44 235	1,283,384
Natural gas	million m^3	72 229	7,077,210	73 656	7,514,628	76 559	6,884,742
Natural gas by-products	million m^3	18 013	2,681,146	19 397	2,782,930	18 781	2,337,920
Petroleum, crude	000 m^3	78 751	16,091,807	82 989	17,887,849	78 712	12,930,225
Total fuels			27,154,107		29,999,407		23,436,271
Structural materials							
Clay products	000 $	..	132,330	..	140,905	..	119,359
Cement	000 t	7 871	606,101	8 619	667,110	9 067	638,834
Lime	000 t	2 232	156,677	2 280	174,482	2 364	151,269
Sand and gravel	000 t	233 408	619,400	220 649	590,525	241 289	557,980
Stone	000 t	67 555	314,545	71 047	333,689	77 248	312,939
Total structural materials			1,829,053		1,906,711		1,780,382
Other minerals[1]		..	244,772	..	381,971		
Total all minerals			38,534,085		43,070,710		35,952,799

Notes: (1) Other minerals include those commodities for which the value of production is confidential.
P Preliminary; .. Not available; - Nil.

TABLE 2. CANADA, VALUE OF MINERAL PRODUCTION, PER CAPITA VALUE OF MINERAL PRODUCTION, AND POPULATION, 1955-84

	Metallics	Industrial Minerals	Fuels	Other Minerals[1]	Total	Per Capita Value of Mineral Production	Population of Canada
			($ million)			($)	(000)
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	19,291
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	20,378
1968	2,493	886	1,343		4,722	228.10	20,701
1969	2,378	891	1,465		4,734	225.42	21,001
1970	3,073	931	1,718		5,722	268.68	21,297
1971	2,940	1,008	2,015		5,963	276.46	21,568
1972	2,956	1,085	2,367		6,408	293.92	21,802
1973	3,850	1,293	3,227		8,370	379.69	22,043
1974	4,821	1,731	5,202		11,754	525.55	22,364
1975	4,796	1,898	6,653		13,347	588.05	22,697
1976	5,315	2,269	8,109		15,693	682.51	22,993
1977	5,988	2,612	9,873		18,473	794.26	23,258
1978	5,682	2,986	11,578	73	20,319	865.51	23,476
1979	7,924	3,514	14,617	81	26,135	1,104.11	23,671
1980	9,666	4,201	17,944	115	31,926	1,333.79	23,936
1981	8,753	4,486	19,012	136	32,420	1,331.85	24,342
1982	6,874	3,709	23,038	215	33,837	1,373.59	24,634
1983	7,398	3,736	27,154	245	38,534	1,548.43	24,886
1984P	8,510	4,179	29,999	382	43,071	1,714.06	25,128

[1] Other minerals include arsenious trioxide, bentonite, calcium, cesium, diatomite, graphite, ilmenite, indium, magnesium, mica, pumice, rhenium, rubidium, serpentine, strontium, titanium dioxyde for which the value of production is confidential.
P Preliminary.

TABLE 3. CANADA, VALUE OF MINERAL PRODUCTION BY PROVINCES, TERRITORIES AND MINERAL CLASSES, 1984P

	Metals		Industrial minerals		Fuels		Other minerals[1]		Total	
	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)
Alberta	43	x	858,771	20.5	25,104,921	83.7	-	-	25,963,735	60.3
Ontario	3,314,100	38.9	934,647	22.4	74,620	0.2	170,358	44.6	4,493,725	10.4
Saskatchewan	398,625	4.7	853,522	20.4	2,531,261	8.4	1,777	0.5	3,785,185	8.8
British Columbia	1,098,453	12.9	360,751	8.6	1,893,626	6.3	890	0.2	3,353,720	7.8
Quebec	1,146,942	13.5	743,883	17.8	-	-	152,600	40.0	2,043,425	4.7
Newfoundland	933,033	11.0	60,501	1.4	-	-	-	-	993,534	2.3
Manitoba	471,835	5.5	108,642	2.6	164,976	0.5	10,270	2.7	755,723	1.8
Northwest Territories	618,268	7.3	49,250	1.2	37,060	0.1	32,220	8.7	737,798	1.7
New Brunswick	472,293	5.5	74,946	1.8	30,343	0.1	12,856	3.4	590,368	1.4
Nova Scotia	-	-	130,433	3.1	162,600	0.5	-	-	293,033	0.7
Yukon	56,572	0.7	3,002	0.1	-	-	-	-	59,574	0.1
Prince Edward Island	-	-	890	x	-	-	-	-	890	x
Total	8,510,094	100.0	4,179,238	100.0	29,999,407	100.0	381,971	100.0	43,070,710	100.0

[1] Other minerals include arsenious trioxide, bentonite, calcium, cesium, diatomite, graphite, ilmenite, indium, magnesium, mica, pumice, rhenium, rubidium, serpentine, strontium, titanium dioxyde for which the value of production is confidential.
P Preliminary; - Nil; x - Amount too small to be expressed.

TABLE 4. PRODUCTION OF LEADING MINERALS, BY PROVINCES AND TERRITORIES, 1984P

	Unit of measure	Nfld.	P.E.I.	Nova Scotia	New Brunswick	Quebec	Ontario
Petroleum, crude	000 m^3	-	-	-	x	-	92
	$000	-	-	-	15	-	17,587
Natural gas	million m^3	-	-	-	2	-	453
	$000	-	-	-	28	-	57,033
Natural gas byproducts	000 m^3	-	-	-	-	-	-
	$000	-	-	-	-	-	-
Coal	000 t	-	-	3 110	575	-	-
	$000	-	-	162,600	30,300	-	-
Iron ore	000 t	21 670	-	-	-	14 745	4 478
	$000	867,662	-	-	-	362,448	235,065
Zinc	000 t	40	-	-	246	49	294
	$000	56,153	-	-	346,719	68,802	413,991
Copper	000 t	x	-	-	7	63	291
	$000	1,421	-	-	13,631	118,967	552,231
Gold	kg	183	-	-	502	29 282	26 472
	$000	2,757	-	-	7,573	442,158	399,731
Nickel	000 t	-	-	-	-	-	138
	$000	-	-	-	-	-	925,871
Uranium (U)	000 t	-	-	-	-	-	4
	$000	-	-	-	-	-	538,733
Potash (K_2O)	000 t	-	-	-	..	-	-
	$000	-	-	-	..	-	-
Cement	000 t	..	-	..	..	2 675	3 100
	$000	9,453	-	17,084	9,676	146,634	222,859
Sand and gravel	000 t	3 715	1 156	7 600	5 410	30 518	65 300
	$000	16,150	890	21,600	10,275	59,510	166,000
Sulphur, elemental	000 t	-	-	-	-	-	3
	$000	-	-	-	-	-	240
Asbestos	000 t	47	-	-	-	695	-
	$000	23,500	-	-	-	301,118	-
Silver	t	6	-	-	136	38	506
	$000	1,933	-	-	47,704	13,210	177,010
Stone	000 t	415	-	1 510	2 005	28 237	29 500
	$000	1,608	-	9,400	10,940	124,581	131,335
Salt	000 t	-	-	..	..	..	6 502
	$000	-	-	..	..	..	124,397
Lead	000 t	4	-	-	73	-	8
	$000	2,594	-	-	53,890	-	6,050
Lime	000 t	-	-	-	..	335	1 545
	$000	-	-	-	5,506	24,162	117,745
Clay products	$000	1,600	-	6,700	3,550	20,430	86,130
Iron, remelt	$000	-	-	-	-	121,000	-
Total leading minerals	$000	984,831	890	217,384[1]	539,807[1]	1,803,020[1]	4,171,768
Total all minerals	$000	993,534	890	293,033	590,368	2,043,425	4,493,725
Leading minerals as % of all minerals		99.1	100.0	74.2	91.4	88.2	92.8

[1] Value of salt and/or potash excluded.
P Preliminary; - Nil; .. Not available; x Less than 1 unit.

Manitoba	Saskat-chewan	Alberta	British Columbia	Yukon	N.W.T.	Total Canada
786	10 563	69 269	2 110	-	170	82 989
164,976	2,323,662	14,927,000	435,964	-	18,645	17,887,849
-	1 581	64 929	6 528	-	163	73 656
-	68,295	6,981,421	389,436	-	18,415	7,514,628
-	187	18 951	259	-	-	19 397
-	24,604	2,717,000	41,326	-	-	2,782,930
-	9 715	22 800	20 600	-	-	56 000
-	114,700	479,500	1,026,900	-	-	1,814,000
-	-	-	172	-	-	41 065
-	-	-	5,775	-	-	1,470,910
49	6	-	93	-	245	1 022
68,330	8,503	-	130,315	-	345,217	1,438,030
58	4	-	289	-	x	712
109,347	8,066	-	547,561	-	149	1,351,373
1 904	159	3	7 550	2 675	12 586	81 316
28,753	2,402	43	114,005	40,388	190,037	1,227,847
36	-	-	-	-	-	174
239,320	-	-	-	-	-	1,165,191
-	5	-	-	-	-	10
-	377,561	-	-	-	-	916,294
-	..	-	-	-	-	6 272
-	..	-	-	-	-	759,270
365	165	1 025	810	-	-	8 619
42,891	17,766	116,450	84,297	-	-	667,110
10 950	9 500	44 500	36 000	500	6 000	220 649
27,500	25,500	127,600	100,450	1,550	33,500	590,525
-	1	7 417	279	-	-	7 700
-	99	556,854	16,984	-	-	574,177
-	-	-	94	-	-	836
-	-	-	88,360	-	-	412,978
30	5	x	356	44	50	1 171
10,478	1,702	x	124,315	15,346	17,564	409,262
1 675	-	300	4 985	-	2 420	71 047
9,300	-	3,275	27,500	-	15,750	333,689
-	383	1 237	-	-	-	10 294
-	21,680	18,254	-	-	-	214,866
x	-	-	84	1	88	259
531	-	-	61,936	838	65,003	190,842
..	-	163	98	-	-	2 280
6,280	-	12,651	8,138	-	-	174,482
2,300	3,740	8,775	7,680	-	-	140,905
-	-	-		-	-	121,000
709,475	2,998,280[1]	25,948,823	3,210,942	58,122	704,280	42,158,158
755,723	3,785,185	25,963,735	3,353,720	59,574	737,798	43,070,710
93.9	79.2	99.9	95.7	97.6	95.5	97.9

TABLE 5. CANADA, PERCENTAGE CONTRIBUTION OF LEADING MINERALS TO TOTAL VALUE OF MINERAL PRODUCTION, 1978-84

	1978	1979	1980	1981	1982	1983	1984P
Oil, crude	28.7	28.6	28.4	29.2	36.0	41.8	41.5
Natural gas	19.4	18.6	19.3	19.8	21.5	18.4	17.4
Natural gas byproduct	5.3	5.5	5.7	6.5	6.8	7.0	6.5
Coal	3.8	3.3	2.9	3.3	3.8	3.4	4.2
Iron ore	6.0	6.9	5.3	5.4	3.6	3.3	3.4
Zinc	4.0	4.1	2.7	3.4	3.1	2.9	3.3
Copper	5.4	5.8	5.8	4.7	3.5	3.5	3.1
Gold	1.9	2.3	3.7	2.8	2.9	3.2	2.9
Nickel	3.1	3.2	4.7	3.8	1.8	2.0	2.7
Uranium (U)	3.1	2.4	2.2	2.5	2.5	1.7	2.1
Potash (K_2O)	2.5	2.8	3.2	3.1	1.9	1.7	1.8
Cement	2.8	2.5	1.8	2.1	2.0	1.6	1.5
Sand and gravel	2.1	1.8	1.6	1.6	1.6	1.6	1.4
Sulphur, elemental	0.5	0.6	1.4	2.0	1.7	1.1	1.3
Asbestos	2.6	2.3	1.9	1.7	1.1	1.0	1.0
Silver	1.2	1.8	2.6	1.4	1.2	1.4	1.0
Stone	1.6	1.3	1.1	1.0	0.8	0.8	0.8
Salt	0.5	0.4	0.4	0.4	0.5	0.4	0.5
Lead	1.3	1.6	0.9	0.8	0.6	0.4	0.4
Lime	0.4	0.3	0.4	0.5	0.4	0.4	0.4
Clay products	0.5	0.5	0.3	0.4	0.3	0.3	0.3
Iron, remelt	0.4	0.2	0.4	0.3	0.3	0.3	0.3
Other minerals	2.9	3.1	3.2	3.3	2.1	1.8	2.2
Total	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, 1978-84

	1978	1979	1980	1981	1982	1983	1984P
				($ million)			
Alberta	10,087	12,899	16,379	17,559	20,913	24,103	25,964
Ontario	2,698	3,265	4,640	4,160	3,148	3,682	4,494
Saskatchewan	1,582	1,874	2,315	2,293	2,313	2,843	3,785
British Columbia	1,883	2,677	2,795	2,822	2,769	2,902	3,354
Quebec	1,796	2,165	2,467	2,420	2,065	2,039	2,043
Newfoundland	675	1,125	1,036	1,030	647	807	994
Manitoba	459	653	803	642	530	733	756
Northwest Territories	310	435	425	447	503	595	738
New Brunswick	339	480	373	531	493	506	590
Nova Scotia	211	210	247	269	281	260	293
Yukon	219	299	361	236	169	63	60
Prince Edward Island	2	2	2	2	2	1	1
Total	20,261	26,084	31,842	32,410	33,831	38,534	43,071

P Preliminary.

TABLE 7. CANADA, PERCENTAGE CONTRIBUTION OF PROVINCES AND TERRITORIES TO TOTAL VALUE OF MINERAL PRODUCTION, 1978-84

	1978	1979	1980	1981	1982	1983	1984P
Alberta	49.8	49.5	51.4	54.2	61.8	62.5	60.3
Ontario	13.3	12.5	14.6	12.8	9.3	9.6	10.4
Saskatchewan	7.8	7.2	7.2	7.0	6.8	7.4	8.8
British Columbia	9.3	10.3	8.8	8.7	8.2	7.5	7.8
Quebec	8.9	8.3	7.7	7.5	6.1	5.3	4.7
Newfoundland	3.3	4.3	3.3	3.2	1.9	2.1	2.3
Manitoba	2.3	2.5	2.5	2.0	1.6	1.9	1.8
Northwest Territories	1.5	1.7	1.3	1.4	1.5	1.5	1.7
New Brunswick	1.7	1.8	1.2	1.6	1.5	1.3	1.4
Nova Scotia	1.0	0.8	0.8	0.8	0.8	0.7	0.7
Yukon	1.1	1.1	1.1	0.7	0.5	0.2	0.1
Prince Edward Island	0.01	0.01	0.01	0.01	0.01	x	x
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

P Preliminary; x - Too small to be expressed.

TABLE 8. CANADA, GROSS DOMESTIC PRODUCT BY INDUSTRY IN CONSTANT 1971 DOLLARS, 1978-84

	1978	1979	1980r	1981r	1982r	1983	1984P
				($ million)			
Goods producing industries							
Agriculture	2,996.5	2,702.8	2,958.9	3,189.4	3,294.9	3,248.3	3,239.3
Forestry	794.9	800.0	839.1	768.4	692.1	848.7	879.5
Fishing and trapping	179.5	182.8	172.6	189.8	189.0	188.4	169.4
Mining[1]	3,015.1	3,347.9	3,492.7	3,271.7	2,916.0	3,026.6	3,399.9
Manufacturing	25,139.9	26,587.7	25,809.1	26,078.1	23,103.4	24,485.8	26,518.1
Construction	6,706.0	7,108.6	7,042.0	7,447.6	6,718.5	6,615.9	6,338.5
Electrical power, gas and water utilities	3,521.6	3,692.6	3,829.3	3,924.3	3,958.0	4,105.2	4,411.7
Total	42,353.6	44,422.4	44,143.8	44,869.3	40,871.9	42,518.9	44,956.4
Service producing industries							
Transportation, storage and communication	11,462.3	12,212.5	12,498.4	12,955.2	12,190.2	12,274.6	13,117.8
Trade	14,206.5	14,998.2	15,023.4	15,212.8	14,181.8	14,776.2	15,602.7
Finance, insurance and real estate	14,119.9	14,768.5	15,388.3	16,013.2	16,107.6	16,443.5	16,808.6
Community, business and personnel services	21,888.1	22,007.6	22,740.3	23,861.0	24,133.6	24,480.1	25,576.0
Public administration and defense	7,927.5	7,886.7	7,985.5	8,141.7	8,403.4	8,512.0	8,619.6
Total	69,604.3	71,873.5	73,635.9	76,183.9	75,016.6	76,486.4	79,724.7
Grand total	111,957.9	116,295.9	117,779.7	121,053.2	115,888.5	119,005.3	124,681.1

[1] Cement, lime, clay and clay products (domestic clays) industries are included under "manufacturing".
P Preliminary; r Revised.

TABLE 9. CANADA'S WORLD ROLE AS A PRODUCER OF CERTAIN IMPORTANT MINERALS, 1983P

			Rank of Five Leading Countries				
		World	1	2	3	4	5
			Canada	U.S.S.R.	Australia	Peru	U.S.A.
Zinc (mine production)[2]	000 t	6 498	1 070	1 025	695	553	293
	% of world total		16.5	15.8	10.7	8.5	4.5
			U.S.S.R.	**Canada**	East Germany	West Germany	France
Potash (K_2O equivalent)	000 t	26 691	9 300	6 294	3 430	2 419	1 537
	% of world total		34.8	23.6	12.9	9.1	5.8
			U.S.S.R.	**Canada**	South Africa	Zimbabwe	Brazil
Asbestos	000 t	4 230	2 250	858	220	190	135
	% of world total		53.2	20.3	5.2	4.5	3.2
			U.S.A.	**Canada**	South Africa	Namibia	France
Uranium (U concentrates)[1]	t	37 110	8 140	7 140	6 060	3 800	3 240
	% of world total		21.9	19.2	16.3	10.2	8.7
			U.S.S.R.	**Canada**	Australia	New Caledonia	Cuba
Nickel (mine production)[2]	000 t	655	172	125	79	46	41
	% of world total		26.3	19.1	12.1	7.0	6.3
			U.S.A.	**Canada**	U.S.S.R.	Poland	France
Sulphur, elemental	000 t	33 071	8 159	5 933	5 165	4 990	1 855
	% of world total		24.7	17.9	15.6	15.1	5.6
			Australia	**Canada**	Norway	U.S.A.	U.S.S.R.
Titanium concentrates (ilmenite)	000 t	4 039	894	612	544	499	431
	% of world total		22.1	15.2	13.5	12.4	10.7
			U.S.A.	**Canada**	France	U.S.S.R.	Iran
Gypsum	000 t	77 881	11 688	7 507	5 987	5 443	5 443
	% of world total		15.0	9.6	7.7	7.0	7.0
			U.S.A.	U.S.S.R.	**Canada**	West Germany	Norway
Aluminum (primary metal)	000 t	14 310	3 353	2 400	1 091	743	715
	% of world total		23.4	16.8	7.6	5.2	5.0
			South Africa	U.S.S.R.	**Canada**	China	U.S.A.
Gold (mine production)[2]	t	1 385	680	267	71	61	59
	% of world total		49.1	19.2	5.1	4.4	4.2
			U.S.S.R.	South Africa	**Canada**	Japan	Colombia
Platinum group metals (mine production)[2]	kg	204 000	112 000	81 000	6 965	1 800	600
	% of world total		54.9	39.7	3.4	0.9	0.3
			Chile	U.S.A.	U.S.S.R.	**Canada**	Mexico
Molybdenum (Mo content)	000 t	60	15	13	11	10	6
	% of world total		25.0	21.7	18.3	16.7	10.0
			Chile	U.S.S.R.	U.S.A.	**Canada**	Zambia
Copper (mine production)[2]	000 t	8 220	1 257	1 180	1 038	625	543
	% of world total		15.3	14.3	12.6	7.6	6.6
			U.S.S.R.	Japan	U.S.A.	**Canada**	Belgium
Cadmium (smelter production)	t	17 665	2 750	2 215	1 382	1 296	1 217
	% of world total		15.5	12.5	7.8	7.3	6.9
			U.S.S.R.	U.S.A.	Australia	**Canada**	Peru
Lead (mine production)[2]	000 t	3 451	580	463	477	252	205
	% of world total		16.8	13.4	13.8	7.3	5.9
			Mexico	Peru	U.S.S.R.	U.S.A.	**Canada**
Silver (mine production)[2]	t	12 393	1 911	1 728	1 600	1 350	1 106
	% of world total		15.4	13.9	12.9	10.9	8.9

[1] Total of western world. [2] Metal content recovered in Canada plus estimated recoverable metal in ores and concentrates shipped for export.
P Preliminary.

TABLE 10. CANADA, CENSUS VALUE ADDED, TOTAL ACTIVITY, MINING AND MINERAL MANUFACTURING INDUSTRIES, 1977-83

	1977	1978	1979	1980	1981	1982	1983
				($ million)			
Mining							
Metallic minerals							
Gold	152.0	207.6	322.8	588.8	519.0	566.2	693.6
Silver-lead-zinc	279.8	372.7	671.9	513.6	380.3	351.1	294.2
Nickel-copper-zinc	1,244.3	1,288.5	2,469.7	2,992.2	2,007.9	1,144.9	1,567.3
Iron	807.3	717.0	1,022.2	1,005.0	1,036.0	761.4	644.6
Uranium	300.1	501.7	525.4	559.3	865.8	600.1	496.9
Miscellaneous metal mines	118.0	138.6	179.7	243.3	150.2	73.7	33.2
Total	2,901.4	3,226.1	5,191.6	5,902.2	4,959.3	3,497.4	3,729.8
Industrial minerals							
Asbestos	474.8	401.6	456.8	473.4	431.5	267.3	254.9
Gypsum	21.0	25.9	27.5	26.9	31.3	26.6	35.1
Peat	27.4	33.7	38.8	42.7	47.8	41.1	43.0
Potash	301.4	360.2	613.5	900.4	889.7	488.5	455.4
Sand and gravel	91.3	85.8	91.5	92.0	98.3	75.6	90.3
Stone	106.1	110.2	121.7	123.4	122.5	109.4	119.5
Miscellaneous nonmetals	116.5	122.6	140.1	152.8	171.0	183.5	201.8
Total	1,138.4	1,139.9	1,489.8	1,811.5	1,791.9	1,192.0	1,200.0
Fuels							
Coal	508.5	566.8	658.6	621.6	671.1	838.0	911.1
Petroleum and natural gas	8,698.3	10,078.6	12,554.1	14,917.3	15,924.6	18,899.8	22,171.3
Total	9,206.9	10,645.4	13,212.7	15,538.9	16,595.7	19,737.8	23,082.4
Total mining industry	13,246.7	15,011.4	19,894.1	23,252.6	23,347.0	24,442.9	28,012.2
Mineral manufacturing							
Primary metal industries							
Iron and steel mills	1,677.6	1,924.9	2,424.3	2,537.9	2,750.9	2,149.9	2,464.9
Steel pipe & tube mills	160.3	225.1	280.4	297.6	378.3	320.3	213.4
Iron foundries	257.7	273.8	298.2	266.9	266.0	279.9	326.0
Smelting and refining	1,176.1	1,387.2	1,401.0	1,976.9	1,808.9	1,493.0	1,912.4
Aluminum rolling, casting and extruding	193.7	154.3	249.0	273.5	292.8	289.9	328.2
Copper and alloy rolling, casting and extruding	78.5	93.1	131.5	103.7	129.3	101.6	117.7
Metal rolling, casting and extruding, nes	110.2	136.2	198.9	203.6	210.4	169.2	234.1
Total	3,654.0	4,194.7	4,983.3	5,660.1	5,836.6	4,803.8	5,596.9
Nonmetallic mineral products industries							
Cement manufacturers	275.0	319.9	388.8	357.3	422.2	387.4	407.5
Lime manufacturers	36.6	44.6	49.3	59.5	62.8	60.1	66.2
Concrete products manufacturers	273.5	309.3	328.7	324.6	378.5	349.7	333.6
Ready-mix concrete manufacturers	292.8	317.3	341.6	352.4	430.1	388.6	405.0
Clay products (domestic clay)	69.6	73.6	87.5	84.6	82.0	57.1	78.2
Clay products (imported clay)	39.8	43.1	44.9	51.6	50.9	37.9	37.2
Glass manufacturers	199.2	266.8	294.9	308.1	364.6	339.6	403.8
Glass products manufacturers	96.6	122.9	141.0	143.6	141.0	144.9	209.8
Abrasive manufacturers	64.1	70.6	79.4	92.1	95.9	80.4	91.4
Other nonmetallic mineral products industries	305.7	408.7	460.0	477.5	483.4	426.7	487.6
Total	1,652.9	1,976.8	2,226.2	2,251.3	2,510.5	2,272.4	2,521.4
Petroleum and coal products industries							
Petroleum refining	1,206.7	1,180.4	1,390.9	1,750.1	2,641.5	2,108.4	2,563.7
Manufacturers of lubricating oil and greases	36.8	36.9	38.3	26.7	35.0	31.7	24.8
Other petroleum and coal products industries	44.4	33.1	30.5	36.0	39.3	39.9	52.6
Total	1,287.9	1,250.4	1,459.8	1,812.8	2,715.8	2,180.1	2,641.1
Total mineral manufacturing	6,594.8	7,421.9	8,669.2	9,724.2	11,062.9	9,256.2	10,759.5
Total mining and mineral manufacturing	19,841.5	22,433.3	28,563.3	32,976.9	34,409.9	33,699.2	38,771.7

nes Not elsewhere specified.

TABLE 11. CANADA, INDEXES OF GROSS DOMESTIC PRODUCT OF INDUSTRIAL PRODUCTION, MINING AND MINERAL MANUFACTURING, 1970-84 (1971=100)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984P
Total industrial production	94.9	100.0	107.6	119.0	122.8	115.5	122.2	125.3	129.9	137.9	135.9	137.1	122.5	129.7	140.8
Total mining	98.7	100.0	104.4	117.8	114.0	100.9	103.1	106.1	95.8	106.4	110.2	104.6	91.8	96.2	108.1
Metals															
All metals	105.4	100.0	94.3	105.7	101.8	91.2	96.7	99.5	73.8	79.1	85.9	83.9	63.7	70.2	81.3
Placer gold and gold quartz mines	105.3	100.0	90.1	80.0	68.4	67.4	69.1	68.2	65.5	59.8	59.0	60.2	81.7	99.3	109.1
Iron mines	116.1	100.0	78.7	97.4	80.4	71.4	104.6	94.7	41.5	82.2	77.4	78.8	53.6	49.4	61.1
Other metal mines	103.0	100.0	98.6	109.3	109.3	97.7	96.0	102.4	82.8	81.9	92.6	89.4	67.9	74.7	85.8
Fuels															
All fuels	92.6	100.0	114.7	130.1	124.7	112.4	107.5	108.6	109.5	123.0	121.3	113.5	113.1	116.6	126.1
Coal	87.5	100.0	105.4	115.5	116.8	137.5	128.5	125.2	138.9	167.8	184.5	193.7	204.4	223.5	305.3
Crude oil and natural gas	93.0	100.0	115.4	131.2	125.3	110.5	105.9	107.3	107.3	119.6	116.5	107.5	106.2	108.4	115.4
Nonmetals															
All nonmetals	95.0	100.0	99.7	107.8	119.7	88.9	103.6	109.4	103.2	116.6	113.3	106.5	82.7	90.5	108.9
Asbestos	95.2	100.0	101.0	102.1	102.0	63.7	85.5	85.5	64.6	69.9	63.4	53.8	37.7	40.2	41.0
Mineral manufacturing															
Primary metals	100.9	100.0	101.3	112.2	118.7	107.0	105.6	113.2	119.5	121.6	121.2	121.3	97.4	106.6	124.0
Nonmetallic mineral products	86.6	100.0	109.1	119.5	125.2	117.7	120.5	119.4	127.3	134.6	122.7	119.9	95.3	104.1	109.4
Petroleum and coal products	94.4	100.0	115.3	136.1	136.8	130.9	120.0	112.1	110.8	97.7	97.6	102.9	89.6	103.1	110.9

P Preliminary.

TABLE 12. CANADA, INDEXES OF GROSS DOMESTIC PRODUCT BY INDUSTRIES, 1970-84 (1971=100)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984P
Gross domestic product, all industries	94.4	100.0	105.9	114.1	119.3	120.4	126.4	130.1	134.5	144.2	146.0	150.2	143.4	142.9	149.7
Agriculture	89.0	100.0	88.7	96.9	89.5	103.0	109.3	113.9	111.2	100.3	108.3	117.2	120.5	120.5	120.2
Forestry	103.3	100.0	105.7	113.7	112.1	97.8	105.4	110.8	118.7	119.6	123.5	113.4	92.9	126.8	131.4
Fishing and trapping	105.4	100.0	95.7	101.6	90.2	85.8	98.0	110.1	121.8	123.8	116.8	127.9	124.1	127.8	114.9
Mines (incl. milling), quarries and oil wells	98.7	100.0	104.4	117.8	114.0	100.9	103.1	106.1	95.8	106.4	110.2	104.6	91.8	96.2	108.1
Electric power, gas and water utilities	93.3	100.0	111.1	120.3	130.1	130.5	142.0	150.9	160.5	172.8	174.7	177.8	178.0	187.1	201.1
Manufacturing	94.5	100.0	107.7	119.1	123.4	116.2	123.1	125.5	132.0	140.1	136.1	138.3	121.6	128.6	139.3
Construction	90.9	100.0	103.0	106.1	110.3	116.0	119.6	117.3	114.7	121.6	120.5	127.9	113.6	113.2	108.4
Transportation, storage and communications	94.2	100.0	108.5	117.9	125.0	126.5	134.2	141.6	148.6	204.9	211.5	217.4	210.9	162.4	173.8
Trade	93.2	100.0	109.9	119.8	129.5	132.5	138.0	139.8	144.9	153.0	153.1	154.4	144.0	150.7	159.1
Community, business and personal service	95.5	100.0	104.8	109.5	115.8	121.1	127.3	131.2	136.1	136.9	141.5	148.5	148.4	152.2	159.0
Finance, insurance and real estate	94.6	100.0	105.3	114.0	120.9	125.9	132.3	140.2	147.3	154.1	159.9	167.1	168.0	171.5	175.3
Public administration and defence	95.2	100.0	104.2	109.7	113.9	119.4	123.0	125.7	128.9	128.2	129.8	132.3	136.7	138.4	140.1

P Preliminary.

TABLE 13. CANADA, GROSS DOMESTIC PRODUCT FOR SELECTED INDUSTRIES BY PROVINCE, 1983

	Newfoundland	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Yukon and Northwest Territories	Canada
						($ million)						
Agriculture	20.5	102.4	119.0	110.1	1,208.8	2,530.2	666.5	2,124.1	1,766.7	548.3	..	9,186.6
Forestry	39.5	0.2	27.0	138.3	339.7	383.0	15.3	36.6	36.9	1,304.9	..	2,321.4
Fishing, Hunting and Trapping	116.4	30.0	192.8	55.8	43.8	28.6	13.1	4.3	5.2	148.2	3.1	641.4
Mining[1]	272.2	-	131.8	83.2	791.3	1,613.0	333.5	1,507.8	14,435.6	1,268.0	241.5	20,689.3
Manufacturing	431.4	78.9	1,099.3	952.7	17,587.5	35,131.8	1,635.4	702.5	3,264.6	5,870.1	13.6	66,771.0
Construction	373.3	56.0	517.9	336.6	3,264.2	4,904.0	495.7	847.8	3,217.5	2,296.1	343.5	16,652.6
Electric power, gas and water utilities	242.0	20.4	330.2	439.6	3,770.0	4,071.0	535.8	1,312.3	1,197.6	1,238.5	53.1	12,198.2
Goods-producing industries	1,495.3	287.9	2,418.0	2,106.3	27,005.5	48,654.3	3,695.3	5,535.4	23,924.1	12,674.1	654.8	128,460.5

[1] Cement, lime, clay and clay products (domestic clays) industries are included under "manufacturing".
.. Not available; - Nil.

TABLE 14. CANADA, GROSS DOMESTIC PRODUCT FOR MINING BY PROVINCE, 1977-83

	Newfoundland	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Yukon and Northwest Territories	Canada
						($ million)						
1977	346.6	-	113.4	65.6	737.1	1,203.1	125.4	660.5	4,804.2	866.9	155.2	9,064.6
1978	230.7	-	103.9	113.2	708.3	1,217.0	184.9	861.4	5,245.9	924.5	215.2	9,794.3
1979	459.2	-	111.1	206.4	1,175.2	1,519.9	426.4	1,045.3	7,120.6	1,507.3	262.2	13,921.7
1980	410.3	-	120.0	88.6	1,123.6	2,806.1	522.6	1,333.0	9,641.6	1,464.3	368.0	17,851.2
1981	444.6	-	126.8	169.8	1,059.9	2,317.7	397.5	1,329.2	9,782.4	1,484.5	220.4	17,288.7
1982	334.2	-	141.2	122.5	831.2	1,327.5	271.8	1,250.1	11,942.0	1,102.2	221.0	17,497.7
1983	272.2	-	131.8	83.2	791.3	1,613.0	333.5	1,507.8	14,435.6	1,268.0	241.5	20,689.3

- Nil.

TABLE 15. CANADA, VALUE OF EXPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS, 1978-84

	1978	1979	1980	1981	1982	1983	1984P
				($ million)			
Ferrous							
Crude material	854.5	1,469.5	1,342.9	1,540.0	1,103.7	1,054.3	1,206.9
Fabricated material	1,696.0	1,947.6	2,358.0	2,664.9	2,295.9	2,011.6	2,666.1
Total	2,550.6	3,417.1	3,701.1	4,205.0	3,399.7	3,065.9	3,873.0
Nonferrous							
Crude material	1,549.2	2,425.1	2,866.6	2,544.0	2,088.3	1,845.9	2,463.2
Fabricated material	3,360.9	3,807.1	6,273.8	5,615.6	4,980.1	5,624.5	6,664.5
Total	4,910.1	6,232.1	9,140.4	8,159.6	7,068.4	7,470.5	9,127.6
Nonmetals							
Crude material	1,369.7	1,715.3	2,305.0	2,618.7	2,132.6	2,103.5	2,767.2
Fabricated material	377.2	455.9	412.5	439.7	408.2	424.8	546.8
Total	1,746.8	2,171.2	2,717.5	3,058.3	2,540.8	2,528.3	3,314.1
Mineral fuels							
Crude material	4,514.9	6,128.9	7,816.8	8,022.0	8,752.4	8,727.9	10,123.5
Fabricated material	1,022.7	1,885.3	2,324.2	2,642.0	2,537.9	2,815.6	3,192.7
Total	5,537.6	8,014.2	10,141.0	10,664.0	11,290.3	11,534.5	13,316.2
Total minerals and products							
Crude material	8,288.2	11,738.8	14,331.4	14,724.6	14,077.0	13,731.6	16,560.8
Fabricated material	6,456.8	8,095.8	11,368.7	11,362.3	10,222.2	10,876.6	13,070.1
Total	14,745.0	19,834.7	25,700.1	26,086.9	24,299.2	24,608.3	29,630.9

P Preliminary.

TABLE 16. CANADA, VALUE OF IMPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS, 1978-84

	1978	1979	1980	1981	1982	1983	1984P
				($ million)			
Ferrous							
Crude material	223.8	322.1	354.2	373.2	227.5	285.2	398.9
Fabricated material	1,838.3	2,533.9	2,329.0	3,303.2	2,113.2	2,004.6	2,701.2
Total	2,062.1	2,856.0	2,683.2	3,676.4	2,340.6	2,289.8	3,100.1
Nonferrous							
Crude material	480.9	808.1	1,778.3	1,509.4	1,254.8	1,365.9	1,456.5
Fabricated material	949.1	2,122.7	2,784.6	2,433.4	1,861.1	2,358.7	2,576.9
Total	1,430.0	2,930.8	4,562.9	3,942.8	3,116.0	3,724.6	4,033.4
Nonmetals							
Crude material	231.0	284.5	329.3	339.3	279.8	271.9	322.2
Fabricated material	526.8	644.7	724.2	805.3	671.6	746.3	884.9
Total	757.8	929.2	1,053.5	1,144.6	951.4	1,018.2	1,207.1
Mineral fuels							
Crude material	4,092.8	5,364.3	7,732.3	8,696.9	5,912.6	4,115.8	4,470.8
Fabricated material	344.8	394.0	687.7	881.3	862.1	1,046.4	1,652.5
Total	4,437.6	5,758.3	8,420.0	9,578.2	6,774.7	5,162.3	6,123.3
Total minerals and products							
Crude material	5,028.6	6,779.0	10,194.1	10,918.7	7,674.6	6,038.8	6,648.3
Fabricated material	3,659.0	5,695.3	6,525.4	7,423.3	5,507.9	6,156.0	7,815.6
Total	8,687.6	12,474.3	16,719.5	18,342.0	13,182.5	12,194.8	14,464.0

P Preliminary.

TABLE 17. CANADA, VALUE OF EXPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS IN RELATION TO TOTAL EXPORT TRADE, 1974, 1979 AND 1984

	1974		1979		1984P	
	($ million)	(%)	($ million)	(%)	($ million)	(%)
Crude material	7,407.4	22.7	11,738.8	17.9	16,560.8	18.2
Fabricated material	3,810.1	11.7	8,095.8	12.3	13,070.1	14.4
Total	11,217.5	34.4	19,834.7	30.2	29,630.9	32.6
Total exports, all products	32,590.9	100.0	65,581.6	100.0	90,825.0	100.0

P Preliminary.

TABLE 18. CANADA, VALUE OF IMPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS IN RELATION TO TOTAL IMPORT TRADE, 1974, 1979 AND 1984

	1974		1979		1984P	
	($ million)	(%)	($ million)	(%)	($ million)	(%)
Crude material	3,473.8	11.2	6,779.0	11.1	6,648.3	9.1
Fabricated material	3,275.7	10.6	5,695.3	9.3	7,815.6	10.6
Total	6,749.5	21.8	12,474.3	20.4	14,464.0	19.8
Total imports, all products	30,902.0	100.0	61,157.0	100.0	73,119.9	100.0

P Preliminary.

TABLE 19. CANADA, VALUE OF EXPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS, BY MAIN GROUPS AND DESTINATION, 1984P

	United States	United Kingdom	EFTA[1]	EEC[2]	Japan	Other Countries	Total
				($ million)			
Ferrous materials and products	3,045.2	142.0	12.6	354.5	96.1	222.6	3,873.0
Nonferrous materials and products	5,913.8	559.8	354.1	682.5	891.4	726.1	9,127.6
Nonmetallic mineral materials and products	1,521.5	38.7	34.4	300.9	137.4	1,281.2	3,314.1
Mineral fuels materials and products	11,317.7	20.5	19.4	115.9	1,356.3	486.4	13,316.2
Total	21,798.1	760.9	420.5	1,453.8	2,481.2	2,716.3	29,630.9
Percentage of total mineral exports	73.6	2.6	1.4	4.9	8.4	9.1	100.0

[1] European Free Trade Association includes Austria, Norway, Portugal, Sweden, Switzerland, Finland and Iceland. [2] European Economic Community includes Belgium-Luxembourg, France, Italy, Netherlands, West Germany, Greece, Denmark and Ireland.
P Preliminary.

TABLE 20. CANADA, VALUE OF IMPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS, BY MAIN GROUPS AND ORIGIN, 1984P

	United States	United Kingdom	EFTA[1]	EEC[2]	Japan	Other Countries	Total
				($ million)			
Ferrous materials and products	1,945.6	139.8	105.5	372.7	237.8	298.6	3,100.1
Nonferrous materials and products	2,796.2	45.2	77.1	279.0	91.6	744.3	4,033.4
Nonmetallic mineral materials and products	844.2	20.3	16.5	171.4	53.6	101.2	1,207.1
Mineral fuels materials and products	2,516.2	528.8	8.0	149.8	0.4	2,920.2	6,123.3
Total	8,102.2	734.0	207.1	972.9	383.4	4,064.3	14,464.0
Percentage of total mineral imports	56.0	5.1	1.4	6.7	2.7	28.1	100.0

[1] European Free Trade Association includes Austria, Norway, Portugal, Sweden, Switzerland, Finland and Iceland. [2] European Economic Community includes Belgium-Luxembourg, France, Italy, Netherlands, West Germany, Greece, Denmark and Ireland.
P Preliminary.

TABLE 21A. CANADA, VALUE OF EXPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS, BY COMMODITY AND DESTINATION, 1984P

	United States	United Kingdom	EFTA[1]	EEC[2]	Japan	Other Countries	Total
				($000)			
Fuels	11,317,684	20,513	19,354	115,860	1,356,349	486,418	13,316,178
Aluminum	1,621,813	6,501	797	52,115	189,764	192,312	2,063,302
Copper	560,288	76,359	64,800	114,471	286,041	206,051	1,308,010
Potash	651,625	3,817	-	24,683	83,623	394,984	1,158,732
Nickel	440,205	198,429	246,533	120,460	89,755	48,672	1,144,054
Iron Ore	591,504	129,840	7,976	273,188	68,667	40,879	1,112,054
Zinc	478,551	56,928	6,417	218,211	41,526	161,577	963,210
Asbestos	97,324	25,784	14,894	91,342	46,309	247,095	522,748
Uranium	295,684	28,188	-	6,354	3,475	-	333,701
Lead	71,013	14,216	1,519	21,859	243	5,542	114,392
Other ferrous metals	57,073	2,560	-	14,360	2,542	18,291	94,826
Molybdenum	3,491	8,821	-	38,855	26,809	7,748	85,724
All other minerals	5,611,863	188,964	58,214	362,028	286,129	906,722	7,413,920
Total	21,798,118	760,920	420,504	1,453,786	2,481,232	2,716,291	29,630,851

[1] European Free Trade Association includes Austria, Norway, Portugal, Sweden, Switzerland, Finland and Iceland. [2] European Economic Community includes Belgium-Luxembourg, France, Italy, Netherlands, West Germany, Greece, Denmark and Ireland.
P Preliminary; - Nil.

TABLE 21B. CANADA, VALUE OF IMPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS, BY COMMODITY AND ORIGIN, 1984P

	United States	United Kingdom	EFTA[1]	EEC[2]	Japan	Other Countries	Total
				($000)			
Fuels	2,516,199	528,778	7,952	149,782	444	2,920,185	6,123,340
Other ferrous metals	1,657,512	139,833	105,775	372,720	237,760	293,709	2,807,309
Precious metals	1,567,702	6,710	12,756	4,937	2,385	125,883	1,720,373
Aluminum	610,984	13,886	5,653	174,899	74,725	334,368	1,214,515
Copper	202,413	3,058	8,193	16,648	8,278	75,840	314,430
Refractory materials	201,120	6,961	3,250	53,665	15,352	17,777	298,125
Iron Ore	288,105	-	-	2	-	4,639	292,746
Glass products	167,971	2,327	2,573	8,212	13,888	3,263	198,234
Gemstones	43,534	4,806	1,800	69,654	2,903	42,173	164,870
Phosphate rock	120,852	-	-	-	-	-	120,852
Nickel	49,432	12,279	23,240	7,598	770	18,174	111,493
All other minerals	676,386	15,407	36,174	114,771	26,924	228,004	1,097,666
Total	8,102,210	734,045	207,366	972,888	383,429	4,064,015	14,463,953

[1] European Free Trade Association includes Austria, Norway, Portugal, Sweden, Switzerland, Finland and Iceland. [2] European Economic Community includes Belgium-Luxembourg, France, Italy, Netherlands, West Germany, Greece, Denmark and Ireland.
P Preliminary; - Nil.

TABLE 22. CANADA, PHYSICAL VOLUME OF IMPORT TRADE FOR SELECTED COMMODITIES, 1978-84

	Units of Weight	1978	1979	1980	1981	1982	1983	1984P
Crude materials								
Metals								
Iron ore	t	4 685 868	5 912 581	5 875 292	5 794 604	3 359 286	4 013 109	4 946 892
Bauxite ore	t	2 434 435	2 149 636	3 504 368	2 734 771	2 574 762	2 329 910	2 451 542
Alumina	t	1 056 190	952 584	983 972	1 020 568	939 282	1 063 181	1 349 213
Manganese ore	t	136 446	45 150	95 161	119 748	71 658	42 260	77 545
Nonmetals								
Phosphate rock	t	3 043 899	3 341 039	3 816 514	3 245 430	2 477 187	2 662 725	3 169 613
Limestone, crushed	t	2 873 601	3 215 717	2 418 330	2 526 863	1 485 420	1 799 861	1 944 046
Sand & gravel	t	1 810 989	1 201 915	1 209 582	1 446 864	1 179 279	878 614	1 266 983
Silica sand	t	1 242 444	1 651 890	1 200 237	1 142 875	788 764	982 662	1 076 082
Salt & brine	t	1 330 474	1 275 627	1 151 203	1 254 985	1 526 873	814 264	1 053 196
Clay, ground & unground	t	381 486	445 231	403 282	413 046	345 389	369 019	403 485
Bentonite	t	353 790	638 307	471 684	311 255	238 031	187 221	377 054
Fluorspar	t	170 237	167 904	223 940	173 599	126 594	141 928	166 709
Fuels								
Coal	t	13 000 320	17 381 794	15 719 025	14 687 202	15 488 032	14 509 685	19 060 700
Petroleum, crude	m^3	36 754 037	35 330 535	32 710 030	30 752 166	19 671 110	14 412 728	14 849 658
Fabricated materials								
Metals								
Steel:								
sheets & strips	t	704 502	1 039 054	582 233	1 717 118	540 409	534 621	699 700
bars & rods	t	318 336	300 069	189 853	340 773	219 619	278 143	407 450
pipes & tubes	t	317 031	285 144	322 121	364 868	249 582	217 379	316 040
structural shapes	t	151 502	273 111	207 657	362 890	120 368	162 244	234 429
castings & forgings	t	116 473	139 095	129 363	118 476	70 425	92 414	135 853
Ferroalloys	t	101 160	167 232	118 516	117 905	64 662	71 611	106 523
Aluminum & aluminum alloy	t	119 154	168 125	128 150	139 356	125 611	152 591	61 782
Nonmetals								
Phosphate fertilizers	t	286 744	381 887	248 328	307 220	249 833	360 304	340 177
Cement	t	256 721	248 422	223 247	721 216	231 834	253 015	236 233
Fire bricks	t	156 002	227 156	236 205	187 016	132 601	154 795	176 767
Fuels								
Fuel oil	000 l	1 277 077	871 425	1 617 606	1 256 790	1 571 003	1 468 464	2 399 280
Coke	t	1 527 342	1 366 182	1 311 535	1 436 068	1 051 315	1 345 806	1 546 991

P Preliminary.

TABLE 23. CANADA, PHYSICAL VOLUME OF EXPORT TRADE FOR SELECTED COMMODITIES, 1978–84

	Unit of Weight	1978	1979	1980	1981	1982	1983	1984P
Crude material								
Metals								
Iron, ores	t	31 929 094	48 849 270	39 020 922	41 451 255	27 281 255	25 527 958	30 737 460
Zinc, ores & concentrates	t	688 186	598 279	435 831	516 216	457 757	660 792	539 635
Copper, ores & concentrates	t	282 159	315 211	286 076	276 816	257 934	313 796	339 053
Lead, ores & concentrates	t	142 693	151 485	147 008	146 307	106 744	85 459	72 937
Nonmetals								
Potash	t	9 275 810	10 630 583	10 554 060	10 067 995	7 221 493	8 963 834	11 214 970
Sulphur, crude	t	4 984 545	5 154 831	6 850 143	7 309 175	6 111 418	5 670 278	7 326 848
Gypsum	t	5 178 631	5 474 764	4 960 240	5 094 845	4 775 755	5 187 032	6 224 574
Salt and brine	t	1 608 582	1 822 120	1 655 768	1 507 698	1 721 883	1 914 627	2 530 039
Limestone, crushed	t	1 710 348	2 296 295	2 214 489	1 758 290	1 517 491	1 390 795	1 216 676
Asbestos, crude & fibers	t	1 398 081	1 461 042	1 217 737	1 062 185	880 684	753 911	795 859
Crude refractory materials	t	1 081 684	1 023 734	803 892	629 781	40 839	241 131	579 487
Nepheline syenite	t	420 961	471 056	448 468	476 275	414 785	398 299	387 069
Sand and gravel	t	269 216	323 639	383 533	318 633	168 690	95 633	109 812
Fuels								
Coal	t	13 657 514	13 852 848	14 310 782	16 285 068	15 528 535	16 978 594	24 354 993
Natural gas	000 m^3	24 992 242	28 047 648	22 963 134	21 689 772	22 074 597	20 023 254	21 061 258
Fabricated materials								
Metals								
Aluminum, pig ingots	t	863 320	551 957	784 720	725 452	896 377	925 402	834 195
Zinc, pig ingots	t	439 260	429 352	472 148	453 538	470 395	500 448	529 655
Iron, pig ingots	t	544 716	255 523	562 351	466 358	485 616	348 278	392 135
Copper, refinery shapes	t	247 727	191 211	335 200	263 052	232 624	298 527	345 980
Lead, pig ingots	t	131 950	117 992	126 538	119 816	146 130	147 263	124 149
Nonmetals								
Cement	t	1 634 582	2 288 822	1 550 562	1 578 684	1 752 141	1 561 081	2 113 382
Peat	t	312 903	358 267	390 457	326 828	356 028	396 883	460 599
Lime, quick & hydrated	t	478 551	490 863	403 166	432 853	281 251	215 941	186 748
Fuels								
Fuel oil	000 l	4 232 409	4 654 162	4 273 510	3 846 906	2 721 922	3 825 520	4 420 429
Propane gas, liquified	000 l	3 543 782	4 858 175	3 879 915	3 867 950	4 513 284	3 534 562	3 880 987
Butane gas, liquified	000 l	2 208 682	2 926 459	2 563 406	3 137 545	3 572 545	3 011 710	3 280 303
Gasoline	000 l	972 282	913 271	706 539	600 969	536 268	1 240 028	1 589 258
Coke	t	352 358	354 016	470 496	392 662	235 924	110 929	171 525

P Preliminary.

TABLE 24. CANADA, APPARENT CONSUMPTION[1] OF SOME MINERALS, AND RELATION TO PRODUCTION[2], 1982-84

		1982			1983			1984P		
	Unit of Measure	Apparent Consumption	Production	Consumption as % of Production	Apparent Consumption	Production	Consumption as % of Production	Apparent Consumption	Production	Consumption as % of Production
Asbestos	t	-	834 249	-	104 047	857 504	12.1	40 467	836 000	4.8
Cement	t	6 636 084	8 156 391	81.4	6 198 902	7 506 968	82.6	6 628 337	8 724 813	76.0
Gypsum	t	1 674 259	5 987 396	28.1	2 784 785	7 870 878	35.4	2 525 835	8 618 600	29.3
Iron ore	t	8 666 497	33 197 561	26.1	11 443 829	32 958 678	34.7	15 274 761	41 065 329	37.2
Lime		1 932 124	2 197 298	87.9	2 038 588	2 231 685	91.3	2 118 000	2 279 900	92.9
Quartz silica	t	2 447 231	1 703 059	143.7	3 182 424	2 303 451	138.2	3 584 295	2 624 002	136.6
Salt	t	7 749 081	7 940 331	97.6	7 502 020	8 602 383	87.2	8 817 262	10 294 105	85.7

1 "Apparent consumption" is production, plus imports, less exports. 2 "Production" refers to producers' shipments.
P Preliminary; - Nil.

TABLE 25. CANADA, REPORTED CONSUMPTION OF MINERALS AND RELATION TO PRODUCTION, 1981-83

	Unit of Measure	1981 Consumption	1981 Production	1981 Consumption as % of Production	1982 Consumption	1982 Production	1982 Consumption as % of Production	1983P Consumption	1983P Production	1983P Consumption as % of Production
Metals										
Aluminum	t	336 989	1 115 691	30.2	273 523	1 064 795	25.7	337 469	1 091 212	30.9
Antimony	kg	209 829	..	..	161 034	..	..	217 352	385 358	56.4
Bismuth	kg	10 094	167 885	6.0	10 074	189 132	5.3	7 241	253 023	2.9
Cadmium	kg	34 092	833 788	4.1	33 818	886 055	3.8	32 885	1 193 379	2.8
Chromium (chromite)	t	24 771	-	..	15 330	-	..	15 682	-	..
Cobalt	kg	101 334	2 080 395	4.9	80 953	1 274 484	6.4	100 996	1 409 626	7.2
Copper[1]	t	216 759	691 327	31.4	130 559	612 455	21.3	170 443	653 040	26.1
Lead[2]	t	137 245	268 556	51.1	114 260	272 187	42.0	108 556	271 961	39.9
Magnesium	t	6 387	..	..	5 005	..	..	5 568	..	..
Manganese ore	t	288 908	-	..	130 826	-	..	96 697	-	..
Mercury	kg	35 635	-	..	27 589	-	..	35 992	-	..
Molybdenum (Mo content)	t	1 315	12 850	10.2	671	13 961	4.8	490	10 194	4.8
Nickel	t	8 603	160 247	5.4	6 723	88 581	7.6	5 015	125 022	4.0
Selenium	kg	9 414	255 369	3.7	10 469	222 323	4.7	11 706	265 672	4.4
Silver	kg	292 130	1 129 394	25.9	180 459	1 313 630	13.7	283 349	1 197 031	23.6
Tellurium	kg	..	31 145	..	..	18 423	..	..	16 391	..
Tin	t	3 766	239	1 575.7	3 528	135	2 613.3	3 381	140	2 415.0
Tungsten (W content)	kg	401 447	2 515 165	16.0	485 606	3 029 730	16.0	503 651	1 125 558	44.7
Zinc	t	113 061	911 178	12.4	100 233	965 607	10.4	116 257	987 713	11.8
Nonmetals										
Barite	t	94 027	78 154	120.3	24 359	23 552	103.4	66 086	45 465	145.4
Feldspar	t	4 606	-	..	2 790	-	..	2 213	-	..
Fluorspar	t	135 091	-	..	173 431	-	..	163 509	-	..
Mica	kg	2 259	..	..	2 745	..	..	3 002	..	..
Nepheline syenite	t	97 734	587 565	16.6	85 373	550 480	15.5	94 634	523 249	18.1
Phosphate rock	t	3 264 779	-	..	2 581 671	-	..	2 922 484	-	..
Potash (K_2O)	t	196 184	6 548 701	3.0	228 460	5 308 532	4.3	229 443	6 293 747	3.6
Sodium sulphate	t	216 298	535 214	40.4	191 843	547 208	35.0	191 618	453 939	42.2
Sulphur	t	847 230	8 017 885	10.6	1 011 534	6 945 183	14.6	1 153 571	7 309 409	15.8
Talc, etc.	t	38 984	82 715	47.1	38 633	70 523	54.8	38 920	97 030	40.1
Fuels										
Coal	000t	38 367	40 088	95.7	41 500	42 906	96.7	42 122	44 787	94.0
Natural gas[3]	million m^3	42 886	73 824	58.1	46 143	69 288	66.6	43 832	72 229	60.7
Crude oil[4]	000 m^3	100 777	74 553	135.2	86 528	79 255	109.2	81 706	78 751	103.8

Note: 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 content of ores, concentrates, matte, etc., and 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] Consumption defined as producers domestic shipments of refined metal. [2] Consumption includes primary and secondary refined metal. [3] Consumption defined as domestic sales. [4] Consumption defined as refinery receipts.

P Preliminary; - Nil; .. Not available or not applicable.

69.28

TABLE 26. CANADA, DOMESTIC CONSUMPTION OF PRINCIPAL REFINED METALS IN RELATION TO REFINERY PRODUCTION[1], 1977-83

	Unit of measure	1977	1978	1979	1980	1981	1982	1983P
Copper								
Domestic consumption[2]	t	200 372	228 694	210 689	195 124	216 759	130 559	170 443
Production	t	508 767	446 278	397 263	505 238	476 655	337 780	464 333
Consumption of production	%	39.4	51.2	53.0	38.6	45.5	38.6	36.7
Zinc								
Domestic consumption[3]	t	105 412	121 375	131 317	116 618	113 061	100 233	116 257
Production	t	494 938	495 243	580 449	591 565	618 650	511 870	617 033
Consumption of production	%	21.3	24.5	22.6	19.7	18.3	19.6	26.9
Lead								
Domestic consumption[3]	t	106 962	100 762	126 464	130 988	137 245	114 260	108 556
Production	t	187 457	194 054	183 769	162 463	168 450	174 310	178 043
Consumption of production	%	57.1	51.9	68.8	80.6	81.5	65.5	60.9
Aluminum								
Domestic consumption[4]	t	322 393	380 291	398 834	329 400	336 989	273 523	337 469
Production	t	973 524	1 048 469	860 287	1 068 197	1 115 691	1 064 795	1 091 212
Consumption of production	%	34.1	36.3	46.4	30.8	30.2	25.7	30.9

1 Production of refined metal from all sources, including metal derived from secondary materials at primary refineries. 2 Producers' domestic shipments of refined metal. 3 Consumption of primary and secondary refined metal, reported by consumers. 4 Consumption of primary refined metal, reported by consumers.
P Preliminary.

TABLE 27. AVERAGE ANNUAL PRICES[1] OF SELECTED MINERALS, 1978-84[2]

	Unit of measure	1978	1979	1980	1981	1982	1983	1984
Aluminum, major U.S. producer[3]	cents/lb	53.075	59.395	69.566	57.274	44.966	65.342	56.526
Antimony, New York dealer	$/lb	1.145	1.407	1.508	1.355	1.072	0.913	1.512
Asbestos, No. 4 cement fibre	Cdn $/st	642.000	687.000	769.000	850.000	876.000	1,083.000	1,083.000
Bismuth, U.S. producer	$/lb	3.378	3.011	2.637	2.044	2.300	2.300	4.141
Cadmium, U.S. producer	$/lb	2.450	2.760	2.843	1.927	1.113	1.129	1.693
Calcium, metal crowns	$/lb	1.680	1.868	2.502	2.831	3.050	3.050	3.099
Chrome, U.S. metal, 9% carbon	$/lb	3.080	3.375	4.017	4.450	4.450	4.450	4.450
Cobalt metal, shot/cathode/250 kg	$/lb	12.246	24.583	25.000	21.429[7]	12.500	12.500	12.417
Columbium, pyrochlore	$/lb	2.550	2.550	2.550	3.250	3.250	3.250	3.250
Copper, electrolytic cathode	Cdn $/lb	0.746	1.076	1.178	1.004	0.885	0.948	0.858
Gold, London[4]	Cdn $/troy oz	220.407	359.289	716.087	551.178	465.102	520.792	466.781
Iridium, major producer	$/troy oz	300.000	258.333	505.833	600.000	600.000	600.000	600.000
Iron ore, taconite pellets	cents/ltu	57.108	63.966	69.562	80.073	80.500	80.500	80.500
Lead, producer	Cdn cents/lb	36.820	59.920	49.350	44.520	32.887	26.770	33.517
Manganese, U.S. metal, regular	cents/lb	58.000	58.333	65.267	70.000	86.274	67.583	73.542
Magnesium, U.S. primary ingot	cents/lb	100.500	105.758	116.667	130.250	134.000	136.508	145.500
Mercury, New York	$/flask (76 lb)	153.322	281.096	389.447	413.885	370.934	322.443	314.381
Molybdenum, dealer oxide	$/lb	9.108	23.141	9.359	6.400	4.100	3.635	3.557
Nickel, major producer cathode	$/lb	2.091	2.707	3.415	3.429	3.200	3.200	3.200
Osmium, New York dealer	$/troy oz	130.000	130.000	130.000	130.000	130.000	133.113	466.479
Palladium, major producer	$/troy oz	70.873	113.143	213.975	129.500	110.000	130.000	146.667
Platinum, major producer	$/troy oz	237.250	351.649	439.425	475.000	475.000	475.000	475.000
Potash, K_2O, coarse major producer	cents/stu	80.583	100.417	112.667	120.750	119.615	116.000	107.638
Rhodium, major producer	$/troy oz	516.667	737.500	764.583	639.583	600.000	600.000	627.500
Ruthenium, major producer	$/troy oz	60.000	45.750	45.000	45.000	45.000	45.000	45.000
Selenium, New York dealer	$/lb	11.366	11.086	8.331	4.115	3.766	3.722	8.995
Silver, Handy & Harman, Toronto	Cdn $/troy oz	6.171	12.974	24.099	12.617	9.831	14.154	10.828
Sulphur, elemental, major producer[5]	Cdn $/lt	17.913	25.665	32.016	61.298	69.396	61.135	70.083
Tantalum, Tanco	$/lb	26.479	60.014	97.604	100.830	48.958	45.000	45.000
Tellurium, major producer, slab	$/lb	20.000	20.000	19.500	..	..	..	..
Tin	Cdn $/lb	7.265	8.898	10.008	8.893	8.144	8.103	8.180
Titanium, ilmenite ore	$/lt	53.229	51.083	55.000	68.021	70.000	70.000	70.000
Tungsten, U.S. hydrogen red	$/lb	13.900	13.900	13.900	13.900	13.350	13.100	13.100
Uranium, U_3O_8[6]	Cdn $/lb	48.081	50.004	51.927	42.311	44.234	38.500	38.500
Vanadium, pentoxide metallurgical	$/lb	2.900	3.050	3.050	3.250	3.350	3.350	3.350
Zinc, special high grade	Cdn cents/lb	34.757	43.717	44.050	54.240	49.167	52.632	63.823

[1] Prices except for noted, are in United States currency. [2] Sources: Alberta Energy Resource Industries Monthly Statistics, Engineering and Mining Journal, Metals Week and Northern Miner. [3] Starting 1981, London Metal Exchange. [4] Average afternoon fixings of London bullion dealers, converted to Canadian dollar. [5] Starting 1980, North American deliveries. [6] From EMR publications on assessment of Canada's uranium supply and demand; series EP 78-3 to EP 84-3. [7] Seven month average.
.. Not available.

TABLE 28. CANADIAN AVERAGE ANNUAL PRICES OF SELECTED MINERALS, 1978-84[1]

	Unit of measure	1978	1979	1980	1981	1982	1983	1984
Aluminum, major U.S. producer[2]	$/kg	1.334	1.534	1.793	1.514	1.223	1.775	1.614
Antimony, New York dealer	$/kg	2.879	3.634	3.887	3.582	2.917	2.481	4.316
Asbestos, No. 4 cement fibre	$/t	707.684	757.288	847.677	936.964	965.625	1,193.800	1,193.800
Bismuth, U.S. producer	$/kg	8.495	7.777	6.796	5.403	6.258	6.248	11.821
Cadmium, U.S. producer	$/kg	6.161	7.128	7.327	5.094	3.028	3.067	4.833
Calcium, metal crowns	$/kg	4.225	4.825	6.448	7.483	8.298	8.287	8.846
Chrome, U.S. metal, 9% carbon	$/kg	7.745	8.717	10.353	11.763	12.107	12.090	12.703
Cobalt metal, shot/cathode/250 kg	$/kg	30.795	63.492	64.430	56.610[6]	34.009	33.961	35.446
Columbium, pyrochlore	$/kg	6.413	6.586	6.572	8.591	8.842	8.830	9.278
Copper, electrolytic cathode	$/kg	1.645	2.372	2.597	2.213	1.951	2.089	1.892
Gold, London[3]	$/gm	7.086	11.551	23.023	17.721	14.953	16.744	15.007
Iridium, major producer	$/gm	11.002	9.730	19.011	23.129	23.806	23.773	24.978
Iron Ore, taconite pellets	$/kg	64.086	73.754	80.034	94.490	97.776	97.638	102.588
Lead, producer	¢/kg	81.174	132.101	108.798	98.150	72.503	59.018	73.892
Manganese, U.S. metal, regular	$/kg	1.459	1.507	1.682	1.850	2.347	1.836	2.099
Magnesium, U.S. primary ingot	$/kg	2.527	2.731	3.007	3.443	3.646	3.709	4.154
Mercury, New York	$/kg	5.073	9.553	13.206	14.395	13.279	11.527	11.808
Molybdenum, dealer oxide	$/kg	22.895	59.767	24.120	16.917	11.155	9.876	10.154
Nickel, major producer cathode	$/kg	5.258	6.992	8.801	9.064	8.706	8.695	9.136
Osmium, New York dealer	$/gm	4.766	4.896	4.886	5.011	5.158	5.274	19.420
Palladium, major producer	$/gm	2.599	4.262	8.042	4.992	4.364	5.151	6.106
Platinum, major producer	$/gm	8.701	13.245	16.515	18.310	18.847	18.820	19.774
Potash, K_2O, coarse major producer	$/t	60.793	87.445	87.110	95.754	97.632	94.547	92.180
Rhodium, major producer	$/gm	18.948	27.778	28.736	24.655	23.806	23.773	26.123
Ruthenium, major producer	$/gm	2.200	1.723	1.691	1.735	1.785	1.783	1.873
Selenium, New York dealer	$/kg	28.571	28.632	21.471	10.877	10.246	10.112	25.677
Silver, Handy & Harman, Toronto	$/kg	198.402	417.124	774.801	405.646	316.074	455.062	348.140
Sulphur, elemental, major producer[4]	$/t	17.630	25.260	31.510	60.330	68.300	60.170	68.976
Tantalum, Tanco	$/kg	66.587	155.002	251.545	266.524	133.201	122.259	128.459
Tellurium, major producer, slab	$/kg	50.294	51.655	50.255	..	..	..	..
Tin	$/kg	16.017	19.617	22.064	19.606	17.954	17.864	18.035
Titanium, ilmenite ore	$/t	61.791	58.900	63.280	80.268	85.022	84.902	89.206
Uranium, U[5]	$/kg	125.000	130.000	135.000	110.000	115.000	100.000	100.000
Vanadium, pentoxide metallurgical	$/kg	7.293	7.877	7.861	8.591	9.114	9.102	9.564
Zinc, special high grade	$/kg	0.766	0.964	0.971	1.196	1.084	1.160	1.407

[1] Sources: Alberta Energy Resource Industries Monthly Statistics, Engineering and Mining Journal, Metals Week and Northern Miner. [2] Starting 1981, London Metal Exchange. [3] Average afternoon fixings of London bullion dealers, converted to Canadian dollar. [4] Starting 1980, North American deliveries. [5] From EMR publications on assessment of Canada's uranium supply and demand; series EP 78-3 to EP 84-3. [6] Seven month average.
.. Not available.

TABLE 29. CANADA, MINERAL PRODUCTS INDUSTRIES, SELLING PRICE INDEXES, 1978-84 (1971 = 100)

	1978	1979	1980	1981	1982	1983	1984P
Iron and steel products industries							
Agricultural implements industry	188.7	206.0	224.9	260.2	293.1	310.9	319.9
Hardware, tool and cutlery manufacturers	179.1	207.3	238.4	268.2	296.0	308.3	326.2
Heating equipment manufacturers	169.8	188.0	213.2	236.5	267.7	280.4	291.0
Primary metal industries	207.7	258.8	308.3	312.6	310.7	320.6	324.6
Iron and steel mills	203.9	233.7	261.7	290.3	314.2	319.2	326.1
Steel pipe and tube mills	218.0	248.1	276.9	322.1	362.6	359.7	363.7
Iron foundries	200.1	223.3	243.2	261.8	268.9	272.4	273.6
Wire and wire products manufacturers	185.8	206.4	226.9	242.4	249.6	252.7	265.9
Nonferrous metal products industries							
Aluminum rolling, casting and extruding	191.5	234.0	271.0	292.6	290.7	291.7	335.1
Copper and alloy, rolling, casting and extruding	153.0	201.8	219.7	205.8	193.0	206.3	192.7
Jewellery and silverware manufacturers	337.6	507.3	871.3	676.1	609.5	699.1	645.6
Metal rolling, casting and extruding, nes	239.8	310.4	327.3	325.7	314.0	324.3	345.7
Nonmetallic mineral products industries							
Abrasives manufacturers	223.6	255.3	290.6	325.1	361.8	371.0	372.7
Cement manufacturers	207.5	233.2	265.7	308.0	359.7	374.2	385.1
Clay products from imported clay	173.7	190.1	215.2	251.9	278.0	290.6	300.7
Glass and glass products manufacturers	162.1	173.4	197.0	223.2	250.2	259.7	268.1
Lime manufacturers	252.9	292.7	338.3	396.1	453.2	514.4	557.0
Concrete products manufacturers	187.7	200.1	222.5	259.4	296.7	310.6	320.7
Clay products from domestic clay	196.4	214.3	226.9	243.0	269.9	287.8	318.1
Petroleum and coal products industries	275.4	321.3	404.6	551.7	634.4	674.8	703.9
Petroleum refineries	278.7	325.8	410.6	559.8	643.7	684.7	714.2
Mixed fertilizers	191.0	229.0	280.3	289.5	294.5	284.2	297.1

nes Not elsewhere specified; P Preliminary.

TABLE 30. CANADA, PRINCIPAL STATISTICS OF THE MINING INDUSTRY[1], 1983

	Mining Activity								Total Activity[2]		
		Production and Related Workers			Costs						
	Establishments (number)	Employees (number)	Person-hours Paid (000)	Wages ($000)	Fuel and Electricity ($000)	Materials and Supplies ($000)	Value of Production ($000)	Value Added ($000)	Employees (number)	Salaries and Wages ($000)	Value Added ($000)
Metals											
Gold	40	6,005	12,179	185,431	49,725	220,832	960,956	690,399	7,956	249,912	693,636
Silver-lead-zinc	18	3,480	7,339	113,826	50,904	463,660	819,323	304,759	5,073	175,307	294,166
Nickel-copper-zinc	33	18,562	33,591	502,248	195,498	1,342,586	3,088,682	1,550,598	24,953	727,427	1,567,341
Iron	13	4,828	9,707	154,450	160,498	422,675	1,259,082	675,909	8,236	275,644	644,555
Uranium	5	4,002	8,188	141,050	45,321	132,515	671,326	493,490	5,390	193,849	496,874
Misc. metal mines	5	393	819	13,303	6,611	16,008	55,700	33,081	586	21,686	33,184
Total	114	37,270	71,824	1,110,308	508,556	2,598,276	6,855,068	3,748,236	52,194	1,643,825	3,729,756
Industrials											
Asbestos	9	3,677	7,334	101,024	54,069	68,156	382,202	259,977	4,617	131,342	254,939
Gypsum	10	564	1,310	11,954	5,071	18,019	58,307	35,216	682	14,903	35,092
Peat	53	1,065	2,093	15,860	3,337	12,438	58,449	42,674	1,301	20,161	42,978
Potash	10	2,880	5,578	82,128	90,185	80,918	627,662	456,559	3,696	116,502	455,356
Sand and gravel	105	997	2,185	24,276	13,357	28,830	129,746	87,559	1,423	33,308	90,335
Stone	110	1,508	3,356	38,370	20,088	49,959	183,383	113,336	1,980	49,134	119,543
Misc. nonmetals	42	2,077	4,524	55,588	35,818	45,937	280,808	199,052	2,874	78,505	201,800
Total	339	12,768	26,381	329,199	221,925	304,258	1,720,557	1,194,373	16,573	443,855	1,200,043
Fuels											
Coal	28	9,172	18,027	263,369	95,945	255,906	1,265,527	913,676	11,684	361,053	911,112
Oil, crude and natural gas	926	8,160	16,708	278,864	195,991	598,186	22,930,249	22,136,072	33,418	1,241,055	22,171,257
Total	954	17,332	34,735	542,233	291,936	854,092	24,195,776	23,049,748	45,102	1,602,108	23,082,369
Total mining industry	1,407	67,370	132,940	1,981,740	1,022,417	3,756,626	32,771,401	27,992,357	113,869	3,689,788	28,012,168

1 Cement manufacturing, lime manufacturers, clay and clay products (domestic clays) are included in the mineral manufacturing industry.
2 Total activity includes sales and head offices.

TABLE 31. CANADA, PRINCIPAL STATISTICS OF THE MINERAL MANUFACTURING INDUSTRIES, 1983

		Mineral Manufacturing Activity								Total Activity[1]		
		Production and Related Workers			Costs							
	Establishments	Employees	Person-hours Paid	Wages	Fuel and Electricity	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	54	35,917	74,095	1,061,847	454,206	3,345,653	6,195,885	2,448,521		47,693	1,463,550	2,464,940
Steel pipe and tube mills	35	3,578	7,400	98,399	25,346	489,932	743,851	214,014		4,521	128,817	213,392
Iron foundries	109	5,945	12,223	135,874	35,616	208,761	591,772	326,800		7,364	177,692	326,046
Smelting and refining	31	21,535	43,343	677,667	366,124	1,554,038	3,803,946	1,830,479		31,788	1,062,203	1,912,447
Aluminum rolling, casting and extruding	72	4,594	9,795	112,251	34,822	795,028	1,136,736	329,404		6,415	172,347	328,224
Copper and alloy rolling, casting and extruding	41	2,218	4,477	50,991	12,986	334,314	462,420	121,323		2,744	66,101	117,733
Metal rolling, casting and extruding, nes	87	3,790	7,760	79,135	22,915	385,260	636,980	232,369		4,827	110,333	234,146
Total	429	77,579	159,094	2,216,614	952,014	7,112,985	13,571,590	5,502,911		105,352	3,181,043	5,596,928
Nonmetallic mineral products industries												
Cement manufacturers	24	2,461	5,054	71,878	131,486	119,995	652,025	404,327		4,057	123,493	407,503
Lime manufacturers	15	615	1,332	17,739	48,101	18,742	132,328	65,576		862	25,741	66,238
Concrete products manufacturers	429	5,469	11,730	123,930	24,115	228,316	578,771	328,691		7,286	176,674	333,613
Ready-mix concrete manufacturers	564	6,395	13,296	161,806	46,522	600,687	1,030,390	383,494		8,390	216,358	405,010
Clay products manufacturers (domestic)	53	1,357	2,786	27,322	26,366	22,572	129,148	77,530		1,845	41,578	78,248
Clay products manufacturers (imported)	66	958	1,848	16,198	4,330	16,187	57,776	36,547		1,163	21,566	37,192
Primary glass manufacturers	17	5,814	12,218	143,725	71,941	172,768	643,638	406,852		7,727	205,404	403,835
Glass products manufacturers	131	3,391	7,034	70,267	12,085	209,988	427,322	208,309		4,169	90,897	209,755
Abrasive manufacturers	31	1,361	2,944	30,324	26,799	81,986	200,013	89,407		1,852	44,099	91,425
Other nonmetallic mineral products industries	253	6,275	12,648	137,565	75,879	399,882	927,678	446,727		10,099	246,846	487,608
Total	1,583	34,097	70,890	800,755	467,624	1,871,122	4,779,088	2,447,460		47,450	1,192,656	2,521,426
Petroleum and coal products industries												
Petroleum refining industry	40	6,608	14,381	244,516	272,351	19,916,449	22,978,460	2,570,885		17,557	719,728	2,563,747
Manufacture of lubricating oils & greases	26	521	1,137	13,133	3,856	174,625	201,375	22,579		857	22,359	24,750
Other petroleum & coal products industries	65	288	599	6,455	5,676	101,900	144,516	36,835		503	12,482	52,616
Total	131	7,417	16,117	264,104	281,883	20,192,974	23,324,351	2,630,299		18,917	754,569	2,641,113
Total, mineral manufacturing industries	2,143	119,093	246,101	3,281,473	1,701,521	29,177,081	41,675,029	10,580,670		171,719	5,128,268	10,759,467

1 Includes sales and head offices.
nes Not elsewhere specified.

TABLE 32. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY[1] BY REGION, 1983

	Mines, Quarries and Oil Well Activity								Total Activity[2]		
		Production and Related Workers			Costs						
	Establish-ments	Employees	Person-hours Paid	Wages	Fuel and Electri-city	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)
Atlantic[3]	64	8,942	18,064	228,468	117,837	510,920	1,247,907	619,149	10,638	282,132	618,346
Quebec	181	11,412	23,613	326,279	160,268	525,571	1,665,878	980,040	16,387	490,973	956,316
Ontario	149	19,256	35,204	522,830	162,573	978,858	3,059,247	1,917,815	26,352	764,820	1,943,066
Prairies	695	16,973	33,634	512,344	366,064	935,010	23,831,494	22,530,421	44,130	1,533,658	22,552,999
British Columbia[4]	197	8,691	17,529	285,833	176,741	616,856	2,477,613	1,684,014	12,698	445,473	1,671,081
Yukon and Northwest Territories[5]	121	2,096	4,894	105,989	38,934	189,409	489,261	260,919	3,664	173,452	269,819
Canada	1,407	67,370	132,938	1,981,742	1,022,417	3,756,625	32,771,401	27,992,357	113,869	3,690,510	28,012,167

1 Cement manufacturing, lime manufacturing, clay and clay products are included in the mineral manufacturing industry. 2 Total activity includes sales and head offices. 3 Includes eastern Canada offshore. 4 Includes western Canada offshore. 5 Includes Arctic Islands and offshore.

TABLE 33. CANADA STATISTICS OF THE MINERAL MANUFACTURING INDUSTRY BY REGION, 1983

	Mines, Quarries and Oil Well Activity								Total Activity[1]		
		Production and Related Workers			Costs						
	Establish-ments	Employees	Person-hours Paid	Wages	Fuel and Electri-city	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)
Atlantic Provinces	139	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Quebec	527	28,499	57,190	797,854	540,320	7,124,505	10,588,258	2,749,564	41,655	1,244,202	2,827,481
Ontario	869	66,887	140,549	1,820,753	795,678	12,571,914	18,662,078	5,336,809	96,483	2,890,540	5,347,486
Prairie Provinces	366	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
British Columbia	239	8,424	17,065	259,277	86,947	2,410,115	3,479,491	942,303	12,270	393,359	998,690
Yukon and Northwest Territories	3	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Canada	2,143	119,093	246,101	3,281,473	1,701,521	29,177,081	41,675,029	10,580,670	171,719	5,128,268	10,759,467

1 Includes sales and head offices. (2) Confidential, included in Canadian total.

TABLE 34. CANADA, PRINCIPAL STATISTICS OF THE MINING INDUSTRY[1], 1977-83

		Mineral Manufacturing Activity							Total Activity[2]		
		Production and Related Workers			Costs						
	Establishments (number)	Employees (number)	Person-hours Paid (000)	Wages ($000)	Fuel and Electricity ($000)	Materials and Supplies ($000)	Value of Production ($000)	Value Added ($000)	Employees (number)	Salaries and Wages ($000)	Value Added ($000)
1977	1,232	79,902	167,884	1,342,508	473,202	2,715,468	16,400,460	13,211,792	119,061	2,137,523	13,246,689
1978	1,178	70,306	150,291	1,275,008	506,119	2,766,072	18,201,459	14,929,268	109,948	2,118,342	15,011,430
1979	1,150	72,580	152,560	1,493,773	605,985	3,252,991	23,626,730	19,767,754	115,245	2,492,715	19,894,086
1980	1,322	80,066	166,427	1,779,388	706,406	3,802,062	27,566,272	23,057,804	126,422	2,979,470	23,252,708
1981	1,361	81,136	167,307	2,053,760	888,554	4,266,637	28,204,485	23,049,295	129,251	3,439,945	23,091,447
1982	1,249	74,958	142,626	2,025,895	956,296	3,768,771	29,101,618	24,376,549	123,486	3,648,004	24,442,997
1983	1,407	67,370	132,940	1,981,740	1,022,417	3,756,626	32,771,401	27,992,357	113,869	3,698,788	28,012,168

[1] Cement manufacturing, lime manufacturers, clay and clay products (domestic clays) are included in the mineral manufacturing industries. [2] Includes sales and head offices.

TABLE 35. CANADA, PRINCIPAL STATISTICS OF THE MINERAL MANUFACTURING INDUSTRIES, 1977-83

		Mineral Manufacturing Activity							Total Activity[1]		
		Production and Related Workers			Costs						
	Establishments (number)	Employees (number)	Person-hours Paid (000)	Wages ($000)	Fuel and Electricity ($000)	Materials and Supplies ($000)	Value of Production ($000)	Value Added ($000)	Employees (number)	Salaries and Wages ($000)	Value Added ($000)
1977	1,616	138,700	288,409	2,110,400	798,486	12,743,217	19,725,082	6,489,111	189,576	3,114,744	6,594,794
1978	2,022	143,917	297,554	2,365,782	981,506	15,700,614	24,036,539	7,272,298	198,085	3,494,336	7,421,897
1979	2,115	145,929	308,770	2,614,816	1,118,146	19,116,369	28,318,690	8,522,128	202,695	3,910,454	8,669,240
1980	2,143	146,606	308,312	2,927,363	1,272,902	22,045,572	32,177,335	9,417,966	204,872	4,386,065	9,599,868
1981	2,124	140,914	293,781	3,187,784	1,560,453	28,125,138	39,495,229	10,862,006	203,051	4,932,893	11,062,937
1982	2,106	124,304	256,900	3,175,123	1,537,247	27,801,486	38,496,873	9,078,253	182,665	5,070,760	9,256,207
1983	2,143	119,093	246,101	3,281,473	1,701,521	29,177,081	41,675,029	10,580,670	171,719	5,128,268	10,759,467

[1] Includes sales and head offices.

TABLE 36. CANADA, CONSUMPTION OF FUEL AND ELECTRICITY IN THE MINING INDUSTRY[1], 1983

	Unit	Metals	Industrials	Fuels	Total
Coal and coke	000 t	150	10	-	160
	$000	6,707	243	-	6,950
Gasoline	000 litres	19 789	15 438	14 981	50 208
	$000	8,099	6,416	5,217	19,732
Fuel oil, kerosene, diesel oil	000 litres	854 624	228 641	135 983	1 219 288
	$000	215,895	69,778	45,646	331,319
Liquefied petroleum gas	000 litres	82 413	4 782	11 464	98 659
	$000	17,302	1,382	2,050	20,734
Natural gas	000 m^3	152 458	699 530	140 000	991 988
	$000	20,798	79,818	15,887	116,503
Other fuels[2]	$000	1,298	235	-	1,532
Total value of fuels	$000	270,098	157,872	68,800	496,770
Electricity purchased	million kWh	9 659	1 928	4 958	16 546
	$000	238,458	64,052	223,136	525,646
Total value of fuels and electricity purchased, all reporting companies	$000	508,556	221,924	291,936	1,022,416

Note: Totals may not add due to rounding.
[1] Cement and lime manufacturing and manufacturers of clay products (domestic clays) are included under mineral manufacturing. [2] Includes wood, manufactured gas, steam purchased and other miscellaneous fuels.
- Nil.

TABLE 37. CANADA, CONSUMPTION OF FUEL AND ELECTRICITY IN THE MINERAL MANUFACTURING INDUSTRIES, 1983

	Unit	Primary Metal Industries	Nonmetallic Mineral Products Industries	Petroleum and Coal Products Industries	Total
Coal and coke	000 t	250	585	-	835
	$000	25,377	33,847	-	59,224
Gasoline	000 litres	11 022	27 984	2 821	41 828
	$000	4,997	11,376	1,137	17,510
Fuel oil, kerosene, diesel oil	000 litres	778 796	326 605	11 376	1 116 777
	$000	166,598	81,807	3,195	251,599
Liquefied petroleum gas	000 litres	45 792	19 849	1 049	66 690
	$000	9,922	3,893	140	13,955
Natural gas	000 m^3	2 373 839	1 369 774	1 188 182	4 931 795
	$000	336,858	191,671	177,592	706,121
Other fuels	$000	11,629	19,721	5,559	36,909
Total value of fuels	$000	555,381	342,315	187,624	1,085,319
Electricity purchased	million kWh	17 524	3 983	3 491	24 997
	$000	396,632	125,310	94,259	616,201
Total value of fuels and electricity purchased, all reporting companies	$000	952,014	467,624	281,883	1,701,521

Totals may not add due to rounding.
- Nil.

TABLE 38. CANADA, COST OF FUEL AND ELECTRICITY USED IN THE MINING INDUSTRY[1], 1977-83

	Unit	1977	1978	1979	1980	1981	1982	1983
Metals								
Fuel	$000	148,578	153,608	193,828	220,052	293,979	275,205	270,098
Electricity purchased	million kWh	11 713	10 739	11 459	11 024	10 494	9 891	9 659
	$000	135,014	132,100	153,905	174,837	209,316	232,137	238,458
Total cost of fuel and electricity	$000	283,591	285,708	347,733	394,889	503,295	507,942	508,556
Industrials[2]								
Fuel	$000	72,946	79,090	92,499	112,672	142,169	143,393	157,872
Electricity purchased	million kWh	2 457	2 082	2 244	2 269	2 100	1 782	1 928
	$000	29,510	35,141	42,982	48,336	56,297	57,567	64,052
Total cost of fuel and electricity	$000	102,456	114,231	135,481	161,008	198,466	200,960	221,924
Fuels								
Fuels	$000	15,117	19,774	23,988	32,582	46,991	70,484	68,800
Electricity purchased	million kWh	2 791	2 699	3 238	3 504	3 740	5 780	4 958
	$000	72,035	81,624	98,783	117,927	139,802	176,911	223,136
Total cost of fuel and electricity	$000	87,152	101,398	122,771	150,509	186,793	247,395	291,936
Total mining industry								
Fuel	$000	236,642	252,470	310,315	365,306	483,139	489,683	496,770
Electricity purchased	million kWh	16 961	15 520	16 941	16 797	16 334	17 453	16 546
	$000	236,559	248,865	295,670	341,100	405,415	466,614	525,646
Total cost of fuel and electricity	$000	473,201	501,335	605,985	706,406	888,554	956,297	1,022,416

1 Cement and lime manufacturing and manufacture of clay products (domestic clays) are included in mineral manufacturing.
2 Includes structural materials.

TABLE 39. CANADA, COST OF FUEL AND ELECTRICITY USED IN THE MINERAL MANUFACTURING INDUSTRIES, 1977-83

	Unit	1977	1978	1979	1980	1981	1982	1983
Primary metals								
Fuel	$000	279,172	336,684	357,775	421,426	538,175	526,073	555,381
Electricity purchased	million kWh	15 352	17 257	18 451	20 535	20 429	16 848	17 524
	$000	183,574	226,313	260,317	316,884	357,186	345,614	396,632
Total cost of fuel and electricity	$000	462,746	562,997	618,092	738,317	895,361	871,687	952,014
Nonmetallic mineral products								
Fuel	$000	181,952	221,855	280,846	271,481	333,061	328,566	342,315
Electricity purchased	million kWh	4 190	4 782	5 163	4 633	4 573	3 973	3 983
	$000	65,553	79,606	98,296	102,765	114,062	116,243	125,310
Total cost of fuel and electricity	$000	247,507	301,461	379,142	374,248	447,123	200,960	467,624
Petroleum and coal products								
Fuels	$000	42,184	61,891	74,968	88,311	137,463	70,484	187,624
Electricity purchased	million kWh	3 205	3 505	3 555	3 705	3 669	5 780	3 491
	$000	46,050	55,303	63,395	72,186	80,517	176,911	94,259
Total cost of fuel and electricity	$000	88,233	117,194	138,363	160,498	217,980	247,395	281,883
Total mineral manufacturing industries								
Fuel	$000	503,308	620,430	713,589	781,218	1,008,699	489,683	1,085,391
Electricity purchased	million kWh	22 747	25 544	27 169	28 873	28 671	17 453	24 997
	$000	295,177	361,222	422,008	491,834	551,765	466,614	616,201
Total cost of fuel and electricity	$000	798,486	981,652	1,135,597	1,273,063	1,560,464	956,297	1,701,521

TABLE 40. CANADA, EMPLOYMENT, SALARIES AND WAGES IN THE MINING INDUSTRY[1], 1977-83

	Unit	1977	1978	1979	1980	1981	1982	1983
Metals								
Production and related workers	Number	49,414	39,977	41,541	47,592	49,586	44,261	37,270
Salaries and wages	$000	849,345	757,258	879,383	1,091,848	1,265,547	1,180,485	1,110,308
Annual average salary and wage	$	17,188	18,942	21,169	22,942	25,522	26,671	29,791
Administrative and office workers	Number	17,831	16,470	17,419	18,526	19,126	17,242	14,924
Salaries and wages	$000	377,714	358,680	428,639	504,316	585,120	585,249	533,517
Annual average salary and wage	$	21,183	21,778	24,608	27,222	30,593	33,943	35,749
Total metals								
Employees	Number	67,245	56,447	58,960	66,118	68,712	61,503	52,194
Salaries and wages	$000	1,227,059	1,115,938	1,308,022	1,596,165	1,850,667	1,765,734	1,643,825
Annual average salary and wage	$	18,248	19,770	22,185	24,141	26,933	28,710	31,495
Industrials								
Production and related workers	Number	16,812	16,133	16,633	16,645	15,666	12,848	12,768
Salaries and wages	$000	266,294	274,037	321,303	343,004	352,302	309,736	329,199
Annual average salary and wage	$	15,840	16,986	19,317	20,607	22,488	24,108	25,783
Administrative and office workers	Number	4,986	4,749	4,829	4,795	4,908	4,323	3,805
Salaries and wages	$000	89,757	95,659	106,776	116,932	128,852	129,116	114,656
Annual average salary and wage	$	18,002	20,143	22,114	24,386	26,253	29,867	30,133
Total nonmetals								
Employees	Number	21,798	20,882	21,462	21,440	20,574	17,171	16,573
Salaries and wages	$000	356,051	369,696	428,079	459,936	481,154	438,852	443,855
Annual average salary and wage	$	16,334	17,704	19,946	21,452	23,387	25,558	26,782
Fuels								
Production and related workers	Number	13,679	14,196	14,406	15,829	15,884	17,849	17,332
Salaries and wages	$000	226,869	243,713	293,087	344,537	435,911	535,673	542,233
Annual average salary and wage	$	16,585	17,168	20,345	21,766	27,443	30,011	31,285
Administrative and office workers	Number	16,342	18,423	20,417	23,035	24,081	26,963	28,230
Salaries and wages	$000	327,544	388,995	463,527	578,832	672,213	907,745	1,059,875
Annual average salary and wage	$	20,043	21,115	22,703	25,128	27,915	33,666	37,544
Total fuels								
Employees	Number	30,021	32,619	34,823	38,864	39,965	44,812	45,102
Salaries and wages	$000	554,413	632,708	756,614	923,369	1,108,124	1,443,418	1,602,108
Average annual salary and wage	$	18,468	19,397	21,727	23,759	27,727	32,211	35,522
Total mining								
Production and related workers	Number	79,905	70,306	72,580	80,066	81,136	74,958	67,370
Salaries and wages	$000	1,342,508	1,275,008	1,493,773	1,779,388	2,053,760	2,025,895	1,981,740
Average annual salary and wage	$	16,801	18,135	20,581	22,224	25,313	27,027	29,416
Administrative and office workers	Number	39,159	39,642	42,665	46,356	48,115	48,528	46,499
Salaries and wages	$000	795,015	843,335	998,942	1,200,081	1,386,184	1,622,110	1,708,048
Annual average salary and wage	$	20,302	21,274	23,414	25,888	28,810	33,426	36,733
Total mining								
Employees	Number	119,064	109,948	115,245	126,422	129,251	123,486	113,869
Salaries and wages	$000	2,137,523	2,118,343	2,492,715	2,979,470	3,439,945	3,648,004	3,689,788
Annual average salary and wage	$	17,954	19,267	21,630	23,568	26,614	29,542	32,404

[1] Does not include cement and lime manufacturing and clay products (domestic clays) manufacturing.

TABLE 41. CANADA, EMPLOYMENT, SALARIES AND WAGES IN THE MINERAL MANUFACTURING INDUSTRIES, 1977-83

	Unit	1977	1978	1979	1980	1981	1982	1983
Primary metal industries								
Production and related workers	Number	91,683	93,798	95,942	97,530	92,337	82,186	77,579
Salaries and wages	$000	1,399,390	1,544,412	1,725,904	1,980,423	2,120,019	2,157,186	2,216,614
Annual average salary and wage	$	15,263	16,465	17,989	20,306	22,960	26,248	28,572
Administrative and office workers	Number	27,536	28,198	30,812	28,920	32,831	31,029	27,773
Salaries and wages	$000	545,957	597,544	713,279	787,022	938,790	1,010,847	964,429
Annual average salary and wage	$	19,827	21,191	23,149	27,214	28,595	32,577	34,725
Total primary metal industries								
Employees	Number	119,219	121,996	126,754	126,450	125,168	113,215	105,352
Salaries and wages	$000	1,945,347	2,140,956	2,432,183	2,767,445	3,058,809	3,168,033	3,181,043
Annual average salary and wage	$	16,317	17,549	19,188	21,886	24,438	27,982	30,194
Nonmetallic mineral products industries								
Production and related workers	Number	39,321	41,297	41,813	40,799	40,145	33,997	34,097
Salaries and wages	$000	564,444	638,152	710,622	743,254	818,566	751,915	800,755
Annual average salary and wage	$	14,355	15,452	16,995	18,217	20,390	22,117	23,485
Administrative and office workers	Number	13,187	14,439	14,935	15,287	15,124	13,952	13,353
Salaries and wages	$000	229,855	264,166	297,211	333,815	369,899	383,405	391,901
Annual average salary and wage	$	17,430	18,295	19,900	21,837	24,458	27,480	29,349
Total nonmetallic mineral products								
Employees	Number	52,508	55,736	56,748	56,086	55,269	47,949	47,450
Salaries and wages	$000	794,299	902,318	1,007,833	1,077,069	1,188,455	1,135,320	1,192,656
Annual average salary and wage	$	15,127	16,189	17,760	19,203	21,503	23,678	25,135
Petroleum and coal products industries								
Production and related workers	Number	7,696	8,822	8,174	8,277	8,432	8,121	7,417
Salaries and wages	$000	146,566	183,218	185,290	203,686	249,199	266,022	264,104
Annual average salary and wage	$	19,044	20,768	22,668	24,609	29,554	32,757	35,608
Administrative and office workers	Number	10,153	11,531	11,019	11,769	14,182	13,380	11,500
Salaries and wages	$000	228,532	267,844	285,148	337,865	436,430	501,385	490,465
Annual average salary and wage	$	22,509	23,228	25,887	28,708	30,773	37,473	42,649
Total petroleum and coal products								
Employees	Number	17,849	20,353	19,193	20,046	22,614	21,501	18,917
Salaries and wages	$000	375,098	451,062	470,438	541,551	685,629	767,407	754,569
Annual average salary and wage	$	21,015	22,162	24,511	27,015	30,319	35,692	39,888
Total mineral manufacturing								
Production and related workers	Number	138,700	143,917	145,929	146,606	140,914	124,304	119,093
Salaries and wages	$000	2,110,400	2,365,782	2,621,816	2,927,363	3,187,784	3,175,123	3,281,473
Annual average salary and wage	$	15,216	16,439	17,966	19,968	22,622	25,543	27,554
Administrative and office workers	Number	50,876	54,168	56,766	55,976	62,137	58,359	52,626
Salaries and wages	$000	1,004,344	1,129,554	1,295,638	1,458,702	1,745,109	1,895,637	1,846,795
Annual average salary and wage	$	19,741	20,853	22,824	26,059	28,085	32,482	35,093
Total mineral manufacturing industries								
Employees	Number	189,576	198,085	202,695	202,582	203,051	182,665	171,719
Salaries and wages	$000	3,114,744	3,494,336	3,910,454	4,386,065	4,932,893	5,070,760	5,128,268
Annual average salary and wage	$	16,430	17,641	19,292	21,651	24,294	27,760	29,864

TABLE 42. CANADA, NUMBER OF WAGE EARNERS EMPLOYED IN THE MINING INDUSTRY, (SURFACE, UNDERGROUND AND MILL), 1977-83

	1977	1978	1979	1980	1981	1982	1983
Metals							
Surface	16,115	12,901	12,664	14,347	14,043	12,133	9,970
Underground	19,482	15,682	15,906	19,308	19,784	18,673	15,861
Mill	13,817	11,394	12,971	13,937	15,759	13,455	11,439
Total	49,414	39,977	41,541	47,592	49,586	44,261	37,270
Industrials							
Surface	7,166	6,660	6,877	6,510	6,015	4,833	4,951
Underground	2,245	2,275	2,370	2,550	2,606	2,055	2,192
Mill	7,401	7,198	7,386	7,585	7,045	5,960	5,625
Total	16,812	16,133	16,633	16,645	15,666	12,848	12,768
Fuels							
Surface	10,510	11,045	11,535	12,929	12,958	14,623	14,436
Underground	3,169	3,151	2,871	2,900	2,926	3,226	2,896
Total	13,679	14,196	14,406	15,829	15,884	17,849	17,332
Total mining industry							
Surface	33,791	30,606	31,076	33,786	33,016	31,589	29,357
Underground	24,896	21,108	21,147	24,758	25,316	23,954	20,949
Mill	21,218	18,592	20,357	21,522	22,804	19,415	17,064
Total	79,905	70,306	72,580	80,066	81,136	74,958	67,370

TABLE 43. CANADA, MINE AND MILL WORKERS BY SEX, 1983

	Mine workers				Mill workers		Total	
	Underground		Surface					
	Male	Female	Male	Female	Male	Female	Male	Female
Metallic minerals								
Gold	3,349	3	1,019	32	1,582	20	5,950	55
Silver-lead-zinc	1,528	4	595	30	1,291	32	3,414	66
Nickel-copper-zinc	8,800	10	5,219	104	4,218	211	18,237	325
Iron ore	153	2	1,339	22	3,199	113	4,691	137
Uranium	1,945	7	1,312	38	647	53	3,904	98
Miscellaneous metal mines	60	-	247	13	71	2	378	15
Total	15,835	26	9,731	239	11,008	431	36,574	696
Industrial minerals								
Asbestos	226	-	1,233	7	2,122	89	3,581	96
Gypsum	114	-	398	-	52	-	564	-
Peat	-	-	604	21	430	10	1,034	31
Potash	1,348	18	71	1	1,416	26	2,835	45
Sand and gravel	-	-	929	5	63	-	992	5
Stone	4	-	1,291	5	205	3	1,500	8
Miscellaneous nonmetals	482	-	371	15	1,179	30	2,032	45
Total	2,174	18	4,897	54	5,467	158	12,538	230
Mining Total	18,009	44	14,628	293	16,475	589	49,112	926

- Nil.

TABLE 44. CANADA, LABOUR COSTS IN RELATION TO TONNES MINED, METAL MINES, 1981-83

Type of Metal Mine	Number of Wage Earners	Total Wages ($000)	Average Annual Wage ($)	Tonnage of Ore Mined (kilotonnes)	Average Annual Tonnes Mined per Wage Earner	Wage Cost per Tonne Mined ($)
1981						
Gold	4,349	105,802	24,328	6 810	1 566	15.54
Nickel-copper-zinc	18,398	433,026	23,537	137 710	7 485	3.14
Silver-lead-zinc	3,832	105,381	27,500	15 964	4 166	6.60
Iron ore	2,755	86,303	31,326	118 579	43 041	0.73
Uranium	3,796	107,707	28,374	7 454	1 964	14.45
Miscellaneous metals	697	17,586	25,231	15 014	21 541	1.17
Total	33,827	855,805	25,299	301 530	8 914	2.84
1982						
Gold	4,440	125,178	28,193	8 368	1 885	14.96
Nickel-copper-zinc	16,307	365,743	22,429	117 833	7 226	3.10
Silver-lead-zinc	3,320	106,834	32,179	14 113	4 251	7.57
Iron ore	2,272	66,205	29,139	81 963	36 075	0.81
Uranium	3,596	124,024	34,489	7 609	2 116	16.30
Miscellaneous metals	871	25,987	29,836	8 477	9 732	3.07
Total	30,806	813,971	26,422	238 362	7 738	3.41
1983						
Gold	4,403	136,370	30,971	9 553	2 170	14.27
Nickel-copper-zinc	14,133	374,211	26,478	116 532	8 245	3.21
Silver-lead-zinc	2,157	76,949	35,674	9 157	4 245	8.40
Iron ore	1,516	50,509	33,317	74 597	49 206	0.68
Uranium	3,302	117,056	35,450	7 073	2 142	16.55
Miscellaneous metals	320	10,959	34,248	2 133	6 665	5.14
Total	25,831	766,053	29,656	219 045	8 480	3.50

TABLE 45. CANADA, PERSON-HOURS PAID, PRODUCTION AND RELATED WORKERS, TONNES OF ORE MINED AND ROCK QUARRIED, METAL MINES AND NONMETALLIC MINERAL OPERATIONS, 1977-83

	Unit	1977	1978	1979	1980	1981	1982	1983
Metal mines[1]								
Ore mined	million t	299.5	248.1	274.8	290.1	301.5	238.4	219.0
Person-hours paid[2]	million	101.2	84.9	85.1	97.5	100.6	80.4	71.8
Person-hours paid per t mine	number	0.34	0.34	0.31	0.34	0.33	0.34	0.33
Tonnes mined per person-hour paid	t	2.96	2.92	3.23	2.98	3.00	2.97	3.05
Nonmetallic mineral operations[3]								
Ore mined and rock quarried	million t	200.2	200.4	192.1	185.0	164.8	113.4	114.4
Person-hours paid[2]	million	27.7	26.3	27.8	26.5	23.5	18.0	17.6
Person-hours paid per t mine	number	0.14	0.13	0.14	0.14	0.14	0.16	0.15
Tonnes mined per person-hour paid	t	7.23	7.62	6.91	6.98	7.01	6.30	6.50

[1] Excludes placer mining. [2] Person-hours paid for production and related workers only.
[3] Includes asbestos, potash, gypsum and stone.

TABLE 46. CANADA, AVERAGE WEEKLY WAGES AND HOURS WORKED (including overtime), HOURLY-RATED EMPLOYEES IN MINING, MANUFACTURING AND CONSTRUCTION INDUSTRIES, 1978-84

	1978	1979	1980	1981	1982	1983	1984[1]
Mining							
Average hours per week	40.5	41.1	40.8	40.4	39.6	38.8	39.5
Average weekly wage ($)	354.51	396.58	440.61	494.62	551.68	552.79	670.83
Metals							
Average hours per week	39.4	40.4	40.1	40.2	39.0	38.3	38.8
Average weekly wage ($)	344.94	387.14	425.08	485.03	535.92	565.60	610.91
Mineral fuels							
Average hours per week	41.0	40.8	41.2	41.3	42.1	39.7	40.6
Average weekly wage ($)	367.34	410.38	476.30	553.71	631.91	626.12	672.85
Nonmetals							
Average hours per week	40.5	40.3	39.5	38.7	37.2	37.5	38.7
Average weekly wage ($)	326.23	366.03	402.98	445.02	479.44	468.05	536.93
Manufacturing							
Average hours per week	38.8	38.8	38.5	38.5	37.7	38.4	38.5
Average weekly wage ($)	265.06	287.82	314.80	352.08	384.79	504.76	469.18
Construction							
Average hours per week	39.0	39.4	39.0	38.9	38.1	36.9	37.3
Average weekly wage ($)	400.58	433.51	470.45	531.54	564.33	512.26	491.11

[1] Ten-month average; new time series.

TABLE 47. CANADA, AVERAGE WEEKLY WAGES (including overtime) OF HOURLY-RATED EMPLOYEES IN THE MINING INDUSTRY, IN CURRENT AND 1971 DOLLARS, 1978-84

	1978	1979	1980	1981	1982	1983	1984[1]
Current dollars							
All mining	354.51	396.58	440.61	494.62	551.68	552.79	670.83
Metals	344.94	387.14	425.08	485.03	535.92	565.60	610.91
Mineral fuels	367.34	414.96	476.30	553.11	631.91	626.12	672.85
Coal	323.49	362.20	430.16	485.03	562.12	564.18	653.52
Nonmetals except fuel	326.23	330.47	402.98	445.02	479.44	504.76	536.93
1971 dollars							
All mining	202.35	207.42	209.22	208.79	210.16	199.04	231.48
Metals	196.88	202.48	226.16	244.74	204.16	203.65	210.80
Mineral fuels	209.67	217.03	220.82	233.48	240.73	225.44	232.18
Coal	184.64	189.44	204.25	204.74	214.14	203.14	225.51
Industrial minerals	186.20	172.84	191.35	187.85	182.64	181.76	185.28

[1] Ten month average; new time series.

TABLE 48. CANADA, INDUSTRIAL FATALITIES PER THOUSAND WORKERS[1], BY INDUSTRY GROUPS 1982-84

	Fatalities (number)[2]			Number of Workers (000)			Rate per 1,000 Workers[3]		
	1982	1983	1984P	1982	1983	1984P	1982	1983	1984P
Agriculture	19	21	19	149.0	156.0	156.0	0.13	0.13	0.12
Forestry	66	61	56	54.3	55.2	56.9	1.22	1.11	0.98
Fishing[4]	18	15	27	11.4	15.0	14.0	1.58	1.00	1.93
Mining[5]	150	100	93	155.5	146.6	149.1	0.96	0.68	0.62
Manufacturing	180	145	118	1,709.2	1,712.2	1,670.9	0.11	0.08	0.07
Construction	144	116	142	409.7	350.9	346.3	0.35	0.33	0.41
Transportation[6]	179	137	107	826.4	789.7	800.2	0.22	0.17	0.13
Trade	68	58	40	1,575.9	1,490.7	1,581.5	0.04	0.04	0.03
Finance[7]	6	4	8	534.7	520.0	539.5	0.01	0.01	0.01
Service[8]	85	73	56	2,965.9	2,876.2	2,927.3	0.03	0.03	0.02
Public administration	54	54	51	646.6	655.0	658.7	0.08	0.08	0.08
Unknown	10	10	13	..	..	..	..	..	..
Total	979	794	730	9,038.6	8,767.5	8,900.4	0.11	0.09	0.08

[1] Excludes the Province of Quebec for which data is unavailable. [2] Includes fatalities resulting from occupational chest illnesses such as silicosis, lung cancer, etc. [3] The rates may be understated because only 80 per cent of workers in the Statistics Canada employment estimates are covered by workers' compensation. [4] Includes trapping and hunting. [5] Includes quarrying and oil wells. [6] Includes storage, communication, electric power and water utilitiesand highway maintenance. [7] Includes insurance and real estate. [8] Includes community, businessand personal service.
P Preliminary; .. Not available.

TABLE 49. CANADA, INDUSTRIAL FATALITIES PER THOUSAND WORKERS, BY INDUSTRY GROUPS, 1978-84[1]

	1978	1979	1980	1981	1982	1983	1984P[2]
Agriculture	0.06	0.11	0.05	0.14	0.13	0.13	0.12
Forestry	1.31	1.55	1.14	0.95	1.22	1.11	0.98
Fishing[3]	1.44	1.25	1.60	1.47	1.58	1.00	1.93
Mining[4]	0.86	0.97	1.08	0.76	0.96	0.68	0.62
Manufacturing	0.10	0.09	0.09	0.09	0.11	0.08	0.07
Construction	0.38	0.40	0.42	0.39	0.35	0.33	0.41
Transportation[5]	0.26	0.26	0.27	0.25	0.22	0.17	0.13
Trade	0.04	0.05	0.05	0.04	0.04	0.04	0.03
Finance[6]	0.01	0.01	0.01	0.02	0.01	0.01	0.01
Service[7]	0.02	0.03	0.03	0.03	0.03	0.03	0.02
Public administration	0.12	0.11	0.07	0.11	0.08	0.08	0.08
Total	0.12	0.12	0.13	0.11	0.11	0.09	0.08

1 Includes fatalities resulting from occupational chest illnesses such as silicosis, lung cancer, etc. 2 The rates may be understated because only 80 per cent of workers in the Statistics Canada employment estimates are covered by workers' compensation. 3 Includes trapping and hunting. 4 Includes quarrying and oil wells. 5 Includes storage, communication, electric power and water utilities and highway maintenance. 6 Includes insurance and real estate. 7 Includes community, business and personal service.
P Preliminary.

TABLE 50. CANADA, INDUSTRIAL FATALITIES BY OCCUPATIONAL INJURIES AND ILLNESSES[1], 1982-84

	Occupational Injuries			Occupational Illnesses[2]			Total		
	1982	1983	1984P	1982	1983	1984P	1982	1983	1984P
Agriculture	13	12	14	0	0	0	13	12	14
Forestry	54	54	54	0	0	0	54	54	54
Fishing	17	15	27	0	0	0	17	15	27
Mining	96	40	47	49	54	40	145	94	87
Manufacturing	99	83	75	49	36	31	148	119	106
Construction	107	79	96	13	16	14	120	95	110
Transportation	156	112	90	6	3	7	162	115	97
Trade	57	43	34	0	1	0	57	44	34
Finance	4	2	4	0	0	0	4	2	4
Service	57	52	43	3	2	0	60	54	43
Public administration	42	39	39	1	2	4	43	41	43
Unknown	0	0	0	0	0	0	0	0	0
Total	702	531	523	121	114	96	823	645	619

1 Excludes the Province of Quebec for which data is unavailable. 2 Includes fatalities resulting from occupational chest illnesses such as silicosis, lung cancer, etc.
P Preliminary.

TABLE 51. CANADA, NUMBER OF STRIKES AND LOCKOUTS BY INDUSTRIES, 1982-84

	1982			1983			1984		
	Strikes and Lockouts	Workers Involved	Duration in Person-days	Strikes and Lockouts	Workers Involved	Duration in Person-days	Strikes and Lockouts	Workers Involved	Duration in Person-days
Agriculture	3	64	7,320	2	26	770	2	123	190
Forestry	3	215	7,840	5	1,326	13,890	9	946	3,390
Fishing and trapping	0	0	0	1	3,000	3,000	0	0	0
Mines	8	12,686	257,140	12	11,889	178,390	9	2,029	37,120
Manufacturing	292	63,959	1,690,560	311	64,206	1,385,290	345	108,092	2,334,820
Construction	63	94,228	2,199,610	24	9,394	243,680	37	19,512	212,710
Transportation and utilities	67	24,005	565,740	63	15,257	275,000	48	20,091	550,120
Trade	72	4,465	171,180	74	14,831	251,690	100	5,720	189,590
Finance, insurance and real estate	15	746	49,620	17	606	9,600	23	561	45,710
Service	110	27,846	415,380	104	168,376	1,770,710	110	26,526	419,500
Public administration	43	36,088	251,030	32	40,398	311,940	34	3,390	77,330
Various industries	1	180,000	180,000	0	0	0	0	0	0
All industries	677	444,302	5,795,420	645	329,309	4,443,960	717	186,990	3,890,480

TABLE 52. CANADA, NUMBER OF STRIKES AND LOCKOUTS BY MINING AND MINERAL MANUFACTURING INDUSTRIES, 1982-84

	1982			1983			1984		
	Strikes and Lockouts	Workers Involved	Duration in Person-days	Strikes and Lockouts	Workers Involved	Duration in Person-days	Strikes and Lock-outs	Workers Involved	Duration in Person-days
Mines	8	12,686	257,140	12	11,889	178,390	9	2,029	37,120
Metal	2	10,211	248,300	6	6,046	91,500	6	1,755	36,240
Mineral fuels	2	2,400	4,670	3	4,991	80,950	0	0	0
Nonmetals	0	0	0	2	847	5,540	2	261	570
Quarries	4	75	4,170	1	5	400	1	13	310
Mineral manufacturing	29	6,839	291,600	32	4,334	118,540	35	6,378	163,160
Primary metals	11	4,259	199,900	15	2,609	88,070	17	3,684	41,920
Nonmetallic mineral products	17	2,576	91,600	17	1,725	30,470	16	2,209	119,480
Petroleum and coal products	1	4	100	0	0	0	2	485	1,760

TABLE 53. CANADA, SOURCE OF ORES HOISTED OR REMOVED FROM SELECTED TYPES OF MINES, 1981-83

Mines	1981			1982			1983		
	Underground	Open-pit	Total	Underground	Open-pit	Total	Underground	Open-pit	Total
	(kilotonnes)								
Asbestos	1 789	23 874	25 664	1 308	16 184	17 492	1 511	13 524	15 035
Gold	5 835	975	6 810	6 710	1 657	8 367	7 497	2 056	9 553
Gypsum	685	5 535	6 220	475	5 355	5 830	873	6 667	7 540
Iron ore	3 269	115 309	118 579	2 448	79 515	81 963	2 803	71 794	74 597
Nickel-copper-zinc	31 193	106 516	137 710	21 431	96 402	117 833	25 078	91 454	116 532
Silver-lead-zinc	9 943	6 021	15 964	9 950	4 163	14 113	7 726	1 431	9 157
Uranium	6 664	790	7 454	6 900	709	7 609	6 259	814	7 073
Miscellaneous metals	1 518	13 496	15 014	1 517	6 959	8 476	528	1 605	2 133
Total	60 896	272 516	333 415	50 739	210 944	261 683	52 275	189 345	241 620
Percentage	18.3	81.7	100.0	19.4	80.6	100.0	21.6	78.4	100.0

TABLE 54. CANADA, SOURCE OF MATERIAL HOISTED OR REMOVED FROM METAL MINES, 1983

	Underground		Open-pit		
	Ore	Waste	Ore	Waste	Overburden
	(kilotonnes)				
Gold	7 497	1 130	2 056	12 196	277
Nickel-copper-zinc	25 078	2 056	91 454	82 169	51 607
Silver-lead-zinc	7 726	1 204	1 431	4 139	8 698
Iron	2 803	38	71 794	23 207	11 871
Uranium	6 259	445	814	1 531	-
Miscellaneous metals	528	52	1 605	1 545	9
Total	49 891	4 925	169 154	124 787	72 462

- Nil.

TABLE 55. CANADA, ORE MINED AND ROCK QUARRIED IN THE MINING INDUSTRY, 1977-83

	1977	1978	1979	1980	1981	1982	1983
				(kilotonnes)			
Metals							
Gold	5 768	5 914	5 478	6 346	6 810	8 368	9 553
Silver-lead-zinc	16 730	15 859	15 078	16 219	15 964	14 113	9 157
Nickel-copper-zinc	129 361	109 613	109 437	121 399	137 709	117 833	116 532
Iron	127 057	96 323	130 799	123 107	118 579	81 963	74 597
Uranium	5 014	6 126	6 141	7 152	7 454	7 608	7 073
Miscellaneous metals	15 599	14 221	7 822	15 871	15 014	8 477	2 133
Total	299 528	248 056	274 755	290 095	301 530	238 362	219 045
Nonmetals							
Asbestos	31 912	28 788	31 522	28 103	25 664	17 493	15 035
Potash	24 813	24 856	25 511	26 988	30 344	16 946	24 222
Gypsum	7 216	8 393	8 310	7 611	6 220	5 830	7 540
Rock salt	4 974	5 050	5 639	5 321	4 927	5 723	5 996
Total	68 915	67 087	70 982	68 023	67 155	45 992	52 793
Structural materials							
Stone, all kinds quarried[1]	120 163	122 144	109 719	103 366	86 860	59 181	67 555
Stone used to make cement	12 614	13 051	13 982	14 138	14 047	10 593	10 154
Stone used to make lime	3 534	3 178	3 028	4 751	1 626	3 411	3 446
Total	136 310	138 373	126 729	122 255	102 533	73 085	81 155
Total ore mined and rock quarried	504 753	453 516	472 466	480 373	471 218	357 439	352 993

1 Excludes stone used to manufacture cement and lime.

TABLE 56. CANADA, EXPLORATION AND CAPITAL EXPENDITURES IN THE MINING INDUSTRY[1], BY PROVINCES AND TERRITORIES, 1981-83

		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	Total all expenditures
		($ million)											
Atlantic provinces	1981	6.3	63.5	80.7	150.5	115.4	265.9	11.0	185.2	196.2	462.1	43.7	505.8
	1982	9.4	78.5	103.7	191.6	105.1	296.7	16.3	174.1	190.4	487.1	20.0	507.1
	1983	6.2	79.6	41.8	127.6	67.3	194.9	13.3	157.2	170.5	365.4	20.6	386.0
Quebec	1981	28.0	156.1	106.5	290.6	135.9	426.5	49.3	261.7	311.0	737.5	81.7	819.2
	1982	32.5	135.5	54.6	222.6	81.7	304.3	43.5	197.0	240.5	544.8	61.5	606.3
	1983	33.7	156.4	24.7	214.8	45.2	260.0	35.3	156.9	192.2	452.2	83.2	535.4
Ontario	1981	17.9	206.2	148.8	372.9	177.2	550.1	70.6	281.7	352.3	902.4	79.5	981.9
	1982	21.6	206.0	153.8	381.4	115.3	496.7	30.9	268.4	299.3	796.0	66.4	862.4
	1983	20.1	188.0	138.6	346.7	113.9	460.6	31.2	279.3	310.5	771.1	93.1	864.2
Manitoba	1981	8.3	27.3	13.5	49.1	34.0	83.1	5.1	44.2	49.3	132.4	20.6	153.3
	1982	(2)	(2)	(2)	47.3	17.0	64.3	4.1	29.6	33.7	98.0	13.9	111.9
	1983	(2)	(2)	(2)	20.9	8.1	29.0	5.3	38.0	43.3	72.3	12.6	84.9
Saskatchewan	1981	20.2	39.0	101.6	160.8	175.7	336.5	11.5	120.5	132.0	468.5	45.4	513.9
	1982	16.2	42.2	163.0	221.4	189.6	411.0	9.6	117.4	127.0	538.0	44.4	582.4
	1983	6.7	36.5	170.9	214.1	202.4	416.5	7.7	99.8	107.5	524.0	27.8	551.8
Alberta	1981	2.6	20.1	52.6	75.3	52.2	127.5	0.9	59.0	59.9	187.4	23.9	211.3
	1982	(2)	(2)	(2)	65.5	141.5	207.0	3.6	76.3	79.9	286.3	21.9	308.2
	1983	(2)	(2)	(2)	96.9	143.3	240.2	2.1	66.9	69.0	309.2	16.1	325.3
British Columbia	1981	34.9	139.7	490.3	664.9	197.2	862.1	24.1	338.9	363.0	1,225.1	111.7	1,336.8
	1982	19.5	186.1	474.8	680.4	203.3	883.7	25.4	317.9	343.3	1,227.0	61.0	1,288.0
	1983	17.2	265.7	613.4	896.3	131.7	1,028.0	18.8	280.4	299.2	1,327.2	90.6	1,417.8
Yukon and Northwest Territories	1981	16.3	43.4	155.3	215.0	106.5	321.5	5.4	57.4	63.8	384.3	78.2	462.5
	1982	7.7	35.0	36.7	79.4	80.4	159.8	7.6	56.2	63.8	223.6	73.3	296.9
	1983	8.8	20.1	10.1	39.0	32.7	71.7	4.8	47.6	52.4	124.1	30.9	155.0
Canada	1981	134.5	695.3	1,149.3	1,979.1	994.1	2,973.2	177.9	1,348.6	1,526.5	4,499.7	484.7	4,984.4
	1982	115.6	724.5	1,048.9	1,889.0	933.9	2,822.9	141.0	1,236.9	1,377.9	4,200.8	362.4	4,563.2
	1983	96.9	772.7	1,086.7	1,956.3	744.6	2,700.9	118.5	1,261.1	1,244.6	3,945.5	374.9	4,320.4

[1] Excludes the crude oil and natural gas industries as well as overhead expenditures; (2) Confidential, included in total.

TABLE 57. CANADA, EXPLORATION AND CAPITAL EXPENDITURES[1] IN THE MINING INDUSTRY, BY TYPE OF MINING, 1981-83

		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	Total, all expenditures
		($ million)											
Metal Mining													
Gold	1981	21.7	111.8	179.7	313.2	96.3	409.5	13.9	44.7	58.6	468.1	40.1	508.2
	1982	27.8	118.0	135.4	281.2	98.2	379.4	11.5	47.2	58.7	438.1	10.8	448.9
	1983	33.4	123.5	123.9	280.8	56.5	337.3	12.2	54.6	66.8	404.1	18.4	422.5
Copper-gold-silver	1981	28.2	91.2	157.1	276.5	161.6	438.1	29.7	292.2	321.9	760.0	13.5	773.5
	1982	28.9	82.0	42.9	153.8	52.2	206.0	22.3	241.9	264.2	470.2	12.3	482.5
	1983	19.4	76.2	6.1	101.7	43.4	145.1	21.3	226.1	247.4	392.5	(2)	392.5
Silver-lead-zinc	1981	21.5	55.2	95.4	172.1	104.7	276.8	6.8	75.4	82.2	359.0	15.4	374.4
	1982	11.3	48.8	27.0	87.1	57.2	144.3	13.6	106.0	119.6	263.9	6.2	270.1
	1983	8.8	22.8	13.4	45.0	27.1	72.1	10.2	90.2	100.4	172.8	(2)	172.8
Iron	1981	(2)	(2)	19.9	127.9	60.4	188.3	35.6	302.8	338.4	526.7	(2)	526.7
	1982	(2)	(2)	23.3	98.1	40.0	138.1	37.7	232.7	270.4	408.5	(2)	408.5
	1983	(2)	(2)	5.1	63.9	15.1	79.0	23.7	165.6	189.3	268.3	(2)	268.3
Other metal mining	1981	37.3	198.6	204.0	439.9	149.1	589.0	65.8	184.8	250.6	839.6	(2)	839.6
	1982	21.8	194.3	172.3	388.4	118.7	507.1	27.3	176.9	204.2	711.3	(2)	711.3
	1983	(2)	(2)	157.0	333.3	167.4	500.7	25.5	189.4	214.9	715.6	(2)	715.6
Total metal mining	1981	(2)	(2)	656.1	1,329.6	572.1	1,901.7	151.8	899.9	1,051.7	2,953.4	97.0	3,050.4
	1982	(2)	(2)	400.9	1,008.6	366.3	1,374.9	112.4	804.7	917.1	2,292.0	35.2	2,327.2
	1983	71.8	447.4	305.5	824.7	309.5	1,134.2	92.9	725.9	818.8	1,953.0	35.0	1,988.0
Nonmetal mining													
Asbestos	1981	(2)	(2)	5.5	53.7	15.3	69.0	4.0	79.5	83.5	152.5	(2)	152.5
	1982	(2)	(2)	3.2	36.6	8.9	45.5	3.7	55.7	59.4	104.9	(2)	104.9
	1983	0.9	57.1	0.2	58.2	4.5	62.7	3.9	67.5	71.4	134.1	(2)	134.1
Other nonmetal mining	1981	21.3	85.4	487.4	594.1	402.4	996.5	22.0	368.3	390.3	1,386.8	(2)	1,386.8
	1982	19.6	174.4	644.2	838.2	554.4	1,392.6	24.9	376.1	401.0	1,793.6	(2)	1,793.6
	1983	16.0	268.2	780.5	1,064.7	428.1	1,492.8	21.5	331.9	353.4	1,846.2	(2)	1,846.2
Total nonmetal mining	1981	(2)	(2)	492.9	647.8	417.7	1,065.5	26.0	447.8	473.8	1,539.3	38.5	1,577.8
	1982	(2)	(2)	647.4	874.8	563.3	1,438.1	28.6	431.8	460.4	1,898.5	31.3	1,929.8
	1983	16.9	325.3	780.7	1,122.9	432.6	1,555.5	25.4	399.4	424.8	1,980.3	25.0	2,005.3
Metal and nonmetal exploration	1981	(2)	(2)	0.3	1.7	4.3	6.0	0.1	0.9	1.0	7.0	349.2	356.2
	1982	(2)	(2)	0.6	5.6	4.3	9.9	-	0.4	0.4	10.3	295.9	306.2
	1983	8.2	-	0.5	8.7	2.5	11.2	0.2	0.8	1.0	12.2	314.9	327.1
Total mining	1981	134.5	695.3	1,149.3	1,979.1	994.1	2,773.2	177.9	1,348.6	1,526.5	4,499.7	484.7	4,984.4
	1982	115.6	724.5	1,048.9	1,889.0	933.9	2,822.9	141.0	1,236.9	1,377.9	4,200.8	362.4	4,563.2
	1983	96.9	772.7	1,086.7	1,956.3	744.6	2,700.9	118.5	1,126.1	1,244.6	3,945.5	374.9	4,320.4

[1] Excludes expenditures in the petroleum and natural gas industries as well as overhead expenditures. (2) Confidential, included in total.
- Nil.

TABLE 58. CANADA, DIAMOND DRILLING IN THE MINING INDUSTRY, BY MINING COMPANIES WITH OWN EQUIPMENT AND BY DRILLING CONTRACTORS, 1981-83

		1981			1982			1983		
		Exploration	Other	Total	Exploration	Other	Total	Exploration	Other	Total
					(metres)					
Metal mining										
Gold	Own equipment	45 162	1 524	46 686	57 957	3 262	61 219	40 381	2 240	42 621
	Contractors	234 432	25 079	259 511	227 202	-	227 202	263 513	46 084	309 597
	Total	279 594	26 603	306 197	285 159	3 262	288 421	303 894	48 324	352 218
Nickel-copper-zinc	Own equipment	318 530	223	318 753	111 189	13 423	124 612	173 155	3 046	176 201
	Contractors	355 586	1 373	356 959	203 357	58 971	262 328	263 209	73 335	336 544
	Total	674 116	1 596	674 712	314 546	72 394	386 940	436 364	76 381	512 745
Silver-lead-zinc	Own equipment	68 716	199 151	267 867	79 110	171 989	251 099	69 863	75 852	145 715
	Contractors	207 126	3 761	210 887	173 119	-	173 119	123 944	-	123 944
	Total	275 842	202 912	478 754	252 229	171 989	424 218	193 807	75 852	269 695
Iron mines	Own equipment	-	-	-	-	-	-	-	-	-
	Contractors	15 817	-	15 817	22 067	-	22 067	728	-	728
	Total	15 817	-	15 817	22 067	-	22 067	728	-	728
Uranium	Own equipment	28 279	-	28 279	41 645	-	41 645	40 984	-	40 984
	Contractors	59 232	21 668	80 900	45 714	13 362	59 076	34 453	-	34 453
	Total	87 511	21 668	109 179	87 359	13 362	100 721	75 437	-	75 437
Miscellaneous metal mining	Own equipment	-	-	-	-	-	-	-	-	-
	Contractors	45 373	-	45 373	41 954	-	41 954	21 496	-	21 496
	Total	45 373	-	45 373	41 954	-	41 954	21 496	-	21 496
Total metal mining	Own equipment	460 687	200 898	661 585	289 901	188 674	478 575	324 383	81 138	405 521
	Contractors	917 566	51 881	969 447	713 413	72 333	785 746	707 343	119 419	826 762
	Total	1 378 253	252 779	1 631 032	1 003 314	261 007	1 264 321	1 031 726	200 557	1 232 283
Nonmetal mining										
Asbestos	Own equipment	-	-	-	-	-	-	-	-	-
	Contractors	10 814	-	10 814	8 400	-	8 400	-	-	-
	Total	10 814	-	10 814	8 400	-	8 400	-	-	-
Gypsum	Own equipment	-	-	-	-	-	-	-	-	-
	Contractors	1 841	-	1 841	-	-	-	762	-	762
	Total	1 841	-	1 841	-	-	-	762	-	762
Salt	Own equipment	1 552	-	1 552	-	-	-	1 835	-	1 835
	Contractors	-	-	-	-	-	-	8 250	-	8 250
	Total	1 552	-	1 552	-	-	-	10 085	-	10 085
Miscellaneous nonmetal mining	Own equipment	404	-	404	1 073	-	1 073	385	-	385
	Contractors	1 128	-	1 128	3 596	-	3 596	909	-	909
	Total	1 532	-	1 532	4 669	-	4 669	1 294	-	1 294
Total nonmetal mining	Own equipment	1 956	-	1 956	1 073	-	1 073	2 220	-	2 220
	Contractors	13 783	-	13 783	11 996	-	11 996	9 921	-	9 921
	Total	15 739	-	15 739	13 069	-	13 069	12 141	-	12 141
Total mining industry	Own equipment	462 648	200 898	663 541	290 974	188 674	479 648	326 603	81 138	407 741
	Contractors	931 349	51 881	983 230	725 409	72 333	797 742	717 264	119 419	836 683
	Total	1 393 992	252 779	1 641 771	1 016 383	261 007	1 277 390	1 043 867	200 557	1 244 424

- Nil.

TABLE 59. CANADA, ORE MINED AND ROCK QUARRIED IN THE MINING INDUSTRY, 1954-83

	Metals	Industrials[1]	Total
		(million tonnes)	
1954	53.5	55.7	109.2
1955	62.7	57.6	120.3
1956	70.2	66.2	136.4
1957	76.4	74.5	150.9
1958	71.4	71.2	142.6
1959	89.9	82.2	172.1
1960	92.1	88.7	180.8
1961	90.1	96.7	186.8
1962	103.6	103.8	207.4
1963	112.7	120.4	233.1
1964	128.0	134.1	262.1
1965	151.0	146.5	297.5
1966	147.6	171.8	319.4
1967	169.1	177.5	346.6
1968	186.9	172.7	359.6
1969	172.0	178.8	350.8
1970	213.0	179.1	392.1
1971	211.5	185.8	397.3
1972	206.0	189.7	395.7
1973	274.8	162.6	437.3
1974	278.7	178.8	457.6
1975	264.2	158.7	422.9
1976	296.5	167.1	463.6
1977	299.5	205.2	504.8
1978	248.1	205.5	453.5
1979	274.8	197.7	472.5
1980	290.1	190.3	480.4
1981	301.5	169.7	471.2
1982	238.4	119.1	357.4
1983	219.0	134.0	353.0

[1] Includes nonmetallic mineral mining and all stone quarried, including stone used to make cement and lime. From 1973 onwards, coverage is the same as in Table 55.

TABLE 60. CANADA, TOTAL DIAMOND DRILLING, METAL DEPOSITS, 1954-83

	Gold Deposits	Copper-zinc- and nickel-copper Deposits	Silver-lead- zinc Deposits	Other Metal Bearing Deposits[1]	Total Metal Deposits
			(metres)		
1954	737 266	826 288	271 873	199 097	2 034 524
1955	717 674	875 942	341 857	537 612	2 473 085
1956	682 600	1 490 298	399 679	383 431	2 956 008
1957	706 273	1 098 490	323 704	287 364	2 415 831
1958	546 861	923 026	297 792	286 970	2 054 649
1959	558 160	1 110 664	282 088	383 471	2 334 383
1960	628 016	1 267 792	226 027	315 067	2 436 902
1961	503 741	1 128 091	255 101	221 079	2 199 452
1962	902 288	1 025 048	350 180	358 679	2 636 195
1963	529 958	977 257	288 204	148 703	1 944 122
1964	458 933	709 588	401 099	104 738	1 674 358
1965	440 020	779 536	331 294	275 917	1 826 727
1966	442 447	729 148	292 223	164 253	1 628 071
1967	391 347	947 955	230 182	120 350	1 689 834
1968	375 263	935 716	198 038	56 780	1 565 797
1969	274 410	923 452	197 670	109 592	1 505 124
1970	214 717	1 132 915	375 019	99 373	1 822 024
1971	193 291	1 089 103	308 798	83 851	1 675 043
1972	229 771	967 640	240 195	50 225	1 487 831
1973	243 708	713 134	185 946	57 730	1 200 518
1974	250 248	798 564	197 322	83 484	1 329 618
1975	216 158	532 991	184 203	97 971	1 031 323
1976	156 030	507 620	166 366	97 735	927 751
1977	175 643	515 780	213 279	124 329	1 029 031
1978	209 335	227 065	490 489	135 197	1 181 743
1979	198 955	437 562	131 032	150 018	917 567
1980	187 635	566 610	259 877	173 945	1 188 067
1981	306 197	675 712	478 754	170 369	1 631 032
1982	288 421	386 940	424 218	164 742	1 264 321
1983	352 218	512 745	269 659	97 661	1 232 283

[1] Includes iron, titanium, uranium, molybdenum and other metal deposits.

TABLE 61. CANADA, EXPLORATION DIAMOND DRILLING, METAL DEPOSITS, 1954-83

	Mining Companies With Own Personnel and Equipment	Diamond Drill Contractors	Total
		(metres)	
1954	295 613	1 109 844	1 405 457
1955	464 118	1 546 025	2 010 143
1956	474 562	1 644 735	2 119 297
1957	358 300	1 233 323	1 591 623
1958	237 133	1 200 625	1 437 758
1959	239 786	1 367 061	1 606 847
1960	268 381	1 409 416	1 677 797
1961	302 696	1 337 173	1 639 869
1962	167 214	1 748 023	1 915 237
1963	361 180	1 169 292	1 530 472
1964	143 013	1 072 985	1 215 998
1965	209 002	1 176 996	1 385 998
1966	163 379	1 044 860	1 208 239
1967	93 164	1 123 137	1 216 301
1968	159 341	990 690	1 150 031
1969	135 311	1 072 328	1 207 639
1970	62 147	1 228 061	1 290 208
1971	86 838	1 053 330	1 140 168
1972	251 651	839 753	1 091 404
1973	321 333	742 899	1 064 232
1974	357 823	892 557	1 250 380
1975	346 770	618 161	964 931
1976	335 919	532 036	867 955
1977	327 241	638 327	965 568
1978	237 250	534 557	771 807
1979	311 221	571 721	882 942
1980	347 829	747 566	1 095 395
1981	460 687	917 566	1 378 253
1982	289 901	713 413	1 003 314
1983	324 383	707 343	1 031 726

TABLE 62. CANADA, DIAMOND DRILLING, OTHER THAN FOR EXPLORATION, METAL DEPOSITS, 1954-83

	Mining Companies With Own Personnel and Equipment	Diamond Drill Contractors	Total
	(metres)		
1954	..	..	629 067
1955	410 925	52 017	462 942
1956	790 522	46 188	836 710
1957	524 724	156 060	680 784
1958	444 376	172 516	616 892
1959	488 783	238 753	727 536
1960	450 246	308 860	759 105
1961	384 432	175 149	559 581
1962	528 700	192 259	720 959
1963	388 228	25 422	413 650
1964	385 765	72 594	458 359
1965	393 947	46 822	440 769
1966	227 968	191 863	419 831
1967	186 463	287 071	473 534
1968	122 851	292 914	415 765
1969	87 552	209 933	297 485
1970	290 363	241 453	531 816
1971	295 966	238 910	534 876
1972	304 523	91 903	396 426
1973	77 162	59 124	136 286
1974	54 353	24 885	79 238
1975	31 917	34 475	66 392
1976	31 413	28 383	59 796
1977	24 303	39 160	63 463
1978	351 344	58 592	409 936
1979	4 090	30 535	34 625
1980	20 545	72 127	92 672
1981	200 898	51 881	252 779
1982	188 674	72 333	261 007
1983	81 138	119 419	200 557

Nonproducing companies excluded since 1964.
.. Not available.

TABLE 63. CANADA, CRUDE MINERALS TRANSPORTED BY CANADIAN RAILWAYS, 1981-83

	1981	1982	1983
		(000 tonnes)	
Metallic minerals			
Alumina and bauxite	3 133	2 793	3 091
Copper ores and concentrates	1 624	1 507	1 488
Iron ores and concentrates	49 788	35 101	30 281
Lead ores and concentrates	511	545	588
Nickel-copper ores and concentrates	4 457	1 890	2 738
Nickel ores and concentrates	612	228	97
Zinc ores and concentrates	1 630	1 638	1 571
Metallic ores and concentrates, nes	72	345	73
Total metallic minerals	61 827	44 047	39 927
Nonmetallic minerals			
Abrasives, natural	61	37	32
Asbestos	332	190	120
Barite	72	21	44
Clay	606	485	534
Gypsum	4 767	3 591	5 065
Limestone, agricultural	61	42	59
Limestone, industrial	299	177	257
Limestone, nes	4 139	3 049	2 715
Nepheline syenite	340	274	291
Peat and other mosses	34	23	19
Phosphate rock	2 572	1 665	2 017
Potash (KCl)	9 703	7 681	9 239
Salt, rock	909	1 078	941
Salt, nes	102	83	112
Sand, industrial	986	743	816
Sand, nes	11	10	263
Silica	16	12	13
Sodium carbonate	552	481	484
Sodium sulphate	600	623	496
Stone, nes	194	93	117
Sulphur, liquid	1 905	1 518	1 440
Sulphur, nes	5 931	4 855	4 477
Nonmetallic minerals, nes	232	152	143
Total nonmetallic minerals	34 424	26 883	29 713
Mineral fuels			
Coal, bituminous	23 054	23 293	24 284
Coal, lignite	1 148	1 312	1 235
Coal, nes	90	68	70
Natural gas and other crude bituminous substances	4	7	11
Oil, crude	163	91	50
Total mineral fuels	24 459	24 771	25 650
Total crude minerals	120 710	95 701	95 290
Total revenue freight moved by Canadian railways	246 643	212 542	222 830
Per cent crude minerals of total revenue freight	48.9	45.0	42.8

nes Not elsewhere specified.

TABLE 64. CANADA, FABRICATED MINERAL PRODUCTS TRANSPORTED BY CANADIAN RAILWAYS, 1981-83

	1981	1982	1983
		(000 tonnes)	
Metallic mineral products			
Ferrous mineral products			
Ferroalloys	102	47	45
Pig iron	134	42	50
Ingots, blooms, billets, slabs of iron and steel	933	630	1 300
Other primary iron and steel	210	21	20
Castings and forgings, iron and steel	179	114	125
Bars and rods, steel	825	521	642
Plates, steel	590	314	413
Sheet and strip, steel	1 016	666	657
Structural shapes and sheet piling, iron and steel	467	216	282
Rails and railway track material	131	94	108
Pipes and tubes, iron and steel	767	448	209
Wire, iron or steel	29	21	12
Iron and steel scrap	1 806	1 162	1 720
Slag, dross, etc.	162	52	126
Total ferrous mineral products	7 351	4 348	5 709
Nonferrous mineral products			
Aluminum paste, powder, pigs, ingots, shot	115	291	252
Aluminum and aluminum alloy fabricated material, nes	229	234	733
Copper matte and precipitates	1	351	5
Copper and alloys, nes	423	350	423
Lead and alloys	126	119	146
Zinc and alloys	453	406	484
Other nonferrous base metals and alloys	19	13	13
Nonferrous metal scrap	189	109	94
Total nonferrous mineral products	1 555	1 873	2 150
Total metallic mineral products	8 906	6 221	7 859
Nonmetallic mineral products			
Natural stone basic products, chiefly structural	196	160	193
Bricks and tiles, clay	46	20	20
Fire brick and similar shapes	86	47	32
Dolomite and magnesite, calcined	71	39	55
Refractories, nes	33	16	12
Glass basic products	91	84	72
Asbestos and asbestos-cement basic products	36	23	4
Portland cement, standard	1 804	1 349	1 589
Cement and concrete basic products, nes	343	173	245
Plaster	18	13	11
Gypsum basic products, nes	32	21	108
Lime, hydrated and quick	219	186	156
Nonmetallic mineral basic products, nes	424	299	268
Sulphuric acid	1 202	957	1 067
Fertilizers and fertilizer materials, nes	1 937	1 581	1 747
Total nonmetallic mineral products	6 538	4 968	6 644
Mineral fuel products			
Gasoline	1 511	1 376	1 332
Diesel fuel	2 778	2 223	2 053
Fuel oil, nes	1 080	890	829
Lubricating oils and greases	342	296	330
Petroleum coke	463	537	467
Coke, nes	701	567	606
Refined and manufactured gases, fuel type	3 010	2 991	2 753
Asphalts and road oils	214	256	183
Other petroleum and coal products	841	676	758
Total mineral fuel products	10 930	9 812	9 311
Total fabricated mineral products	26 374	21 001	23 814
Total revenue freight moved by Canadian railways	246 643	212 542	22 830
Fabricated mineral products as a percentage of total revenue freight	10.7	9.9	10.7

nes Not elsewhere specified.

TABLE 65. CANADA, CRUDE AND FABRICATED MINERALS TRANSPORTED BY CANADIAN RAILWAYS, 1954-83

	Total Revenue Freight	Total Crude Minerals	Total Fabricated Minerals	Total Crude and Fabricated Minerals	Crude and Fabricated Minerals as Per cent of Revenue Freight
			(million tonnes)		
1954	129.8	45.0	16.8	61.8	47.6
1955	152.2	61.2	19.0	80.2	52.7
1956	172.0	68.7	21.8	90.5	52.6
1957	157.9	64.2	17.1	81.3	51.5
1958	139.2	52.4	15.2	67.6	48.6
1959	150.6	62.8	15.3	78.1	52.9
1960	142.8	57.1	14.5	71.6	50.1
1961	138.9	54.1	13.6	67.7	48.7
1962	146.0	60.3	13.8	74.1	50.8
1963	154.6	62.9	15.5	78.3	50.6
1964	180.0	74.6	15.9	90.5	50.3
1965	186.2	80.9	17.3	98.2	52.7
1966	194.5	80.6	17.8	98.4	50.6
1967	190.0	81.2	17.7	98.9	52.1
1968	195.4	86.7	18.8	105.5	54.0
1969	189.0	81.9	27.6	109.5	57.9
1970	211.6	97.5	28.4	127.9	60.4
1971	214.5	95.6	27.4	123.0	57.3
1972	215.8	89.4	27.6	117.0	54.2
1973	241.2	113.1	29.1	142.2	59.0
1974	246.3	115.3	30.9	146.2	59.4
1975	226.0	110.6	26.6	137.2	60.7
1976	238.5	116.6	25.5	142.1	59.6
1977	247.2	121.1	25.7	146.8	59.4
1978	238.8	107.7	26.2	133.9	45.1
1979	257.9	127.2	26.6	153.8	59.6
1980	254.4	124.8	24.6	149.4	58.8
1981[r]	246.6	120.7	26.4	147.1	59.7
1982[r]	212.5	95.7	21.0	116.7	54.9
1983	222.8	95.3	23.8	119.1	53.5

[r] Revised.

TABLE 66. CANADA, CRUDE AND FABRICATED MINERALS TRANSPORTED THROUGH THE ST. LAWRENCE SEAWAY[1], 1982-84

	Montreal-Lake Ontario Section			Welland Canal Section		
	1982	1983	1984	1982	1983	1984
	(tonnes)					
Crude minerals						
Coal	1 046 580	350 170	452 898	6 478 426	5 494 597	6 603 148
Iron ore	6 740 758	10 280 210	11 421 521	6 364 815	9 229 290	10 088 727
Aluminum ores and concentrates	96 024	115 345	185 500	96 024	115 345	185 452
Clay and bentonite	129 267	76 849	157 206	129 266	76 849	157 206
Sand and gravel	33	7 975	6 992	118 341	203 063	318 736
Stone, ground or crushed	30 839	47 462	117 233	102 695	401 719	537 585
Stone, rough	2 025	292	206	2 026	289	206
Salt	648 547	878 535	898 931	1 287 540	1 455 070	1 725 967
Phosphate rock	-	35 156	5 484	-	16 326	-
Sulphur	2 733	-	-	2 733	-	-
Other crude minerals	449 397	651 140	842 988	475 377	419 199	694 588
Total crude minerals	9 146 203	12 443 134	14 008 959	15 057 243	17 411 747	20 311 615
Fabricated mineral products						
Coke	617 617	638 042	793 112	686 590	683 081	858 598
Gasoline	144 035	249 993	237 388	157 842	218 092	251 160
Fuel oil	909 030	936 121	745 378	972 930	835 488	678 186
Lubricating oils and greases	44 330	13 070	17 430	34 414	12 889	17 106
Other petroleum products	157 202	110 029	134 353	139 305	116 155	134 139
Tar, pitch and creosote	38 236	25 154	51 533	45 328	43 015	74 189
Pig iron	138 048	161 017	243 817	128 814	150 896	218 538
Iron and steel: bars, rods, slabs	103 714	286 838	861 123	99 304	361 841	769 358
Iron and steel: nails, wire	15 005	4 184	25 888	10 705	3 305	10 822
Iron and steel: manufactured	2 412 338	2 605 115	3 566 220	1 459 619	2 416 949	3 182 737
Scrap iron and steel	414 788	390 006	303 619	382 445	366 974	325 725
Cement	3 129	2 522	10	215 523	409 794	531 399
Total fabricated minerals	4 997 472	5 422 091	6 979 871	4 332 819	5 618 479	7 051 957
Total crude and fabricated minerals	14 143 675	17 865 225	20 988 830	19 390 062	23 030 226	27 363 572
Total all products	38 841 399	45 060 981	47 505 456	44 473 919	50 145 086	53 916 858
Crude and fabricated minerals as a per cent of total	36.4	39.6	44.2	43.6	45.9	50.8

[1] Total of cargo transported regardless of travel directive.
- Nil.

TABLE 67. CANADA, CRUDE AND FABRICATED MINERALS TRANSPORTED THROUGH THE ST. LAWRENCE SEAWAY[1], 1955–84

	Montreal - Lake Ontario Section				Welland Canal Section			
	Total All Products	Total Crude Minerals	Total Fabricated Minerals	Crude and Fabricated Minerals as Per Cent of All Products	Total All Products	Total Crude Minerals	Total Fabricated Minerals	Crude and Fabricated Minerals as Per Cent of All Products
	(kilotonnes)				(kilotonnes)			
1955	10 384	3 859	1 244	49.1	18 954	10 257	2 097	65.2
1956	12 247	4 807	1 314	50.0	20 925	11 405	2 169	64.8
1957	11 059	4 439	1 392	52.7	20 296	11 305	2 421	67.6
1958	10 670	3 064	1 020	38.3	19 300	8 994	2 107	57.5
1959	19 252	7 725	2 197	51.5	24 953	12 117	2 246	57.6
1960	18 460	5 760	2 904	46.9	26 563	12 679	2 606	57.5
1961	21 212	6 706	2 358	42.7	28 490	12 599	2 378	52.7
1962	23 271	7 531	2 522	43.2	32 215	15 625	2 342	55.8
1963	28 198	9 507	2 804	43.7	37 490	18 094	2 524	55.0
1964	35 701	13 127	3 558	46.7	46 644	23 489	3 095	57.0
1965	39 352	13 788	6 024	50.3	48 477	23 555	4 933	58.8
1966	44 538	16 376	6 340	51.0	53 648	25 712	5 329	57.8
1967	39 918	17 800	6 430	60.7	47 945	26 010	5 459	65.6
1968	43 496	19 312	8 425	63.8	52 712	29 075	7 587	69.6
1969	37 256	12 682	8 263	56.2	48 601	25 090	6 715	65.4
1970	46 445	15 554	8 932	52.7	57 121	27 233	7 156	60.2
1971	48 069	14 204	9 263	48.8	57 205	23 903	7 914	55.6
1972	48 607	13 425	9 837	47.9	58 146	24 808	7 701	55.9
1973	52 285	17 111	9 639	51.1	60 958	26 907	7 718	56.8
1974	40 049	16 137	7 018	57.8	47 500	23 952	5 437	61.9
1975	43 554	15 698	6 071	50.0	53 387	26 100	5 129	58.5
1976	49 348	20 884	7 181	56.9	58 368	29 914	6 323	62.1
1977	57 456	23 008	9 918	57.3	65 079	30 459	8 933	60.5
1978	51 658	15 057	8 558	45.7	59 576	22 700	7 759	51.1
1979	50 187	16 408	8 104	48.8	60 023	24 851	7 940	54.6
1980	42 142	12 248	6 009	43.3	54 074	20 487	5 405	47.9
1981	45 876	15 453	5 711	46.1	53 389	22 132	5 529	51.8
1982	38 841	9 146	4 997	36.4	44 474	15 057	4 333	45.9
1983	45 061	12 443	5 422	39.6	50 145	17 412	5 618	45.9
1984	47 505	14 009	6 980	44.2	53 917	20 312	7 056	50.8

1 Total of cargo transported regardless of travel direction.

TABLE 68. CANADA, CRUDE MINERALS LOADED AND UNLOADED IN COASTWISE SHIPPING, 1983

	Loaded				Unloaded			
	Atlantic	Great Lakes	Pacific	Total	Atlantic	Great Lakes	Pacific	Total
	(tonnes)							
Metallic minerals								
Iron ore and concentrates	4 281 343	1 432 534	11 249	5 725 126	715 105	4 998 772	11 249	5 725 126
Titanium ore	1 838 055	-	-	1 838 055	1 838 055	-	-	1 838 055
Zinc ore and concentrates	65	-	30 119	30 184	65	-	30 119	30 184
Metallic ores and concentrates	4 049	-	-	4 049	4 049	-	-	4 049
Total metals	6 123 512	1 432 534	41 368	7 597 414	2 557 274	4 998 772	41 368	7 597 414
Nonmetallic minerals								
Dolomite	-	47 806	-	47 806	47 806	-	-	47 806
Gypsum	556 104	-	15 735	571 839	446 015	110 089	15 735	571 839
Limestone	3 256	1 154 085	1 233 180	2 390 521	3 256	1 154 085	1 233 180	2 390 521
Potash	852	170 219	-	171 071	852	170 219	-	171 071
Quartz-silica	34 056	7 000	136	41 192	7 000	34 056	136	41 192
Salt	719 822	1 440 117	-	2 159 939	1 500 723	659 216	-	2 159 939
Sand and gravel	385 458	-	2 349 731	2 735 189	377 936	7 522	2 349 731	2 735 189
Stone, crude, nes	649	348 799	75 702	425 150	649	348 799	75 702	425 150
Sulphur crude and refined	11 059	-	1 225	12 284	11 059	-	1 225	12 284
Crude nonmetallic minerals, nes	1 109	-	324	1 433	1 109	-	324	1 433
Total nonmetals	1 712 365	3 168 026	3 676 033	8 556 424	2 396 405	2 483 986	3 676 033	8 556 424
Mineral fuels								
Coal and peat for fuel	257 709	2 344 165	-	2 601 874	257 709	2 344 165	-	2 601 874
Petroleum, crude	2 491 812	-	-	2 491 812	2 491 812	-	-	2 491 812
Total mineral fuels	2 749 521	2 344 165	-	5 093 686	2 749 521	2 344 165	-	5 093 686
Total crude minerals	10 585 398	6 944 725	3 717 401	21 247 524	7 703 200	9 826 923	3 717 401	21 247 524
Total all commodities	19 529 072	28 193 612	19 875 786	67 598 470	33 333 649	14 389 039	19 875 786	67 598 470
Crude minerals as a per cent of all commodities	54.2	24.6	18.7	31.4	23.1	68.3	18.7	31.4

- Nil; nes Not elsewhere specified.

TABLE 69. CANADA, FABRICATED MINERALS LOADED AND UNLOADED IN COASTWISE SHIPPING, 1983

	Loaded				Unloaded			
	Atlantic	Great Lakes	Pacific	Total	Atlantic	Great Lakes	Pacific	Total
	(tonnes)							
Metallic mineral products								
Ferrous mineral products								
Primary iron, steel	8 121	-	-	8 121	-	8 121	-	8 121
Castings and forgings, steel	3 591	738	3 606	7 935	4 325	4	3 606	7 935
Bars and rods, steel	3 106	1 334	-	4 440	3 106	1 334	-	4 440
Plates and sheets, steel	1 873	8 763	-	10 636	1 873	8 763	-	10 636
Structual shapes, iron and steel	12 494	53 954	5 575	72 023	12 494	53 954	5 575	72 023
Rails and railway track material	862	469	-	1 331	1 285	46	-	1 331
Pipes and tubes, iron and steel	4 685	28	44	4 757	4 685	28	44	4 757
Wire, iron and steel	833	-	-	833	833	-	-	833
Ferroalloys	2 020	-	-	2 020	20	2 000	-	2 020
Aluminum and aluminum products	108 389	-	-	108 389	108 389		-	108 389
Total metallic mineral products	145 974	65 286	9 225	220 485	137 010	74 250	9 225	220 495
Nonmetallic mineral products								
Asbestos basic products	631	-	-	631	631	-	-	631
Bricks, tiles and pipes, clay	3 884	-	-	3 884	3 884	-	-	3 884
Cement	12 041	515 159	180 111	707 311	12 041	515 159	180 111	707 311
Cement basic products	569	-	12 083	12 652	569	-	12 083	12 652
Fertilizers and fertilizer material nes	19 594	-	5 400	24 994	7 385	12 209	5 400	24 994
Glass basic products	302	-	-	302	302	-	-	302
Sulphur acid	36 523	-	8 401	44 924	36 523	-	8 401	44 924
Other nonmetallic mineral products	4 678	-	16 656	21 344	4 678	-	16 656	21 334
Total nonmetallic mineral products	78 222	515 159	222 651	816 032	66 013	527 368	222 651	816 032
Mineral fuel products								
Asphalts and road oils	67 537	-	35 342	102 879	37 221	30 316	35 342	102 879
Fuel oil	4 751 219	1 398 977	1 180 692	7 330 888	5 318 816	831 380	1 180 692	7 330 888
Gasoline	2 233 151	549 607	624 334	3 407 092	2 369 872	412 886	624 334	3 407 092
Lubricating oils and greases	34 534	437	-	34 971	15 517	19 454	-	34 971
Petroleum coke	11 319	18 465	-	29 784	29 784	-	-	29 784
Other petroleum and coal products	19 230	63 695	77	83 002	38 703	44 222	77	83 002
Total mineral fuel products	7 116 990	2 031 181	1 840 445	10 988 616	7 809 913	1 338 258	1 840 445	10 988 616
Total fabricated mineral products	7 341 186	2 611 626	2 072 321	12 025 133	8 012 936	1 939 876	2 072 321	12 025 133
Total all commodities	19 529 072	28 193 612	19 875 786	67 598 470	33 333 649	14 389 039	19 875 786	67 598 470
Fabricated mineral products as a per cent of all commodities	37.6	9.3	10.4	17.8	24.0	13.5	10.4	17.8

- Nil; nes Not elsewhere specified.

TABLE 70. CANADA, CRUDE AND FABRICATED MINERALS LOADED AT CANADIAN PORTS IN COASTWISE SHIPPING; 1954-83

	Total All Commodities	Total Crude Minerals	Total Fabricated Minerals	Crude and Fabricated Minerals as Per cent of All Products
		(kilotonnes)		
1954	23 402	4 101	5 552	41.2
1955	25 050	4 371	6 229	42.3
1956	31 303	6 750	7 275	44.8
1957	34 354	8 696	7 832	48.1
1958	34 808	7 673	7 258	42.9
1959	36 494	9 984	7 819	48.8
1960	37 058	8 786	8 229	45.9
1961	41 861	9 527	8 857	43.9
1962	39 763	8 361	9 768	45.6
1963	40 328	7 998	9 942	44.5
1964	47 171	8 522	11 194	41.8
1965	48 200	9 183	11 766	43.5
1966	55 122	10 155	12 653	41.4
1967	49 799	11 509	12 207	47.6
1968	50 921	13 698	13 245	52.9
1969	51 890	12 746	14 181	51.9
1970	57 301	14 415	14 818	51.0
1971	55 128	14 783	15 374	54.7
1972	55 326	14 197	15 290	53.3
1973	55 314	16 573	15 615	58.2
1974	53 633	11 723	16 575	52.8
1975	54 373	15 687	17 510	61.1
1976	53 882	15 924	16 208	59.6
1977	58 309	18 131	17 435	61.0
1978	60 668	18 318	16 619	57.6
1979	79 950	22 130	17 486	50.2
1980	82 761	22 947	17 134	48.4
1981	71 271	17 849	16 669	48.4
1982	65 881	16 473	13 214	45.1
1983	67 598	21 248	12 025	49.2

TABLE 71. CANADA, CRUDE MINERALS LOADED AND UNLOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE, 1981-83

	1981		1982		1983	
	Loaded	Unloaded	Loaded	Unloaded	Loaded	Unloaded
			(tonnes)			
Metallic minerals						
Alumina, bauxite ore	6 595	3 886 501	7 336	3 367 797	9 225	3 561 112
Copper ores and concentrates	1 034 946	78 240	1 097 233	108 646	1 137 386	77 460
Iron ore and concentrates	41 909 908	7 713 979	27 770 684	3 322 648	26 803 303	4 364 451
Lead ore and concentrates	124 939	3 833	206 261	6 119	350 835	7 396
Manganese ore	25 959	168 395	-	165 332	10 555	108 112
Nickel ore and concentrates	85 603	2 620	39 089	3 531	92 033	18 229
Titanium ore	855 586	14 936	845 861	5 518	683 513	8 035
Zinc ore and concentrates	728 140	-	940 419	-	937 716	277
Other nonferrous ores, concentrates and metal scrap, nes	119 493	107 307	29 311	31 211	108 120	30 808
Total metals	44 891 169	11 975 811	30 936 194	7 010 802	30 132 686	8 175 880
Nonmetallic minerals						
Asbestos	706 622	25 286	605 982	25 564	648 320	638
Barite	-	8 158	25	14 573	-	25 668
Bentonite	4	176 559	18	96 908	15 012	99 488
China clay	-	34 693	-	6 409	132	26 415
Clay materials, nes	1 334	5 533	1 756	50 242	519	4 629
Dolomite	948 552	-	117 788	10 724	410 440	17 319
Fluorspar	-	190 592	-	125 789	-	127 681
Gypsum	5 062 237	134 252	4 475 409	80 864	5 415 167	104 599
Limestone	1 711 487	2 261 324	1 443 482	1 266 945	1 690 721	1 786 294
Phosphate rock	-	1 197 106	-	1 353 595	-	1 317 237
Potash (KCl)	4 253 511	18	4 103 313	-	4 659 250	37
Salt	1 431 460	1 327 244	1 664 815	1 164 624	1 838 079	741 470
Sand and gravel	151 833	1 322 115	98 179	935 763	34 212	1 040 504
Stone, crude, nes	95 377	27 290	17 037	50 911	25 801	17 195
Stone, crushed	13 442	62 766	-	5 315	34 186	19
Sulphur	5 726 661	3	4 869 230	-	4 687 209	5
Crude, nonmetallic minerals, nes	145 860	26 201	97 002	10 151	100 411	59 304
Total nonmetals	20 248 380	6 799 140	17 494 036	5 198 377	19 599 459	5 368 502
Mineral fuels						
Coal, bituminous	17 458 453	16 066 286	17 162 442	15 142 357	16 901 990	14 884 124
Fuels, nes	194	3	101	1	397	240 663
Petroleum, crude	408 408	14 070 091	891	8 246 236	517 290	7 432 267
Total fuels	17 867 055	30 136 380	17 163 434	23 388 594	17 419 677	22 557 054
Total crude minerals	83 006 604	48 911 331	65 593 664	35 597 773	67 151 822	36 101 436
Total all commodities	145 445 080	68 187 889	125 281 616	48 729 336	129 490 483	48 914 996
Crude minerals as a per cent of all commodities	57.1	71.7	52.4	73.1	51.9	73.8

- Nil; nes Not elsewhere specified.

TABLE 72. CANADA, FABRICATED MINERAL PRODUCTS LOADED AND UNLOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE, 1981-83

	1981		1982		1983	
	Loaded	Unloaded	Loaded	Unloaded	Loaded	Unloaded
	(tonnes)					
Metallic products						
Aluminum	272 585	47 503	557 593	42 200	339 355	61 182
Copper and alloys	224 600	44 540	157 620	36 606	219 095	47 933
Ferroalloys	24 858	50 890	19 764	19 805	19 530	39 763
Iron and steel, primary	2 737	29 898	1 002	7 916	26 681	9 561
Iron, pig	458 534	7 717	431 916	-	397 316	1 500
Iron and steel, other						
bars and rods	79 921	199 244	131 415	127 193	56 048	186 667
castings and forgings	120 633	64 419	109 329	52 690	33 235	55 823
pipes and tubes	62 462	278 956	27 845	173 819	15 043	117 069
plates and sheet	191 667	1 282 572	1 013 763	351 119	135 406	272 898
rails and track material	97 644	12 433	42 095	16 105	25 179	13 639
structural shapes	24 030	240 887	38 170	41 690	137 749	88 282
wire and rope	15 910	132 814	31 558	106 943	24 434	149 730
Lead and alloys	53 320	3 781	57 668	1 479	59 190	3 247
Nickel and alloys	40 847	7 661	44 979	5 489	35 297	8 111
Zinc and alloys	140 043	19 277	133 918	7 065	140 079	21 350
Nonferrous metals, nes	68 487	155 811	23 887	11 443	11 982	8 032
Metal fabricated basic products	56 351	170 980	72 131	121 232	56 638	29 696
Total metals	1 934 629	2 749 383	2 894 653	1 122 794	1 733 287	1 115 483
Nonmetallic products						
Asbestos basic products	5 606	1 907	1 878	1 194	2 444	563
Building blocks, nes	31 527	36 057	18 681	45 736	21 438	128 401
Cement	1 719 170	130 990	1 187 272	7 599	1 010 708	8 347
Cement basic products	850	681	22 724	129	40 770	1 643
Glass basic products	35 226	15 631	30 271	13 131	30 249	20 501
Nonmetallic mineral basic products	54 739	73 732	61 800	204 060	30 210	92 468
Sulphuric acid	96 244	55 716	21 791	133 519	90 037	5 998
Fertilizers, nes	138 603	125 364	71 921	92 572	83 563	236 475
Total nonmetals	2 081 965r	440 078r	1 416 338r	497 940r	1 309 419	494 396
Mineral fuel products						
Asphalts, road oils	44 512	36 388	9 650	12 109	3 416	9 871
Coal tar, pitch	17 028	83 515	3 625	52 687	7 506	78 570
Coke	666 609	1 110 170	403 347	781 671	414 853	958 263
Fuel oil	3 380 547	1 888 349	1 612 410	1 721 714	1 829 947	1 851 282
Gasoline	615 796	63 450	487 160	41 047	532 633	453 430
Lubricating oils and greases	14 801	9 051	12 609	34 193	8 361	6 678
Petroleum and coal products, nes	266 081	47 448	275 031	106 462	357 494	1 236
Total fuels	5 005 374	3 238 371	2 803 832	2 749 885	3 154 210	3 359 330
Total fabricated mineral products	9 021 968r	6 427 832r	7 114 823r	4 370 619r	6 196 916	4 969 209
Total all commodities	145 445 080	68 187 889	125 281 616	48 729 336	129 490 483	48 914 996
Fabricated mineral products as a per cent of all commodities	6.2	9.4	5.7	9.0	4.8	10.2

- Nil; nes Not elsewhere specified; r Revised.

TABLE 73. CANADA, CRUDE AND FABRICATED MINERALS LOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE, 1954-83

	Total All Commodities	Total Crude Minerals	Total Fabricated Minerals	Crude and Fabricated Minerals as Per cent of All Products
		(kilotonnes)		
1954	27 878	9 316	1 108	37.4
1955	35 836	17 126	1 684	52.5
1956	44 791	23 284	1 904	56.2
1957	44 539	24 210	2 588	60.2
1958	36 559	16 602	1 642	49.9
1959	45 772	25 789	1 619	59.9
1960	45 872	24 671	2 039	58.2
1961	48 771	23 241	2 133	52.0
1962	54 676	30 446	2 296	59.9
1963	62 031	32 214	2 503	56.0
1964	75 760	42 087	2 602	59.0
1965	74 521	41 338	2 746	59.2
1966	76 192	41 374	3 350	58.7
1967	72 598	42 704	3 701	63.9
1968	78 663	48 680	2 960	65.6
1969	70 432	42 442	3 456	65.1
1970	95 807	55 849	4 965	63.5
1971	95 887	53 245	5 022	60.7
1972	98 988	51 912	9 091	61.6
1973	112 434	64 195	10 103	66.1
1974	106 110	64 093	9 041	68.9
1975	102 444	61 970	7 495	67.8
1976	114 815	71 527	6 108	67.6
1977	119 770	70 257	5 979	63.7
1978	116 522	62 291	7 556	59.9
1979	134 639	79 685	8 901	65.8
1980	138 161	67 898	11 770	57.7
1981	145 445	83 007	9 022[r]	63.3[r]
1982	125 282	65 594	7 115[r]	58.1[r]
1983	129 490	67 152	6 197	56.7

[r] Revised.

TABLE 74. CANADA, FINANCIAL STATISTICS OF CORPORATIONS IN THE MINING INDUSTRY[1], BY DEGREE OF NON-RESIDENT OWNERSHIP, 1982

	Corporations		Assets		Equity		Sales		Profits		Taxable Income	
	(number)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)
Metal mines												
Reporting corporations												
Canadian	95	54.0	19,296	76.8	9,009	77.2	5,681	69.7	-134	39.1	78	81.0
Foreign	40	22.7	5,812	23.1	2,666	22.8	2,469	30.3	-214	61.4	18	18.8
Unclassified	41	23.3	3	--	--	--	2	--	--	--	--	--
Total all corporations	176	100.0	25,111	100.0	11,675	100.0	8,153	100.0	-348	100.0	97	100.0
Mineral fuels												
Reporting corporations												
Canadian	883	62.7	38,654	61.6	15,024	58.1	10,167	41.1	1,979	30.5	456	11.8
Foreign	197	14.0	24,056	38.3	10,826	41.9	14,544	58.8	4,515	69.5	3,411	88.1
Unclassified	330	23.3	31	.1	12	--	17	.1	2	--	4	.1
Total all corporations	1,410	100.0	62,740	100.0	25,862	100.0	24,728	100.0	6,496	100.0	3,871	100.0
Other mining (including mining services)												
Reporting corporations												
Canadian	2,130	44.9	7,586	64.0	3,178	59.8	2,959	60.6	-99	--	113	24.8
Foreign	223	4.7	4,089	34.5	2,103	40.0	1,737	35.6	213	221.0	327	71.5
Unclassified	2,388	50.4	187	1.6	26	.5	186	3.8	-17	--	17	3.7
Total all corporations	4,741	100.0	11,862	100.0	5,307	100.0	4,882	100.0	96	100.0	457	100.0
Total mining												
Reporting corporations												
Canadian	3,108	49.1	65,536	65.7	27,211	63.5	18,807	49.8	1,746	28.0	1 647	14.6
Foreign	460	7.3	33,957	34.1	15,595	36.4	18,750	49.6	4,514	72.3	3,756	84.9
Unclassified	2,759	43.6	221	.2	38	.1	205	.5	-15	--	21	.5
Total all corporations	6,327	100.0	99,713	100.0	42,844	100.0	37,763	100.0	6,245	100.0	4,425	100.0

Note: Footnotes for Table 75 apply to this table. Figures may not add to totals due to rounding.
[1] Cement, lime and clay products (domestic clay) are included in mineral manufacturing.
-- Amount too small to be expressed.

TABLE 75. CANADA, FINANCIAL STATISTICS OF CORPORATIONS IN THE MINERAL MANUFACTURING INDUSTRIES[1], BY DEGREE OF NON-RESIDENT OWNERSHIP, 1982

	Corporations[2]		Assets[4]		Equity[5]		Sales[6]		Profits[7]		Taxable Income[8]	
	(number)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)
Primary metal products												
Reporting corporations[2]												
Canadian	255	64.6	12,078	85.7	5,243	84.6	8,834	83.2	-231	96.7	65	61.9
Foreign	45	11.4	2,013	14.3	957	15.4	1,767	16.7	-8	3.3	39	36.7
Unclassified[3]	95	24.0	8	.1	1	--	14	.1	--	.1	1	.5
Total all corporations	395	100.0	14,099	100.0	6,201	100.0	10,615	100.0	-239	100.0	105	100.0
Nonmetallic mineral products												
Reporting corporations[2]												
Canadian	762	49.6	1,912	25.5	678	22.1	2,137	41.0	107	43.9	76	41.1
Foreign	85	5.5	5,515	73.7	2,389	77.7	2,974	57.1	139	56.9	104	56.2
Unclassified[3]	690	44.9	60	.8	7	.2	101	1.9	-2	--	5	2.5
Total all corporations	1,537	100.0	7,487	100.0	3,074	100.0	5,212	100.0	244	100.0	185	100.0
Petroleum and coal products												
Reporting corporations[2]												
Canadian	46	59.0	12,294	40.1	4,419	31.5	6,322	22.4	552	33.7	147	43.2
Foreign	17	21.8	18,343	59.9	9,594	68.5	21,950	77.6	1,087	66.4	193	56.9
Unclassified[3]	15	19.2	2	--	--	--	2	--	--	--	--	--
Total all corporations	78	100.0	30,639	100.0	14,013	100.0	28,274	100.0	1,639	100.0	340	100.0
Total mineral manufacturing industries												
Reporting corporations[2]												
Canadian	1,063	52.9	26,284	50.3	10,340	44.4	17,293	39.2	428	26.0	288	45.7
Foreign	147	7.3	25,871	49.5	12,940	55.6	26,691	60.5	1,218	74.1	336	53.3
Unclassified[3]	800	39.8	70	.1	8	--	117	.3	-2	--	6	1.0
Total all corporations	2,010	100.0	52,225	100.0	23,288	100.0	44,101	100.0	1,644	100.0	630	100.0

[1] Includes cement, lime, and clay products (domestic clay). [2] Corporations reporting under the Corporations and Labour Unions Returns Act. A corporation is considered to be foreign controlled if 50 per cent 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. [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] 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 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] 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] 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 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.
-- Amount too small to be expressed.

TABLE 76. CANADA, FINANCIAL STATISTICS OF CORPORATIONS IN NON-FINANCIAL INDUSTRIES, BY MAJOR INDUSTRY GROUP AND BY CONTROL, 1981 AND 1982

	Agriculture, Forestry, Fishing and Trapping		Mines, Quarries & Oil Wells		Manufacturing		Construction		Transportation, Communication and Other Utilities		Trade		Services		Total	
	1981	1982P	1981	1982P	1981	1982P	1981	1982P	1981	1982P	1981	1982P	1981	1982P	1981	1982P
	(number)															
Number of corporations																
Canadian control	9,758	10,825	3,124	3,112	17,688	17,307	16,988	16,589	6,542	6,601	48,607	49,926	24,472	26,441	127,179	130,801
Foreign control	102	110	445	460	2,019	2,038	189	195	284	306	1,786	1,911	611	715	5,436	5,735
Other corporations	10,229	10,335	2,753	2,759	18,567	18,635	43,084	44,078	15,073	15,710	73,922	74,112	84,175	87,221	247,803	252,850
Total corporations	20,089	21,270	6,322	6,331	38,274	37,480	60,261	60,862	21,899	22,617	124,315	125,949	109,258	114,377	380,418	389,386
	($ million)															
Assets																
Canadian control	8,062	9,160	55,597	65,535	90,978	92,105	18,713	18,096	121,679	135,004	65,953	68,084	27,950	29,072	388,572	417,058
Foreign control	421	454	32,304	33,957	75,437	76,621	2,476	2,493	5,436	5,731	16,403	16,170	5,683	6,176	138,160	141,602
Other corporations	985	994	229	221	1,462	1,442	2,626	2,585	1,072	1,072	5,320	5,283	4,929	4,998	16,623	16,594
Total corporations	9,467	10,607	88,130	99,713	167,877	170,169	23,815	23,175	128,187	141,807	87,677	89,537	38,202	40,246	543,355	575,254
Equity																
Canadian control	2,514	3,029	25,549	27,211	31,856	30,901	4,044	3,983	32,229	35,361	19,435	21,647	7,106	7,398	122,732	129,529
Foreign control	142	166	16,183	15,595	36,410	36,815	807	831	1,852	1,930	5,591	5,649	2,101	2,257	63,087	63,243
Other corporations	181	165	49	38	237	224	481	458	160	150	890	820	885	824	2,882	2,679
Total corporations	2,837	3,359	41,781	42,843	68,502	67,941	5,332	5,272	34,240	37,441	25,915	28,117	10,092	10,479	188,701	195,452
Sales																
Canadian control	6,483	6,727	18,988	18,808	110,627	105,072	31,214	31,148	55,643	60,613	163,172	162,627	27,136	28,828	413,264	413,823
Foreign control	317	325	17,892	18,750	106,940	105,827	4,256	4,499	3,761	4,141	42,688	43,370	6,794	7,462	182,648	184,374
Other corporations	1,072	1,077	214	206	2,814	2,815	5,794	5,658	1,737	1,794	11,882	11,833	8,198	8,615	31,711	31,997
Total corporations	7,872	8,128	37,094	37,763	220,381	213,713	41,264	41,306	61,141	66,548	217,743	217,830	42,128	44,906	627,623	630,195
Profits																
Canadian control	356	217	3,729	1,745	6,881	546	1,081	513	5,109	4,578	5,220	3,528	1,852	1,128	24,228	12,256
Foreign control	21	23	3,840	4,514	7,420	3,881	159	147	447	446	1,230	577	781	645	13,898	10,234
Other corporations	65	12	--	-16	94	39	194	72	55	20	279	95	527	345	1,212	567
Total corporations	442	253	7,568	6,244	14,396	4,466	1,434	1,733	5,611	5,044	6,728	4,199	3,159	2,117	39,338	23,056

Note: Figures may not add to totals due to rounding.
P Preliminary. -- Amount to small to be expressed.

TABLE 77. CANADA, CAPITAL AND REPAIR EXPENDITURES BY SELECTED INDUSTRIAL SECTOR, 1983-85

		Capital Expenditures			Repair Expenditures			Capital and Repair Expenditures		
		Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total
		($ million)								
Agriculture	1983	1,211.5	2,875.0	4,086.5	365.3	1,071.5	1,436.8	1,576.8	3,946.5	5,523.3
	1984p	1,280.1	2,924.0	4,204.1	329.5	1,148.5	1,478.0	1,609.6	4,072.5	5,682.1
	1985f	1,236.9	2,996.8	4,233.7	342.3	1,213.6	1,555.9	1,579.2	4,210.4	5,789.6
Forestry	1983	96.9	58.0	154.9	77.9	240.1	318.0	174.8	298.1	472.9
	1984p	104.5	99.2	203.7	75.3	254.0	329.3	179.8	353.2	533.0
	1985f	118.2	98.8	217.0	90.1	259.0	349.1	208.3	357.8	566.1
Mining[1]	1983	7,996.5	1,626.5	9,623.0	546.2	1,786.2	2,332.4	8,542.7	3,412.7	11,955.4
	1984p	8,001.5	1,651.4	9,652.9	477.1	1,999.2	2,476.3	8,478.6	3,650.6	12,129.2
	1985f	9,094.0	1,954.7	11,048.7	518.6	2,160.1	2,678.7	9,612.6	4,114.8	13,727.4
Construction	1983	205.2	1,079.7	1,284.9	28.4	824.7	853.1	233.6	1,904.4	2,138.0
	1984p	203.0	1,066.7	1,269.7	28.0	814.7	842.7	231.0	1,881.4	2,112.4
	1985f	207.6	1,090.5	1,298.1	28.7	833.2	861.9	236.3	1,923.7	2,160.0
Housing	1983	12,994.1	-	12,994.1	3,857.3	-	3,857.3	16,851.4	-	16,851.4
	1984p	12,453.2	-	12,453.2	4,044.1	-	4,044.1	16,497.3	-	16,497.3
	1985f	12,682.7	-	12,682.7	4,229.8	-	4,229.8	16,912.5	-	16,912.5
Manufacturing	1983	1,895.9	6,962.5	8,858.4	784.5	4,226.9	5,011.4	2,680.4	11,189.4	13,869.8
	1984p	1,837.8	7,251.5	9,089.3	892.3	4,707.8	5,600.1	2,730.1	11,959.3	14,689.4
	1985f	2,089.6	9,372.7	11,462.3	920.0	4,938.6	5,858.6	3,009.6	14,311.3	17,320.9
Utilities	1983	7,642.3	7,814.3	15,456.6	1,684.9	4,258.6	5,943.5	9,327.2	12,072.9	21,400.1
	1984p	7,001.1	7,424.2	14,425.3	1,853.7	4,631.0	6,484.7	8,854.8	12,055.2	20,910.0
	1985f	6,634.9	7,152.5	13,787.4	1,970.3	4,808.0	6,778.3	8,605.2	11,960.5	20,565.7
Trade	1983	630.5	1,395.6	2,026.1	243.3	326.9	570.2	873.8	1,722.5	2,596.3
	1984p	685.9	1,726.7	2,412.6	248.8	318.0	566.8	934.7	2,044.7	2,979.4
	1985f	650.3	1,682.4	2,332.7	260.2	318.4	578.6	910.5	2,000.8	2,911.3
Other[2]	1983	13,003.1	6,031.2	19,034.3	2,681.5	1,118.6	3,800.1	15,684.6	7,149.8	22,834.4
	1984p	13,908.4	7,450.7	21,359.1	2,688.3	1,221.2	3,909.5	16,596.7	8,671.9	25,268.6
	1985f	14,977.9	8,087.0	23,064.9	2,891.9	1,269.5	4,161.4	17,869.8	9,356.5	27,226.3
Total	1983	45,676.0	27,842.8	73,518.8	10,269.3	13,853.3	24,122.8	55,945.3	41,696.3	97,641.6
	1984p	45,475.5	29,594.4	75,069.9	10,637.1	15,094.4	25,731.5	56,112.6	44,688.8	100,801.4
	1985f	47,692.1	32,435.4	80,127.5	11,251.9	15,800.4	27,052.3	58,944.0	48,235.8	107,179.8
Mining as a percentage of total	1983	17.5	5.8	13.1	5.3	12.9	9.7	15.3	8.2	12.2
	1984p	17.6	5.5	12.9	4.5	13.2	9.6	15.1	8.2	12.0
	1985f	19.1	6.0	13.8	4.6	13.7	9.9	16.3	8.5	12.8

[1] Includes mines, quarries and oil wells. [2] Includes finance, real estate, insurance, commercial services, institutions and government departments.
p Preliminary; f Forecast; - Nil.

TABLE 78. CANADA, CAPITAL AND REPAIR EXPENDITURES IN MINING[1] BY GEOGRAPHICAL REGION, 1983-85

		Capital Expenditures			Repair Expenditures			Capital and Repair Expenditures		
		Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total
						($ million)				
Atlantic Region	1983	1,473.8	317.6	1,755.4	13.3	162.9	176.2	1,451.1	480.5	1,931.6
	1984P	1,473.3	158.5	1,631.8	14.7	159.5	174.2	1,488.0	318.0	1,806.0
	1985f	1,440.9	195.7	1,636.6	14.9	159.5	174.4	1,455.8	355.2	1,811.0
Quebec	1983	221.7	46.5	268.2	35.6	159.0	194.6	257.3	205.5	462.8
	1984P	234.4	73.7	308.1	34.5	165.1	199.6	268.9	238.8	507.7
	1985f	323.2	78.9	402.1	41.6	180.7	222.3	364.8	259.6	624.4
Ontario	1983	389.3	115.1	504.4	33.1	280.8	313.9	422.4	395.9	818.3
	1984P	402.3	145.4	547.7	49.8	323.8	373.6	452.1	469.2	921.3
	1985f	465.4	262.8	728.2	49.8	341.5	391.3	515.2	604.3	1,195.5
Prairie Region	1983	3,688.9	707.0	4,395.9	408.1	829.9	1,238.0	4,097.0	1,536.9	5,633.9
	1984P	4,202.6	981.3	5,183.9	325.3	948.3	1,273.6	4,527.9	1,929.6	6,457.5
	1985f	5,430.4	1,225.6	6,656.0	364.5	1,031.6	1,396.1	5,794.9	2,257.2	8,052.1
British Columbia	1983	1,014.5	136.3	1,150.8	49.7	305.3	355.0	1,064.2	441.6	1,505.8
	1984P	502.3	171.4	673.7	39.2	323.7	362.9	541.5	495.1	1,036.6
	1985f	417.4	143.9	561.3	33.8	364.1	397.9	451.2	508.0	959.2
Yukon and Northwest Territories	1983	1,224.3	304.0	1,548.3	6.4	48.3	54.7	1,250.7	352.3	1,603.0
	1984P	1,186.6	121.1	1,307.7	13.6	78.8	92.4	1,200.2	199.9	1,400.1
	1985f	1,016.7	47.8	1,064.5	14.0	82.7	96.7	1,030.7	130.5	1,161.2
Canada, total	1983	7,996.5	1,626.5	9,623.0	546.2	1,786.2	2,332.4	8,542.7	3,412.7	11,955.4
	1984P	8,001.5	1,651.4	9,652.9	477.1	1,999.2	2,476.3	8,478.6	3,650.6	12,129.2
	1985f	9,094.0	1,954.7	11,048.7	518.6	2,160.1	2,678.7	9,612.6	4,114.8	13,727.4

[1] Includes mines, quarries and oil wells.
P Preliminary; f Forecast.

TABLE 79. CANADA, CAPITAL AND REPAIR EXPENDITURES IN MINING[1] AND MINERAL MANUFACTURING INDUSTRIES, 1983-85

	1983			1984p			1985f		
	Capital	Repair	Total	Capital	Repair	Total	Capital	Repair	Total
				($ million)					
Mining industry									
Metal mines									
Gold	337.3	66.8	404.1	492.5	76.1	568.6	647.7	79.9	727.6
Silver-lead-zinc	72.1	100.1	172.2	117.4	109.5	226.9	131.7	112.0	243.7
Copper-gold-silver	150.7	248.0	398.7	196.6	272.8	469.4	246.6	277.0	523.6
Iron	79.0	189.3	268.3	84.0	201.1	285.1	78.0	200.2	278.2
Other metal mines	512.0	217.1	729.1	408.1	284.6	692.7	464.4	296.8	761.2
Total metal mines	1,151.1	821.3	1,972.4	1,298.6	944.1	2,242.7	1,568.4	965.9	2,534.3
Nonmetal mines									
Asbestos	62.6	71.3	133.9	41.2	50.4	91.6	31.9	58.9	90.8
Other nonmetal mines[2]	1,494.6	355.7	1,850.3	1,136.4	409.1	1,545.5	855.2	477.1	1,332.3
Total nonmetal mines	1,557.2	427.0	1,984.2	1,177.6	459.5	1,637.1	887.1	536.0	1,423.1
Mineral fuels									
Oil, crude and gas[3]	6,914.7	1,084.1	7,998.8	7,176.7	1,072.7	8,249.4	8,593.2	1,176.8	9,770.0
Total mining industries	9,623.0	2,332.4	11,955.4	9,652.9	2,476.3	12,129.2	11,048.7	2,678.7	13,727.4
Mineral manufacturing									
Primary metal industries									
Iron and steel mills	166.2	654.2	820.4	228.3	751.6	979.9	679.9	784.8	1,464.7
Steel pipe and tube mills	63.6	41.9	105.5	34.6	66.1	100.7	148.5	56.6	205.1
Iron foundries	13.3	38.9	51.9	43.2	59.4	102.6	23.4	59.5	82.9
Smelting and refining	373.7	371.2	744.9	733.3	380.7	1,114.0	861.6	373.9	1,235.5
Aluminum rolling, casting and extruding	25.0	41.8	66.8	42.4	42.8	85.2	43.7	46.8	90.5
Copper and copper alloy, rolling, casting and extruding	4.5	6.2	10.7	9.0	7.0	16.0	9.4	6.8	16.2
Metal rolling, casting and extruding	17.1	10.3	27.4	19.8	11.8	31.6	16.2	12.8	29.0
Total primary metal industries	663.1	1,164.5	1,827.6	1,110.6	1,319.4	2,430.0	1,782.7	1,341.2	3,123.9
Nonmetallic mineral products									
Cement	27.7	58.7	86.4	15.0	57.2	72.2	28.2	55.6	83.8
Stone products	3.4	0.8	4.2	2.8	0.6	3.4	1.3	0.9	2.2
Concrete products	12.5	23.6	36.1	15.5	28.3	43.8	15.4	28.7	44.1
Ready-mix concrete	15.0	52.0	67.0	24.0	54.4	78.4	19.3	56.9	76.2
Clay products	6.2	8.1	14.3	6.4	8.3	14.7	5.2	8.1	13.3
Glass and glass products	36.8	22.6	59.4	54.6	31.3	85.9	117.4	43.4	160.8
Abrasives	12.5	11.8	24.3	11.8	15.9	27.7	11.0	16.0	27.0
Lime	1.2	3.7	4.9	7.5	4.4	11.9	4.4	4.0	8.4
Other nonmetallic mineral products	25.0	43.5	68.5	40.4	51.4	91.8	45.5	52.6	98.1
Total nonmetallic mineral products	140.3	224.8	365.1	178.0	251.8	429.8	247.7	266.2	513.9
Petroleum and coal products	840.8	264.6	1,105.4	535.6	275.8	811.4	487.6	248.7	736.3
Total mineral manufacturing industries	1,644.2	1,653.9	3,198.1	1,824.2	1,847.0	3,671.2	2,518.0	1,856.1	4,374.1
Total mining and mineral manufacturing industries	11,267.2	3,986.3	15,253.5	11,477.1	4,323.3	15,800.4	13,566.7	4,534.8	18,101.5

[1] Does not include cement, lime and clay products (domestic clay) manufacturing, smelting and refining. [2] Includes coal mines, gypsum, salt, potash and miscellaneous nonmetal mines and quarrying. [3] The total of capital expenditures shown under "petroleum and gas" is equal to the total capital expenditure under the column entitled "petroleum and natural gas extraction" and under the column "natural gas processing plants" of Table 82.
p Preliminary; f Forecast.

TABLE 80. CANADA, CAPITAL AND REPAIR EXPENDITURES IN THE MINING INDUSTRY[1], 1979-85

	1979	1980	1981	1982	1983	1984P	1985f
				($ million)			
Metal mines							
Capital							
Construction	606.4	1,109.1	1,331.3	1,099.4	839.1	936.6	1,095.7
Machinery	281.6	467.2	576.4	370.6	312.0	362.0	1,298.6
Total	888.0	1,576.3	1,907.7	1,470.0	1,151.1	1,298.6	1,568.4
Repair							
Construction	70.2	137.3	151.9	112.4	93.3	110.9	117.7
Machinery	632.1	767.7	900.8	805.1	728.0	833.2	848.2
Total	702.3	905.0	1,052.7	917.5	821.3	944.1	965.9
Total capital and repair	1,590.3	2,481.3	2,960.4	2,387.5	1,972.4	2,242.7	2,534.3
Nonmetal mines[2]							
Capital							
Construction	248.8	346.4	647.8	888.6	1,123.3	599.6	466.3
Machinery	202.6	267.6	417.7	563.3	433.9	578.0	420.8
Total	451.4	614.0	1,065.5	1,451.9	1,557.2	1,177.6	887.1
Repair							
Construction	14.6	32.5	26.0	28.6	25.5	44.3	57.6
Machinery	332.5	393.1	447.8	431.8	401.5	415.2	478.4
Total	347.1	425.6	473.8	460.4	427.0	459.5	536.0
Total capital and repair	798.5	1,039.6	1,539.3	1,912.3	1,984.2	1,637.1	1,423.1
Mineral fuels							
Capital							
Construction	3,820.3	5,453.1	5,825.1	6,019.2	6,034.1	6,465.3	7,532.0
Machinery	494.9	800.3	1,206.3	1,420.5	880.6	711.4	1,061.2
Total	4,315.2	6,253.4	7,031.4	7,439.7	6,914.7	7,176.7	8,593.2
Repair							
Construction	444.1	627.6	514.4	484.4	427.4	321.9	343.3
Machinery	242.1	313.6	639.0	698.3	656.7	750.8	833.5
Total	686.2	941.2	1,153.4	1,182.7	1,084.1	1,072.7	1,176.8
Total capital and repair	5,001.4	7,194.6	8,184.8	8,622.4	7,998.8	8,249.4	9,770.0
Total mining							
Capital							
Construction	4,675.5	6,908.6	7,804.2	8,007.2	7,996.5	8,001.5	9,094.0
Machinery	979.1	1,535.1	2,200.4	2,354.4	1,626.5	1,651.4	1,954.7
Total	5,654.6	8,443.7	10,004.6	10,361.6	9,623.0	9,652.9	11,048.7
Repair							
Construction	528.9	797.4	692.5	625.4	546.2	477.1	518.6
Machinery	1,206.7	1,474.4	1,987.6	1,935.2	1,786.2	1,999.2	2,160.1
Total	1,735.6	2,271.8	2,680.1	2,560.6	2,332.4	2,476.3	2,678.7
Total capital and repair	7,390.2	10,715.5	12,684.7	12,922.2	11,955.4	12,129.2	13,727.4

[1] Does not include cement, lime and clay products (domestic clays) manufacturing, smelting and refining. [2] Includes coal mines, asbestos, gypsum, salt, potash, miscellaneous nonmetals, quarrying and sand pits.
P Preliminary; f Forecast.

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TABLE 81. CANADA, CAPITAL AND REPAIR EXPENDITURES IN THE MINERAL MANUFACTURING INDUSTRIES[1], 1979-85

	1979	1980	1981	1982	1983	1984P	1985f
				($ million)			
Primary metal industries[2]							
Capital							
Construction	153.4	328.2	330.1	278.3	112.5	291.0	297.8
Machinery	621.1	960.9	1,289.6	927.5	550.6	819.6	1,484.9
Total	774.5	1,289.1	1,619.7	1,205.8	663.1	1,110.6	1,782.7
Repair							
Construction	87.6	122.1	139.0	99.2	111.4	125.3	123.4
Machinery	887.7	998.5	1,053.3	1,021.6	1,053.1	1,194.1	1,217.8
Total	975.3	1,120.6	1,192.3	1,120.8	1,164.5	1,319.4	1,341.2
Total capital and repair	1,749.8	2,409.7	2,812.0	2,326.6	1,827.6	2,430.0	3,123.9
Nonmetallic mineral products[3]							
Capital							
Construction	102.0	70.0	93.4	32.0	14.8	22.1	29.2
Machinery	293.5	249.7	254.0	134.4	125.5	155.9	218.5
Total	395.5	319.7	347.4	166.4	140.3	178.0	247.7
Repair							
Construction	20.2	16.7	23.7	20.7	20.7	21.0	21.6
Machinery	206.1	213.8	227.5	211.1	204.1	230.8	244.6
Total	226.3	230.5	251.2	231.8	224.8	251.8	266.2
Total capital and repair	621.8	550.2	598.6	398.2	365.1	429.8	513.9
Petroleum and coal products							
Capital							
Construction	180.0	215.6	629.9	890.8	629.6	398.8	358.2
Machinery	94.0	109.1	215.0	333.7	211.2	136.8	129.4
Total	274.0	324.7	844.9	1,224.5	840.8	535.6	487.6
Repair							
Construction	158.1	190.5	212.9	218.5	196.0	207.7	186.2
Machinery	61.3	76.2	89.1	101.2	68.6	68.1	62.5
Total	219.4	266.7	302.0	319.7	264.6	275.8	248.7
Total capital and repair	493.4	591.4	1,146.9	1,544.2	1,105.4	811.4	736.3
Total mineral manufacturing industries							
Capital							
Construction	435.4	613.8	1,053.4	1,201.1	756.9	711.9	685.2
Machinery	1,008.6	1,319.7	1,758.6	1,395.6	887.3	1,112.3	1,832.8
Total	1,444.0	1,933.5	2,812.0	2,596.7	1,644.2	1,824.2	2,518.0
Repair							
Construction	256.9	329.3	375.6	338.4	328.1	354.0	331.2
Machinery	1,155.1	1,288.5	1,369.9	1,333.9	1,328.1	1,493.0	1,524.9
Total	1,412.0	1,617.8	1,745.5	1,672.3	1,653.9	1,847.0	1,856.1
Total capital and repair	2,856.0	3,551.3	4,557.5	4,269.0	3,298.1	3,671.2	4,374.1

[1] Industry groups are the same as in Table 29. [2] Includes smelting and refining. [3] Includes cement, lime and clay products manufacturing.
P Preliminary; f Forecast.

TABLE 82. CANADA, CAPITAL EXPENDITURES IN THE PETROLEUM, NATURAL GAS AND ALLIED INDUSTRIES[1], 1979-85

	Petroleum and Natural Gas Extraction[2]	Transportation Including Rail, Water and Pipelines	Marketing (Chiefly Outlets of Oil Companies)	Natural Gas Distribution	Petroleum and Coal Products Industries	Natural Gas Processing Plants	Total Capital Expenditures
				($ million)			
1979	4,013.4	229.3	134.3	262.5	274.0	301.8	5,215.3
1980	5,744.2	602.1	205.2	386.4	324.7	311.5	7,574.1
1981	6,444.9	1,745.7	264.1	408.7	844.9	311.6	10,046.9
1982	6,743.4	1,994.3	320.5	517.6	1,224.5	522.8	11,323.1
1983	6,563.5	660.5	374.5	516.8	840.8	195.8	9,151.9
1984P	6,872.0	709.2	405.3	574.8	535.6	271.6	9,368.5
1985f	8,188.3	594.7	397.1	455.8	487.6	373.9	10,497.4

[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] Does not include expenditures for geological and geophysical operations. See also Footnote 2 to Table 80.
P Preliminary; f Forecast.

TABLE 83. CANADA, TOTAL INTRAMURAL RESEARCH AND DEVELOPMENT EXPENDITURES FOR MINING RELATED INDUSTRIES IN CURRENT AND CONSTANT (1975) DOLLARS, 1978-84

	1978	1979	1980	1981	1982	1983	1984P
				($ million)			
Current dollars							
Mining	56	110	131	170	168	182	181
Mines	18	21	31	48	44	46	49
Oil and gas wells	38	89	100	122	124	136	132
Mineral manufacturing	170	202	247	328	319	307	313
Ferrous primary metals	16	19	21	24	21	21	23
Nonferrous primary metals	50	60	85	86	86	68	88
Nonmetallic mineral products	6	7	9	11	11	12	13
Petroleum products	98	116	132	207	201	206	189
Constant dollars							
Mining	45	78	84	100	90	91	86
Mines	15	15	20	28	24	23	23
Oil and gas wells	30	63	64	72	66	68	63
Mineral manufacturing	136	145	161	192	170	154	149
Ferrous primary metals	13	14	14	14	11	11	11
Nonferrous primary metals	40	43	56	51	46	34	42
Nonmetallic mineral products	5	5	6	6	6	6	6
Petroleum products	78	83	85	121	107	103	90

P Preliminary.

TABLE 84. CANADA, CURRENT AND CAPITAL INTRAMURAL RESEARCH AND DEVELOPMENT EXPENDITURES FOR MINING RELATED INDUSTRIES, 1978-84

	1978	1979	1980	1981	1982	1983	1984P
				($ million)			
Capital expenditures							
Mining	8	51	37	21	39	43	28
Mines	1	2	4	3	4	7	7
Oil and gas wells	7	49	33	18	35	36	21
Mineral manufacturing	42	61	58	59	79	66	41
Ferrous primary metals	-	1	1	2	1	2	2
Nonferrous primary metals	4	9	24	17	10	3	4
Nonmetallic mineral products	-	1	1	1	1	1	1
Petroleum products	38	50	32	39	67	60	34
Current expenditures							
Mining	48	59	94	149	129	139	152
Mines	17	19	27	45	40	39	41
Oil and gas wells	31	40	67	104	89	100	111
Mineral manufacturing	127	140	190	270	241	240	271
Ferrous primary metals	16	18	20	22	20	19	21
Nonferrous primary metals	45	50	62	70	76	64	83
Nonmetallic mineral products	6	7	8	10	10	11	12
Petroleum products	60	65	100	168	135	146	155
Total expenditures							
Mining	56	110	131	170	168	182	181
Mines	18	21	31	48	44	46	49
Oil and gas wells	38	89	100	122	124	136	132
Mineral manufacturing	170	202	247	328	319	307	313
Ferrous primary metals	16	19	21	24	21	21	23
Nonferrous primary metals	50	60	85	86	86	68	88
Nonmetallic mineral products	6	7	9	11	11	12	13
Petroleum products	98	116	132	207	201	206	189

P Preliminary; - Nil.