MINERAL POLICY SECTOR | SECTEUR DE LA POLITIQUE MINÉRALE

1992 CANADIAN MINERALS YEARBOOK

REVIEW AND OUTLOOK

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

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Preface

Each year, the Mineral Policy Sector of Energy, Mines and Resources Canada completes a comprehensive review of developments in the mineral and metal industry and publishes the results as the *Canadian Minerals Yearbook*. This publication forms a continuing record from year to year, with this edition reporting on the activities of the industry during 1992.

The Yearbook contains detailed industry statistics and includes separate chapters devoted to each of the major minerals and metals. The subject matter spans all stages of mineral industry activity from geoscience and exploration, through mining and processing, to markets, consumption and recycling. Although domestic matters receive the greatest attention, international developments are also reviewed because of the global nature of the mineral industry and the potentially significant impact that such developments could have on the Canadian industry. Some chapters of the Yearbook are intended to be general enough to be of interest to a broad readership, while others are more technical and will appeal to individuals who are more closely associated with the industry.

Although mineral fuels are normally included in reporting the overall value of Canada's mineral production, the main focus of this publication is the nonfuel sector, including coal and uranium. The industry is defined to encompass mining and concentrating, smelting and refining, as well as the minerals- and metals-based semi-fabricating and fabricating industries.

Excluding the oil and natural gas industries, the mineral industry accounted for 2.8% of total national employment, 4.2% of Canada's GDP and 16.4% of Canada's total domestic exports in 1992.

Preliminary estimates show that the total value of production of all mineral commodities, including mineral fuels, increased from $35.2 billion in 1991 to $35.4 billion in 1992, an increase of 0.6%. In comparison to 1991, the results for individual commodities were mixed, as advances in the value of output of some minerals were offset by losses in others.

Excluding mineral fuels, the overall value of production declined from $15.3 billion in 1991 to $14.6 billion in 1992, a decrease of 4.4%. In general, commodity prices remained low. Based on value of output, the top nonfuel commodities in 1992 were gold ($2.1 billion), copper ($2.1 billion), zinc ($1.7 billion), nickel ($1.7 billion), iron ore ($1.1 billion) and potash ($1.0 billion). Nonfuel minerals accounted for 41.2% of the total value of Canada's mineral production in 1992.

The Yearbook's first chapter entitled "General Review" highlights the importance of the industry in the context of the Canadian economy. This chapter provides a summary of the overall volume and value of Canadian mineral production in 1992, along with a brief overview and production statistics for Canada's leading minerals. It is followed by chapters that focus on: the international scene; the regional outlook; labour and employment; mine reserves, investment, and promising deposits; mine openings and closures; and mineral exploration. The

37 commodity chapters in this edition feature economic and policy developments and data specific to each commodity in respect of markets, prices, production, trade and consumption. These commodity reviews also provide an outlook of the industry's future position.

The Statistical Report at the end of the Yearbook is comprised of over 80 tables which provide a detailed statistical overview of the mineral industry. These tables are grouped according to the following topics: production; trade; consumption; prices; principal statistics; employment, salaries and wages; mining, exploration and drilling; transportation; and investment and finance. Although the tables focus on the most recent data available, many of the tables also include an historical series covering past years.

The basic statistics on Canada's mineral and metal production, trade and consumption were collected by the Mineral and Metal Statistics Division, Mineral Policy Sector, and by Statistics Canada, unless otherwise noted. Market quotations were taken mainly from published marketing reports. Corporate data presented in the various chapters of this Yearbook were obtained by the authors directly from company officials through surveys or correspondence, or were taken from annual reports. Energy, Mines and Resources Canada is grateful to everyone who has contributed information used in the preparation of this publication.

Additional copies of the 1992 Yearbook may be purchased from the Canada Communication Group–Publishing (telephone: (819) 956-4802) and associated bookstores. Previous editions of the *Canadian Minerals Yearbook* have been deposited in various libraries across Canada.

Reprints of individual chapters, as well as copies of Map 900A, *Principal Mineral Areas of Canada*, may be obtained from:

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Note: Commodities shown in **bold** type are covered in this issue. The other commodities listed have appeared in previous editions.

1992

Canadian Minerals Yearbook

Review and Outlook

NOTE TO READER

The reader should note that a number of abbreviations for common units of measurement appear in the text:

cm	centimetre
cm^2	square centimetres
cm^3	cubic centimetres
ct	carats
ct/t	carats per tonne
dm^3	cubic decimetres
g	grams
g/t	grams per tonne
GJ	gigajoules
GJ/t	gigajoules per tonne
ha	hectares
kcal	kilocalories
kg	kilograms
kg/m	kilograms per month
kgU	kilograms of uranium
km	kilometres
km^2	square kilometres
kt/y	kilotonnes per year
kW	kilowatts
L	litres
lb	pounds
m	metres
m^2	square metres
m^3	cubic metres
mg	milligrams
mm	millimetres
Mt	million tonnes or megatonnes
MW	megawatt
MWe	megawatts electric
oz	ounces
st	short ton
t	tonnes (metric)
t/d	tonnes per day
t/h	tonnes per hour
t/m	tonnes per month
t/y	tonnes per year
tU	tonnes of uranium
μg	microgram

General Review

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THE CANADIAN ECONOMY

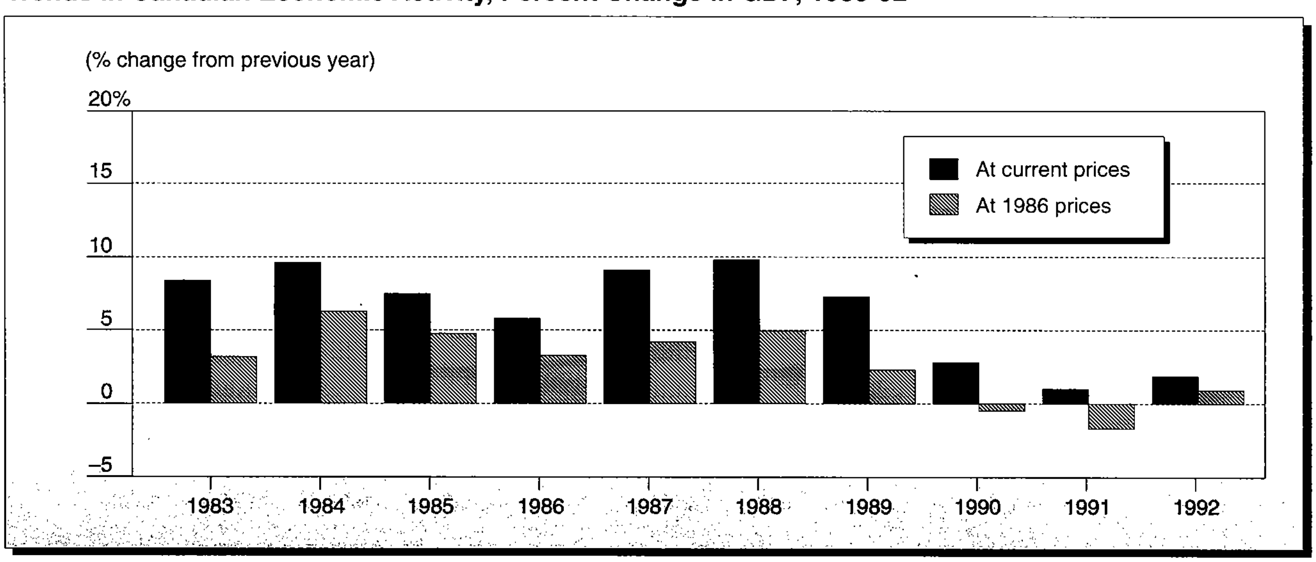
In 1992, Canada's Gross Domestic Product (GDP) grew by an estimated 0.9%. This was a very modest gain in light of the reduced economic output that was recorded in each of the two previous years (–0.5% in 1990 and –1.7% in 1991). Throughout the year, merchandise exports were the major source of strength to an otherwise struggling Canadian economy. Increased housing construction activity also helped to sustain the recovery during 1992.

The 1992 recovery could simply be described as weak and agonizingly slow, particularly to the 1.6 million Canadians who found themselves unemployed. Surprisingly to some, perhaps, economic output has actually been increasing since the second quarter of 1991, albeit at a very modest and uneven pace, and with only marginal growth at times. Approaching the end of 1992, however, the Canadian economy was still operating below the level at which it entered the recession in April 1990.

As in 1991, the economy continued to be held down by high unemployment, weak spending by consumers, plant layoffs and closings, depressed levels of investment in non-residential building construction, and record numbers of business and personal bankruptcies. As the year progressed, however, there was encouraging improvement in some sectors of the economy. After slowing down somewhat in the second quarter, the pace of economic growth picked up again in the third quarter, its best quarterly advance in over a year.

Consumer spending grew 0.9% in real terms in the third quarter after 0.3% growth in the second

Figure 1
Trends in Canadian Economic Activity, Percent Change in GDP, 1983-92



NOTE: Data for 1992 are estimated.
SOURCE: Statistics Canada.

quarter and no net advance in the previous three quarters. This increased pace of spending reflected an upturn in personal disposable income since the beginning of the year, improved consumer confidence and lower interest rates. Nevertheless, caution due to high unemployment and the burden of high consumer debt continued to have a moderating effect on consumer expenditures for goods and services.

On a positive note, the continuing drop in mortgage interest rates, along with special government home ownership programs, helped to stimulate the home-building sector. The total number of housing starts for the year was estimated at 168 000, an increase of 7.7% over the 1991 level of 156 000.

The overall pace of economic improvement was not sufficient to prevent the unemployment rate from increasing over the course of the year. In November, the jobless rate rose to a high of 11.8%. This was the highest rate recorded in over nine years and represented 1 645 000 Canadians who were looking for work. For the year overall, the unemployment rate averaged about 11.3% compared to 10.3% in 1991. At year-end, there were about 156 000 more Canadians unemployed than in December 1991. As the economy improved, more and more people re-entered the labour force looking for work.

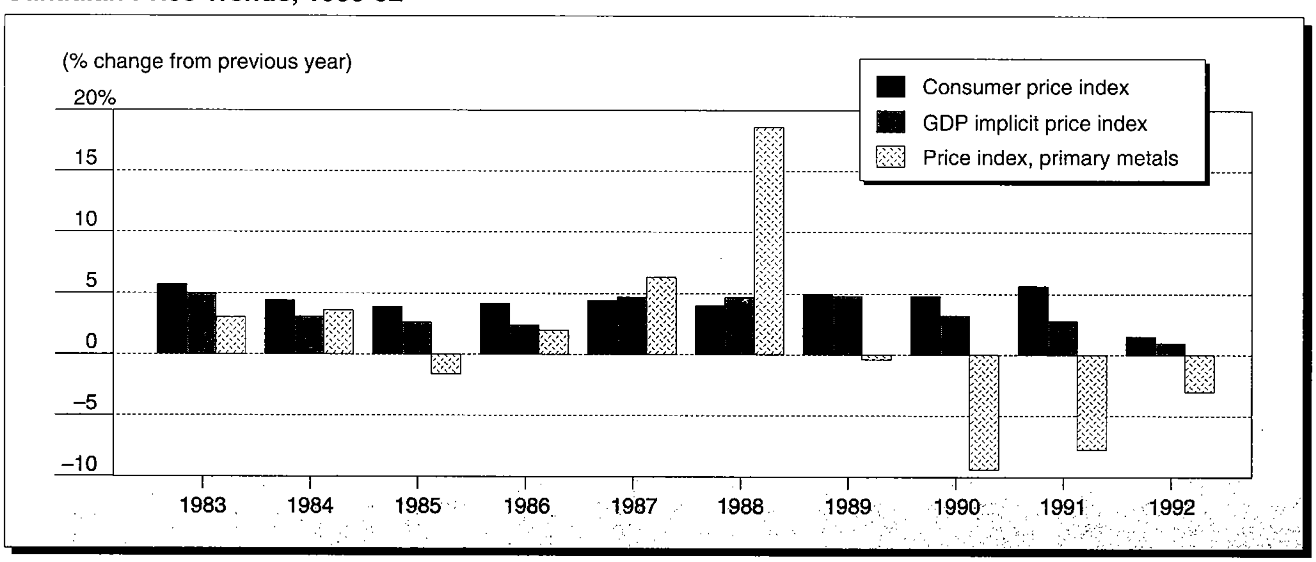
During the latter half of the year, the overall level of employment in the country increased steadily but moderately. Despite the increase, total employment by December had changed very little from a year earlier, although employment in the goods-producing sector was still down by about 2%. Statistics Canada reported that the average employment over the year was 12.2 million, down 100 000 from 1991 and down 331 000 from its peak in 1990.

The rate of inflation, as measured by changes in the Consumer Price Index (CPI), remained well below 2% on an annual basis throughout the year, except for the last month. With little inflationary pressure from an economy still coping with an underlying weakness, the rate fell as low as 1.1% in June. For the year overall, the rate of inflation averaged 1.5%, the lowest rate in 30 years.

Short-term interest rates followed a general downward trend for much of the year, with the Bank of Canada rate and the prime lending rate of the chartered banks both hitting 20-year lows early in September. The prime rate dropped to 6.25%, while the central bank rate bottomed out at 4.93%. In the following months, however, interest rates became extremely unstable, reflecting volatile conditions in international currency markets, as well as political uncertainties over Canada's constitutional referendum.

Figure 2

Canadian Price Trends, 1983-92



NOTE: Data for 1992 are estimated.

SOURCE: Statistics Canada (based on 1986 price indexes = 100).

The Canadian dollar also followed a downward trend, falling by about 10% relative to the U.S. dollar over the course of the year. It hit a low of US77.7¢ in November, its lowest level in almost five years. Only one year earlier, the dollar had been trading at more than US89¢. When the Canadian dollar stabilized in the range of US78-79¢ late in the year, short-term interest rates began to decline once again.

Capacity utilization rates in the non-farm goods-producing sector of the economy averaged 77.8% during the first nine months of the year. This compares with the average rate of 80.7% for the period since 1981. In the manufacturing sector, capacity utilization averaged only 74.2% during the first nine months of 1992.

Investment in non-residential building construction continued to decline. In general, poor profit levels, low capacity utilization rates and weak corporate balance sheets have inhibited investment in building construction. Business investment in machinery and equipment, however, managed to follow an upward trend since the beginning of the year. Outlays for machinery and equipment advanced by 6.8% in real terms in the third quarter.

Throughout the course of the year, merchandise exports were a major source of strength to an otherwise struggling Canadian economy. Exports and imports advanced to new highs as the year progressed. For the full year, Canada's exports rose by 11.2% to $157.5 billion, reflecting the impact of a low-priced Canadian dollar and an improving U.S. economy. Merchandise imports rose by 8.9% over the same period to $148.1 billion. On balance, Canada recorded a merchandise trade surplus of $9.5 billion in 1992 compared to $5.8 billion in 1991.

With approximately three quarters of Canada's merchandise exports going to the United States, the performance of the U.S. economy has a major impact on Canada's economic well-being. As in Canada, the U.S. economy also followed a cautious path of recovery during the year, although it did manage to achieve stronger gains than the Canadian economy. In the last quarter of the year, GDP in the United States grew at an annual rate of 3.8%, its strongest advance in four years. For the year in total, real GDP in the United States was estimated to have grown by 2.1%, a relatively weak performance, but still its strongest since 1989.

THE MINERAL INDUSTRY

Although mineral fuels are normally included in the overall value of Canada's mineral production, the main focus of this review is the nonfuel sector of the mineral industry plus coal. Mineral industry activities encompass more than just the production of basic ores and concentrates, as the output from mining and concentrating becomes the input for subsequent processing. In addition, activities associated with mineral recycling are an important and integral part of mineral industry operations. In broad terms, the industry is often described in terms of four stages of processing activity which are defined as follows:

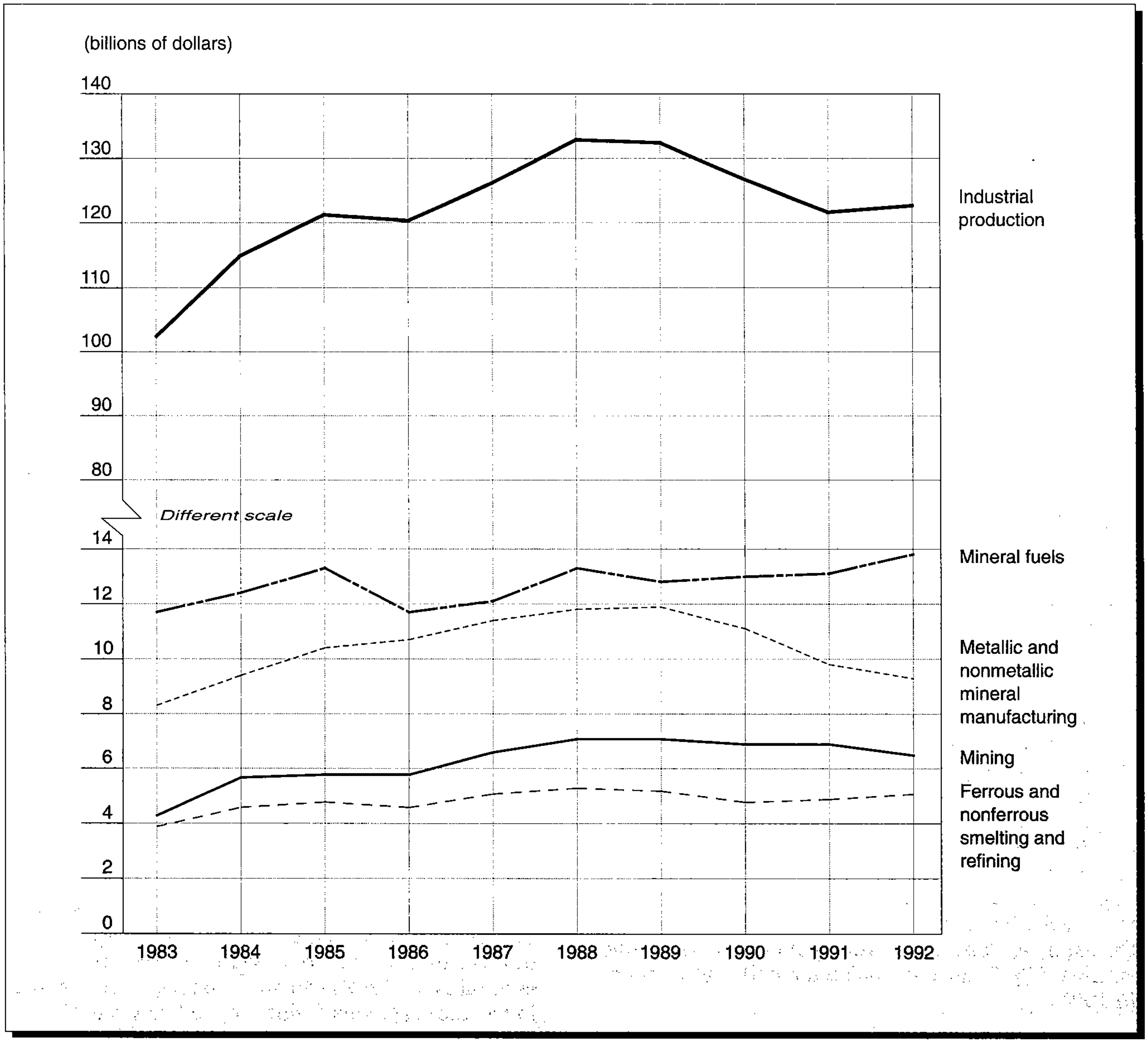
- Stage I – Primary Mineral Production (mining and concentrating);
- Stage II – Metal Production (smelting and refining);
- Stage III – Minerals and Metals-Based Semi-Fabricating Industries; and
- Stage IV – Metal-Fabricating Industries.

Including all four stages of activity, the mineral industry accounted for about 4.2% of Canada's GDP in 1992 (including the coal and uranium industries, but excluding oil and natural gas). The mining and concentrating stage alone accounted for about one third of mineral industry GDP. In 1992, the mineral industry overall contributed about $21.0 billion (at 1986 prices) to Canada's GDP, a decrease from the 1991 level of $21.6 billion.

Total employment in the mineral industry continued the decline which began in 1989 when the number of jobs peaked at 422 000. Preliminary estimates for 1992 indicated that total employment in the industry was about 338 000, down 3.7% from 351 000 in 1991. This decrease reflected the fragile state of the economy and the continued weakness in labour markets, particularly in the goods-producing sectors. Overall, the industry accounted for 2.8% of total national employment in 1992. All stages of the mineral industry experienced a decline in employment from the previous year.

The total number of employees in Stage I (metal mining, nonmetal mining, quarrying and coal mining) was estimated at 64 000, down from 69 000 in 1991. In addition, there were approximately 8600 people employed in diamond drilling and other services incidental to mining operations in 1992.

Figure 3
Gross Domestic Product at Factor Cost at 1986 Prices, 1983-92



NOTE: Data for 1992 are estimated.
SOURCE: Statistics Canada.

Employment in Stage II (nonferrous smelting and refining and the primary steel industries) was estimated at 58 000, down from 64 000 in 1991.

Employment in Stages III and IV (semi-fabricating and fabricating mineral industries) fell from 218 000 in 1991 to 216 000 in 1992. Total employment in Stages I and II fell by 8.3% compared with 0.9% for Stages III and IV combined. The semi-fabricating and fabricating industries, however, had recorded a 13% decline in the previous year compared to 7.3% for the mining, smelting and refining industries.

The capacity utilization rate in Canada's mining industries, including quarrying, was down slightly from the previous year. The rate was fairly steady at about 86% during the first three quarters of

1992, averaging 86.3% over this period compared to 88.1% for the corresponding period in 1991.

The capacity utilization rates in mineral-based manufacturing industries also remained fairly constant, but relatively low, during the first three quarters of the year. Capacity utilization in the primary metals industries was 78.4% in the third quarter of 1992. Compared to a year earlier, this was down from 82.7% in the third quarter of 1991. Fabricated metal products industries operated at 66% of capacity in the third quarter of 1992, down from 68.7% a year earlier. Capacity utilization in the nonmetallic mineral products industries was 65% in the third quarter of 1992 compared to 66.8% in the third quarter of 1991.

Capital expenditure intentions by the mineral industry (excluding the petroleum and natural gas industries) totalled $3.7 billion for 1992. This level of spending, which reflected revised investment intentions released in mid-year by Statistics Canada, represented a decrease from the $4.9 billion spent in 1991 on construction, machinery and equipment. Most of this decrease was expected to occur in the nonferrous smelting and refining industries in which capital outlays were projected to decline from $1.7 billion in 1991 to $0.8 billion in 1992. Capital spending intentions in the mining sector of the industry totalled $1.7 billion for 1992 compared to $1.9 billion in 1991. Including repair expenditures, total investment spending planned by the mineral industry overall was $8 billion in 1992 compared to $9.1 billion a year earlier. This level of spending represented 4.9% of total capital and repair expenditures in the Canadian economy, down from 5.6% in 1991 and 6.2% in 1990.

Research and development (R&D) spending intentions by the mineral industry (excluding the petroleum and natural gas industries) totalled $318 million for 1992, an increase from $305 million in 1991. This level of R&D spending represented 6% of total R&D expenditures planned by Canadian industries in 1992. Metal mines were expected to account for 19% ($60 million) of mineral industry R&D spending in 1992, an increase of $5 million over the previous year. Spending intentions of the primary metal manufacturing industries (ferrous and nonferrous) represented 61% ($194 million) of the mineral industry R&D total for 1992, an increase of $4 million over 1991.

Total spending on exploration for nonfuel minerals in 1992 was expected to fall as low as $420 million, compared to $532 million in 1991 and $775 million in 1990. The 1992 estimate was lower than the $498 million of intended exploration spending indicated by federal-provincial surveys carried out early in the year. In constant dollar terms, Canadian mineral exploration expenditures in 1991 and 1992 were the lowest since the mid-1970s.

MINERAL PRODUCTION

Preliminary estimates show that the total value of production of all mineral commodities, including mineral fuels, increased from $35.2 billion in 1991 to $35.4 billion in 1992, a gain of 0.6%. Of the four mineral commodity groups (metals, nonmetals, structural materials and fuels), mineral fuels recorded the only increase in the overall value of output, as shown in the following table:

THE CANADIAN MINERAL INDUSTRY VALUE OF PRODUCTION, 1991 AND 1992

	1991	1992	Change
	($ millions)		(%)
Metals	10 473.1	10 209.2	–2.5
Nonmetals	2 381.7	2 199.4	–7.7
Structurals	2 405.1	2 184.1	–9.2
Total Nonfuels	15 259.9	14 592.6	–4.4
Fuels	19 945.3	20 818.9	4.4
Total	35 205.2	35 411.5	0.6

Sources: Energy, Mines and Resources Canada; Statistics Canada.
Notes: Numbers may not add to totals due to rounding. Data for 1992 are preliminary.

A gain of approximately $874 million in the total value of mineral fuels production was partly offset by a decline of $667 million in the total value of nonfuel mineral production, as commodity prices generally remained low. EMR's Metal Price Index, which tracks the monthly prices of copper, nickel, lead, zinc, gold and silver, followed an upward trend through to mid-year, but then began to decline. Although the index turned upward again in December, by that time it was lower than at any time since 1987. The average annual prices for five of the six metals in the index were lower in 1992 than in 1991. Only the average price for zinc was higher on the basis of mid-year strength.

In comparison to the value of production in 1991, the results for individual commodities were mixed, as advances in the value of output of some minerals were offset by losses in others. Gains in the overall value of production were led by crude petroleum (+$795 million), zinc (+$342 million) and natural gas (+$214 million). Declines were led by gold (–$263 million), coal (–$254 million) and elemental sulphur (–$204 million).

Excluding mineral fuels, the overall value of production declined from $15.3 billion in 1991 to $14.6 billion in 1992, a decrease of 4.4%. Nonfuel minerals accounted for 41.2% of the total value of Canada's mineral production in 1992 (metals, 28.8%; nonmetals, 6.2%; and structural materials, 6.2%).

The total value of metallic mineral production fell by 2.5% from $10.5 billion in 1991 to $10.2 billion in 1992. Gold and copper continued to be the two leading metals in Canada on the basis of their overall values of production, although both metals had recorded reduced levels of output. Gold and copper production were each valued at about $2.1 billion.

Zinc placed third among the metallic minerals on the strength of a 10.2% increase in production combined with a higher average price in 1992. In comparison to 1991, which saw a significant drop in zinc prices, the overall value of zinc production rose by 24.7% in 1992 to $1.7 billion. The value of nickel production followed closely behind, also at approximately $1.7 billion. The total output of nickel remained essentially unchanged from the previous year. Nickel prices, however, followed a downward trend caused by weak international markets, high production levels and increased exports from Russia.

The value of output of the nonmetallic minerals, including minerals such as asbestos, potash, salt and sulphur, declined from $2.4 billion in 1991 to $2.2 billion in 1992. Of the leading nonmetallic minerals, potash and elemental sulphur recorded gains in production while asbestos and salt recorded decreases.

The value of production of structural materials, including clay products, sand and gravel, stone, cement and lime, fell from $2.4 billion in 1991 to $2.2 billion in 1992. The continued weakness in non-residential construction activity resulted in lower production of structural material commodities.

The fuels sector includes crude petroleum, natural gas, natural gas by-products and coal. Together they accounted for 58.8% of the total value of Canada's mineral production in 1992. The value of mineral fuels output increased by 4.4% from $19.9 billion in 1991 to $20.8 billion in 1992. This gain of $0.9 billion was attributable to increases in the values of production of crude oil (7.6%), natural gas (4.0%) and natural gas by-products (5.5%), and was partly offset by a decrease in the overall value of coal production (–13.2%). Although coal output declined in 1992, crude oil, natural gas and natural gas by-products all recorded gains in production levels.

Crude oil production increased by 4.7% to 94.0 million m^3 in 1992, with a total value of $11.3 billion. Natural gas output rose by 13.0% to 118.9 billion m^3 with a value of $5.6 billion. Natural gas by-products recorded a 6.6% increase in output to 26.6 million m^3 valued at $2.3 billion.

On a provincial basis, Alberta's contribution to total Canadian mineral output (including fuels) in 1992 represented the largest share, amounting to $17.1 billion, or 48.2% of the total. Ontario was second with a value of $4.8 billion, or 13.5% of the total. British Columbia accounted for $3.4 billion (9.7%), Saskatchewan for $3.1 billion (8.6%), Quebec for $2.6 billion (7.4%), and Manitoba for $1.1 billion (3.2%). The other provinces and the territories accounted for the remaining 9.4%.

The top 10 commodities in terms of value of output in 1992 were: crude petroleum ($11.25 billion), natural gas ($5.61 billion), natural gas by-products ($2.30 billion), gold ($2.09 billion), copper ($2.06 billion), zinc ($1.73 billion), nickel ($1.68 billion), coal ($1.66 billion), iron ore ($1.13 billion), and potash ($0.96 billion).

MINERAL TRADE

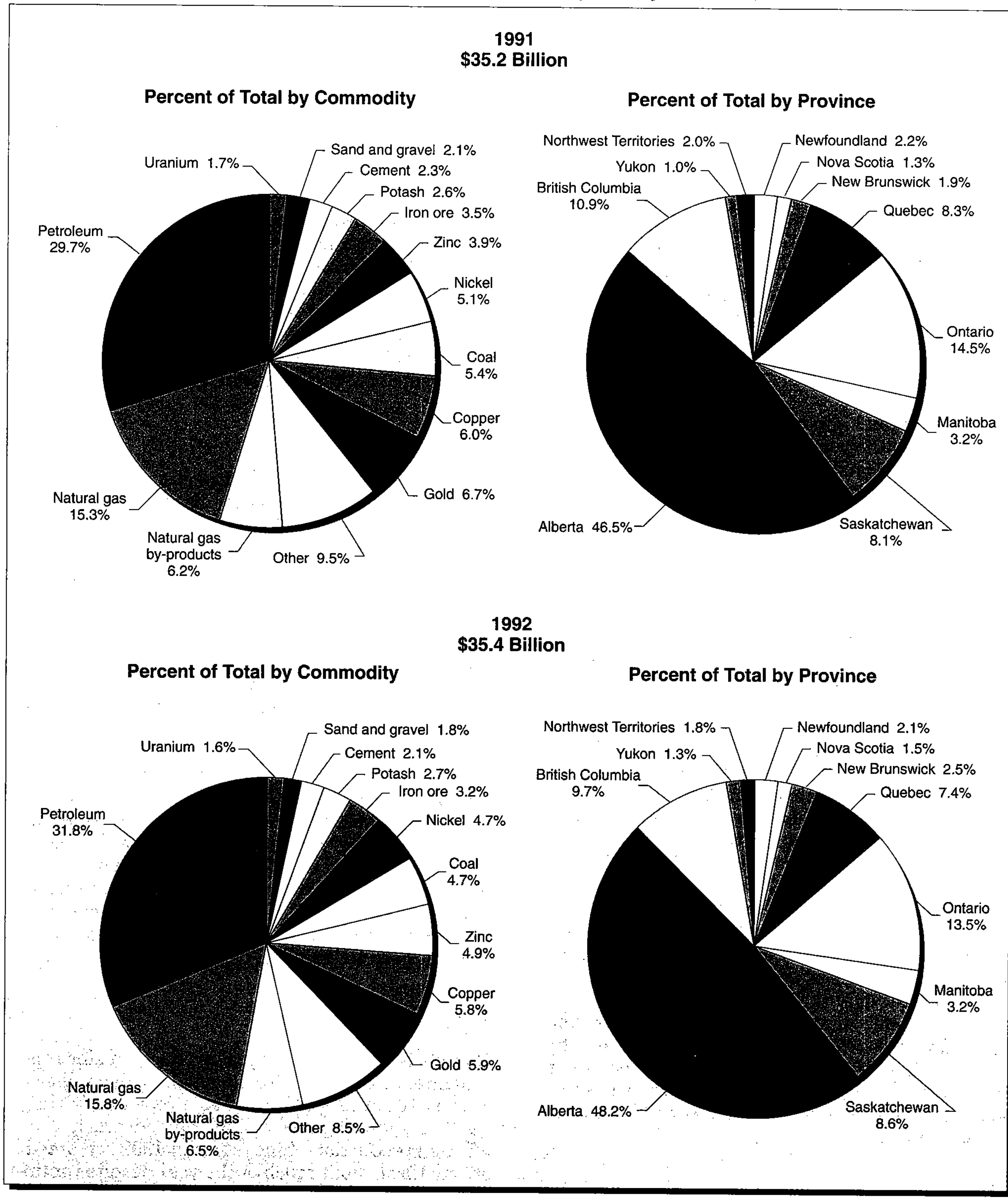
Nonfuel Minerals and Mineral Fuels

The mineral industry continued to make a significant contribution to Canada's merchandise balance of trade. Minerals and mineral product exports, including fuels, totalled $29.1 billion for the first three quarters of 1992, a 4.6% increase over the corresponding period in 1991. Over the first nine months of the year, 73.2% of total mineral exports went to the United States, 8.6% went to the European Community, and 6.4% went to Japan. Minerals and mineral product exports represented 25.8% of total domestic exports.

Imports of minerals and mineral products, including fuels, for the first three quarters of 1992 totalled $14.3 billion, or 13% of total Canadian

Figure 4

Value of Mineral Production, Percent Shares by Commodity and by Province, 1991 and 1992



NOTE: The provincial shares may not add to 100% due to rounding and the exclusion of Prince Edward Island's share as it is too small to be expressed.
SOURCES: Statistics Canada; Energy, Mines and Resources Canada.

imports. In terms of net trade, a surplus of approximately $14.8 billion was recorded for minerals and mineral products during the first three quarters of 1992. Preliminary estimates indicated that the surplus for the full year was almost $20 billion.

Nonfuel Minerals and Coal

The total value of exports of nonfuel minerals and coal was estimated at $18.4 billion for the first nine months of 1992, an increase of 3.5% over the corresponding period in 1991. These exports included crude minerals, smelted and refined products, semi-fabricated and fabricated forms, as well as waste and scrap for recycling. Overall, they represented 16.4% of Canada's total domestic exports. The United States received 58.8% of Canada's exports of nonfuel minerals and coal, while the European Community received 13.3% and Japan received 9.9%.

Imports of nonfuel minerals and coal for the first nine months of the year were valued at $10.2 billion, or 9.3% of total Canadian imports. On balance, this resulted in a trade surplus for nonfuel minerals and coal of more than $8.2 billion for the first three quarters of 1992. It was estimated that the surplus for the full year was approximately $11 billion.

LEADING MINERALS

Gold

Canada is the world's fifth largest producer of gold. For 1992, gold production in Canada was estimated at 157.6 t, a decrease of 10.5% from the record level of 176.1 t in 1991. The decrease in gold production was the result of a number of mine closures, as well as reduced output at several other operations. Gold prices remained low and traded within a relatively narrow range, between US$330 and $359 per troy ounce (oz) in 1992. The average price for the year was US$344/oz, down from $362/oz in 1991 (its lowest level since 1985). With total output valued at $2.09 billion in 1992, gold remained Canada's leading metal in terms of overall value of production, but only slightly ahead of copper. The current economic slowdown, low inflation rates and high real interest rates are factors that will tend to keep gold prices near their prevailing levels. Assuming prices stay close to current levels, or even weaken, Canadian gold production would be expected to decline further.

Copper

Canada ranks fourth in the world in the mine production of copper. Shipments of recoverable copper from Canadian mines in 1992 declined by 4.6% to 745 000 t from 780 000 t in 1991. Copper production declined as a result of a mine closure in British Columbia as well as reduced output at some locations, particularly in Quebec. The overall value of shipments was $2.06 billion. World copper prices remained relatively strong in 1992, despite some build-up of inventories. Western World demand for copper in 1992 was about the same as in 1991. The market was buoyed by expectations that demand would strengthen in the coming year. The threat of serious supply disruptions in a number of major copper-producing areas also helped to support copper prices. Prices averaged US$1.04/lb on the London Metal Exchange (LME) in 1992 compared to $1.06/lb in 1991. Since the North American recovery is progressing rather slowly, and since other major economies in the world are still weak, there is likely to be some further easing of copper prices in the first half of 1993.

Nickel

Canada is the world's second largest producer of nickel, topped only by Russia. Nickel mine shipments increased by 0.5% to 189 000 t in 1992 from 188 000 t in 1991. As a result of weak nickel prices, however, the value of shipments fell by 7.1% to $1.68 billion. Demand for nickel in the Western World declined by about 9%. This, in combination with high levels of production and increased exports from Russia, resulted in lower prices for nickel. Prices averaged US$3.18/lb on the LME, compared to $3.70/lb in 1991. Production cuts announced in the third quarter by Inco Limited and Falconbridge Limited helped to stem the downward price slide in world nickel markets. Stainless steel demand, which accounts for over 60% of nickel consumption, declined in Europe and Japan. A recovery in these two markets does not seem likely this year, although U.S. demand in this sector is forecast to increase as the American economy improves. Nickel prices are expected to remain depressed until the world's supply is brought back in line with demand.

Zinc

Canada is the world's largest producer of zinc concentrates. Shipments from Canadian zinc mines rose by 10.2% to 1.19 Mt in 1992 from 1.08 Mt in 1991. Labour disputes in 1991 had adversely affected production. Zinc prices in 1992 remained strong throughout much of the year despite continued weak global demand and rising stock levels. Speculative trading on the LME during this period added volatility to zinc prices. In October, prices began to fall in response to poor market conditions and a decreased threat of strikes at Canadian smelters. Zinc prices averaged US56¢/lb on the LME in 1992 compared to 51¢/lb in 1991. The combination of increased Canadian production and higher zinc prices led to a 24.7% increase in the overall value of shipments to $1.73 billion in 1992. World demand for zinc is expected to increase in 1993, particularly for galvanizing applications, as a modest economic recovery takes place. However, significant exports by Eastern Bloc countries are expected to result in a substantial surplus of zinc metal. Prices are expected to weaken before recovering late in the year.

Lead

Canada ranks fifth in the world in the mine production of lead. Shipments of recoverable lead in ores and concentrates from Canadian mines increased by 28.4% to 319 000 t in 1992 from 248 000 t in 1991. The value of shipments increased by 9.5% to $231 million. Lead inventories rose in 1992 as world demand weakened and supplies increased from other countries. Lead prices weakened in the last quarter, falling to a six-year low of US20.2¢/lb on the LME. The average price for the year, however, was 24.6¢/lb, only slightly lower than the 1991 price of 25.3¢/lb. An increasing surplus of world supply is projected, resulting in rising inventories and downward pressure on prices.

Silver

Canada ranks fourth in the world in the mine production of silver. In Canada, silver is produced as a by-product or co-product of base-metal mining or gold mining. Shipments of silver fell to an estimated 1147 t in 1992, a decrease of 9% from the 1991 level of 1261 t. This reduction was the result of mine closures, as well as declining production at some mines. The overall value of shipments fell by 7.7% to $173 million. The price of silver has been declining over the past decade due to a combination of relatively weak demand and the increased production of silver. Silver prices averaged US$3.95/oz in 1992, a slight decrease from $4.06/oz in 1991. The price of silver is expected to remain essentially unchanged or fall slightly in 1993 as investor demand and world economies remain weak.

Iron Ore

Iron ore shipments fell from 35.4 Mt in 1991 to 32.8 Mt in 1992, a decrease of 7.5%. Correspondingly, the overall value of shipments declined by 8% to $1.13 billion. This was the lowest level of shipments recorded since 1983. It was estimated that Canadian exports were also at their lowest level since 1983. The use of iron ore in Canadian blast furnaces remained low for the third year in a row, although the use of domestic ores increased by 11% over 1991. Canada ranks seventh in production among world producers of iron ore. The world steel industry is forecast to remain flat in 1993 and negotiations for shipments of iron ore are expected to be difficult because of announced demands by steelmakers for lower iron ore prices.

Asbestos

Shipments of asbestos were estimated at 601 000 t in 1992, a decrease of 12.4% from the 1991 level of 686 000 t. The value of shipments declined by 13% to $236 million. The decrease in asbestos output resulted from the closure of a mine in British Columbia, as well as reduced production at a mine in Quebec in order to concentrate on mine development. Canada is the world's second largest producer of asbestos. International regulatory issues associated with asbestos and the ongoing debate surrounding its use have had an adverse impact on world markets for asbestos products. However, the overturn by U.S. courts in 1991 of the 1989 U.S. Environmental Protection Agency's asbestos ban rule has had a positive effect on the Canadian industry as the negative trend in exports to the United States has moderated. Asia remains a major market for Canadian production, while gains are expected in South America.

Potash

Shipments of potash remained at the 7-Mt level in 1992, with a total value of approximately $960 million. Canada is the world's second largest producer of potash, exceeded only by the countries making up the former U.S.S.R. Canada is by far the largest exporter of potash, accounting for about 40% of world trade in that commodity. World potash demand was weak in 1992. In particular, the collapse of fertilizer consumption in the former U.S.S.R. and in Eastern Europe continued to have a negative impact on the world's demand for potash. Strong demand prevailed in the United States, however, leading to an estimated 10% increase in Canada's potash exports to that country in 1992. World potash supply continues to face overcapacity. Canada's potash industry has been operating at rates between 50% and 60% over the last three years and is expected to continue to be the swing supplier.

Coal

Coal production fell to 64.6 Mt in 1992, a decline of 9.3% from the 1991 record level of 71.1 Mt. The overall value of coal production fell to $1.66 billion compared to $1.92 billion in the previous year. The decline in coal output was the result of production problems at three of the major coal mines in British Columbia, reflecting problems of restructuring within the industry as well as labour difficulties. Production in British Columbia, Canada's largest coal producer, fell by 32.1% in 1992. Canada's coal output is expected to increase in 1993. Canada is one of the world's leading exporters of coal, ranking fourth in 1991. World coal trade is expected to become more competitive than before, with an increased supply of low-cost coal putting downward pressure on prices.

Structural Materials

The total value of structural materials production declined to $2.18 billion in 1992 from $2.41 billion in 1991, a decrease of 9.2%. Increased housing activity provided some stimulus to the industry as the number of housing starts increased by almost 8% in 1992. However, non-residential building activity, as well as engineering construction work (such as in building roads and bridges), continued to be very weak. Consequently, the industry recorded lower shipments in 1992 of primary construction materials such as cement, stone, sand and gravel.

CHALLENGES FOR THE INDUSTRY

International Competitiveness for Mineral Investment

With increasingly severe competition in the global mineral economy, the Canadian industry faces its toughest challenge yet. Canada's position as a leading source of base metals has become jeopardized as base-metal reserves have been declining since the early 1980s. These reserves are not likely to be replaced in the near future if Canada does not reverse the significant decline in mineral exploration spending that has taken place over the past several years. Aggressive promotion by other mineral-rich countries has prompted many Canadian companies to shift their focus to mineral development opportunities elsewhere in the world. In the wake of political and economic reforms in Latin America and in other developing regions of the world, there is serious concern that Canada may no longer be viewed as one of the prime areas for mineral investment. Indeed, the perception may be that the best and most promising opportunities actually lie in the development of known mineral deposits in other countries.

A decline in Canada's mineral industry would represent a significant loss to the Canadian economy. Such a loss would have a major impact on the many regional economies that depend on mining, milling, smelting and refining industries, and other spin-off industries, for their prosperity. What is required to prevent such an occurrence? What needs to be done to ensure that there is adequate investment in the Canadian mineral industry to sustain and develop this important sector of the Canadian economy? To address these concerns, a government/industry task force was established following the September 1991 Mines Ministers' Conference in Halifax, Nova Scotia, to review and assess Canada's international competitiveness for mineral investment.

Because of the many complex factors that influence mineral investment decisions, the work of the task force involved a broad range of detailed studies, such as: trends and outlook in the competitive position of the Canadian mineral industry; trends in prices and the production of nonferrous metals; mineral exploration trends in Canada and the world; changing global competitiveness for mineral capital; and Canada's mineral taxation system. Thirteen background papers were prepared, along with a final report which summarized the findings and views of the task force. These reports were tabled for consideration at the September 1992 Mines Ministers' Conference held in Whitehorse, Yukon Territory.

The task force's summary report, entitled *The Canadian Mineral Industry in a Competitive World,* identified three areas of particular concern that could have a major negative impact on Canada's long-term competitiveness for mineral investment:

- Environmental assessment, permitting and regulation: The potential for a negative impact on Canada's investment climate stems from uncertainty and unpredictability in the regulatory framework, the possibility of excessive delays and costs, excessive regulations and jurisdictional overlap, and the costs of up-front reclamation funds.

- Land use: Restrictions on land access and uncertainties over security of tenure have created great concern for the mining industry.

- Mineral taxation: Recent changes to the Canadian taxation system have somewhat eroded Canada's previous most-favourable standing among its international competitors.

Because of their complexity and the fact that conditions and circumstances are rapidly evolving, it was recommended in the report that these areas of concern and others be the focus of further research and analysis in 1993.

Whitehorse Mining Initiative

At the conclusion of the Whitehorse Conference, the mines ministers released a statement announcing the launch of the Whitehorse Mining Initiative. It was announced that "... the Ministers agreed, in response to a proposal from The Mining Association of Canada, to begin a process to put into place a comprehensive initiative on the future of the mining industry." In its presentation on behalf of Canada's metal and mineral industries, The Mining Association of Canada (MAC) had identified similar concerns to those expressed in the task force report discussed above. Environmental matters, land use and taxation were cited as some of the main issues that are currently affecting the industry's competitiveness and growth. Concerns were also expressed about the public's negative perception of the mining industry.

It was noted by MAC that the time was ripe for governments, industry and other stakeholders to put together a coordinated and comprehensive plan of action, a plan with a common vision and mission. In response to these concerns, a steering committee of three mines ministers was established to oversee and coordinate the development of such a plan. Government and industry officials and representatives of special interest groups have since met to begin the process of making the Whitehorse Mining Initiative a reality. Reflecting its multi-stakeholder involvement, a 14-member planning committee has been established to represent federal/provincial governments, industry, labour, aboriginals and environmentalists.

The scope of the initiative is very broad. It will address the many issues that were identified in the MAC presentation and in the government/industry task force report on Canada's international competitiveness for mineral investment. It is anticipated that the subsequent findings and recommendations will help to guide governments and industry in taking the necessary action to reaffirm Canada's strong position in the mineral economy of the world.

OUTLOOK FOR 1993

Most forecasts at the beginning of 1992 indicated that growth in the Canadian economy would be in the range of 2%-4%, only about half of the historical rate of recovery from previous recessions. Despite the increase, economists did not expect it to have much impact on the unemployment rate, which was forecast to remain in the 11% range. Consumer confidence had waned somewhat in the last quarter of 1992, reflecting apprehensions about increasing unemployment and fluctuating interest rates. This indicated that consumers were still quite concerned about their own finances and that there would not be a very strong recovery in consumer spending levels. Housing starts were forecast to continue increasing, but at a relatively modest rate.

Although business confidence was improving, indicating an increased optimism in the economy, investment was still seen to be restricted by weak profits, slow growth in demand and heavy corporate debt. Exports were expected to continue as the leading sector in the economy, spurred on by an improving U.S. economy and a relatively low Canadian dollar. The U.S. economy, however, was still being held back somewhat by relatively high unemployment and slow job growth.

While the North American economy is gathering momentum, there is lingering weakness in other major economies of the world, such as in Europe and Japan. In fact, some countries, such as Germany, are expected to experience very little growth in 1993, if any at all. Subdued economic growth and generally weak demand for goods in international markets will continue to put downward pressure on commodity prices. Current expectations, however, are that international economies will begin to show signs of improvement by mid-1993.

Canada's mineral resources are a source of strength to the economy. Canada enjoys a richness of mineral resources that many nations of the world do not. In 1992, Canada's mineral industry (excluding oil and natural gas) accounted for more than 4% of Canada's GDP, about 3% of total national employment, and over 16% of total Canadian exports. In helping to meet the world's demand for basic minerals and mineral products, there should be opportunities for Canada to remain a significant player on the international scene. However, these opportunities have not, and will not, come without having to face major challenges ... challenges such as those presented by increasingly restrictive environmental protection regulations, the competition for investment dollars, and stiff competition in commodity markets. With a determined and cooperative effort by industry, governments, environmentalists, labour, and the native people, it is expected that joint endeavours, such as the Whitehorse Mining Initiative, will be rewarded with success and that the Canadian mineral industry will continue to be a major contributor to the economy of the country.

Note: Information in this review was current as of February 1, 1993.

TABLE 1. CANADA, PRODUCTION OF LEADING MINERALS, 1991 AND 1992

		Volume		Percent Change	Value		Percent Change
		1991	1992p	1992/1991	1991	1992p	1992/1991
		(000 tonnes except where noted)			($ millions)		
METALS							
Gold	kg	176 125.9	157 554.0	–10.5	2 349.9	2 086.8	–11.2
Copper		780.4	744.7	–4.6	2 112.2	2 062.9	–2.3
Zinc		1 083.0	1 193.6	10.2	1 385.2	1 727.1	24.7
Nickel		188.1	189.1	0.5	1 807.6	1 679.9	–7.1
Iron ore		35 421.2	32 771.9	–7.5	1 228.2	1 129.4	–8.0
Uranium	tU	8 161.7	9 057.5	11.0	595.5	575.6	–3.3
Lead		248.1	318.5	28.4	210.9	230.9	9.5
Silver	t	1 261.4	1 147.4	–9.0	187.7	173.2	–7.7
Cobalt		2.2	2.2	2.2	77.5	136.9	76.5
Platinum group	kg	11 122.6	10 504.7	–5.6	150.2	117.1	–22.0
NONMETALS							
Potash (K_2O)		7 087.0	7 324.2	3.3	931.9	963.3	3.4
Salt		11 870.9	11 100.4	–6.5	259.2	253.8	–2.1
Asbestos		686.0	601.3	–12.4	271.0	235.8	–13.0
Sulphur, elemental		6 180.0	6 349.7	2.7	335.4	131.4	–60.8
Peat		833.1	855.6	2.7	100.1	108.2	8.1
Gypsum		6 727.2	6 891.9	2.4	71.7	79.2	10.5
STRUCTURALS							
Cement		9 372.2	8 483.7	–9.5	810.8	739.2	–8.8
Sand and gravel		216 263.9	201 081.8	–7.0	741.3	637.0	–14.1
Stone		87 825.7	81 639.1	–7.0	539.7	507.6	–5.9
Lime		2 375.3	2 383.3	0.3	193.5	182.8	–5.5
Clay products		. .	. .	. .	119.8	117.3	–2.1
FUELS							
Petroleum	000 m^3	89 788.4	93 997.1	4.7	10 456.4	11 251.1	7.6
Natural gas	million m^3	105 243.7	118 925.4	13.0	5 394.1	5 607.7	4.0
Natural gas by-products	000 m^3	24 918.8	26 551.4	6.6	2 178.1	2 296.8	5.5
Coal		71 133.0	64 550.0	–9.3	1 916.8	1 663.3	–13.2

Sources: Energy, Mines and Resources Canada; Statistics Canada.
. . Not available; p Preliminary.
Note: Figures have been rounded.

TABLE 2. EXPORTS OF MINERAL COMMODITIES BY COUNTRY AND BY COMMODITY AS DEFINED BY THE HARMONIZED SYSTEM (H.S.), 1992 (9 MONTH)

H.S. Chapter[1]	Description	United States		EEC[2]		Japan		Mexico		Other		Total	
		($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)
25	Salts; sulphur; earths or stone, plastering materials, lime and cement	362 768	43.0	68 826	8.2	45 727	5.4	19 218	2.3	346 674	41.1	843 213	100
26	Ores, slag and ash	297 413	16.4	822 991	45.3	479 526	26.4	12 176	0.7	203 076	11.2	1 815 182	100
27	Mineral fuels, oils and products of their distillation; bituminous substances; mineral waxes[3]	10 651 802	87.0	229 869	1.9	863 905	7.1	25 775	0.2	466 757	3.8	12 238 108	100
28	Inorganic chemicals; compounds of precious metals, radioactive elements, etc.	1 018 215	81.6	82 131	6.6	75 151	6.0	302	–	71 458	5.7	1 247 257	100
31	Fertilizers	800 458	66.4	21 867	1.8	47 838	4.0	–	–	335 565	27.8	1 205 728	100
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	241 928	92.5	6 506	2.5	3 740	1.4	–	–	9 270	3.5	261 444	100
69	Ceramic products	29 821	80.1	1 837	4.9	225	0.6	6	–	5 338	14.3	37 227	100
70	Glass and glassware	258 615	83.1	38 201	12.3	3 010	1.0	42	–	11 155	3.6	311 023	100
71	Natural/cultured pearls, precious stones and metals, coins, etc.	1 230 192	55.5	115 596	5.2	42 586	1.9	71	–	829 105	37.4	2 217 550	100
72	Iron and steel	1 508 807	83.5	98 526	5.5	7 024	0.4	49 862	2.8	141 900	7.9	1 806 119	100
73	Articles of iron or steel	1 140 034	91.8	19 649	1.6	1 850	0.1	20 010	1.6	59 720	4.8	1 241 263	100
74	Copper and articles thereof	752 952	65.4	283 383	25.5	1 983	0.2	5	–	98 028	8.8	1 109 351	100
75	Nickel and articles thereof	422 542	34.1	373 069	30.1	71 166	5.8	4 682	0.4	366 112	29.6	1 237 571	100
76	Aluminum and articles thereof	1 967 174	74.5	294 244	11.1	179 304	6.8	274	–	198 509	7.5	2 639 505	100
78	Lead and articles thereof	66 451	72.8	8 247	9.0	1 576	1.7	–	–	14 966	16.4	91 240	100
79	Zinc and articles thereof	512 603	82.5	15 157	2.4	18 033	2.9	–	–	75 564	12.2	621 357	100
80	Tin and articles thereof	6 403	87.1	137	1.9	142	1.9	–	–	668	9.1	7 350	100
81	Other base metals; cermets; and articles thereof	64 742	40.2	35 335	21.9	11 372	7.1	1 074	0.7	48 643	30.2	161 166	100
	Total mineral exports	21 305 920	73.2	2 515 571	8.6	1 854 158	6.4	133 497	0.5	3 282 508	11.3	29 091 654	100
	Total domestic exports	86 289 538	76.6	8 106 544	7.2	5 513 169	4.9	547 108	0.5	12 162 923	10.8	112 619 282	100
	Percentage, mineral to domestic	24.7		31.0		33.6		24.4		27.0		25.8	

Source: Statistics Canada, Catalogue 65-003 (Quarterly).
[1] Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System," as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] EEC: European Economic Community. [3] Total value of coal exports included in Chapter 27 is $1577 million.
– Nil.

International Scene

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The international economic climate of 1992 was, in many respects, inimical to the hoped-for economic recovery. Economic growth in industrial economies was handicapped by the cumulative adverse effects of such factors as:

- fiscal restraints to cope with escalating cyclical and structural budget deficits;
- relatively high real interest rates, declining asset prices, and undesirably high corporate debt-equity ratios;
- structural adjustments in response to the imperatives of technological change, and the accompanying phenomenon of high rates of unemployment among the skilled, technical, professional and managerial workforce of many industrial economies;
- rising protectionist sentiments; and
- the social and economic dislocation of the industrial restructuring process of the economies of Central and Eastern Europe.

With the exception of the United States, which showed signs of a recovery, Canada's principal trading partners were mired, throughout 1992, in the recession. In 1992, the downturn in the Japanese economy deepened, resulting in an estimated fall in the country's real Gross National Product (GNP) growth to 1.6%. The strength of the German economy was sapped by the cost of re-unification. Throughout the European Community, economic activity decelerated and business confidence was shaken a bit by the suspension of the British pound sterling and the Italian lira from the European Exchange Rate Mechanism.

All these factors, plus marked reductions in expenditures on newly produced military hardware, impacted negatively on the pace of global economic activity and, in the process, generated considerable instability in international markets for minerals and metals. Global mineral production failed to adjust appropriately to the reduction in the rate of consumption. Thus, excess supply prevailed for many mineral commodities and the prices for many minerals and metals plummeted. This situation resulted, in part, from the marketing initiatives of former member states of the U.S.S.R. which, in their efforts to earn badly needed foreign exchange, flooded Western markets with mineral commodities at prices below production costs.

Against this background, it is important to look briefly at developments in foreign investment flows in mineral exploration and development.

Foreign Direct Investment

Investment in mineral exploration and development is customarily cyclical in nature, but this seems to be changing. Recently, an increasing number of developing countries have initiated major restructuring programs in the mineral sector and related areas in an effort to attract and facilitate the flow of private foreign capital. In varying degrees, mining legislation is in the process of being revised, the process of obtaining permits is being streamlined, and tax structures and profit repatriation terms are being made more favourable. Efforts have also been made to undertake or upgrade geoscientific surveys, make existing geological data more accessible, and train nationals in skills required in mineral resources development. Multilateral institutions have expanded programs to facilitate the flow of financial resources from the private sector by offering extended non-commercial risk insurance coverage, investment banking services, financing and guarantees, and foreign investment advisory services.

These endeavours have accomplished two things. First, they have enhanced the flow of foreign direct investment for mineral exploration and development in certain developing countries, even under the unfavourable economic conditions that dominated the international economy in 1992. Second, they have demonstrated that an attractive investment climate can induce contra-cyclical investment in mineral exploration. It is also likely that changing perceptions of land use, problems of land access, stringent environmental regulations and the cost of compliance in the United States, Canada and Australia have, of late, become important determinants of the geographical direction of investment flows in mineral exploration and development.

MINERAL TRADE

Viewed in the context of a weak cyclical rebound of the U.S. economy, sluggish economic growth in Japan and the European Community, and the dumping of minerals and metals in international markets by some members of the former Council for Mutual Economic Assistance (CMEA), the trade performance of the Canadian mineral industry was commendable. The value of mineral exports grew appreciably, and market share was maintained. This could be attributed largely to the cost-competitiveness of the industry, and the fall in the value of the Canadian dollar relative to the U.S. dollar.

Preliminary trade data for the first nine months of 1992 indicate that Canada's total fuel and nonfuel mineral and mineral products exports were $29.1 billion. This amounted to a 4.6% increase over the figure for the corresponding period in 1991. It also accounted for approximately 25% of total domestic exports. Conversely, Canada's imports of fuel and nonfuel minerals stood at $14.3 billion, or about 13% of total Canadian imports.

The value of nonfuel minerals and coal exports was $18.4 billion, an increase of 3.5% over the same period in 1991. Approximately 58.8% of these exports, which included crude, refined, semi-fabricated, and fabricated mineral products, went to the United States; the European Economic Community accounted for 13.3% and Japan, 9.9%.

Imports of nonfuel minerals and coal, for the first nine months of 1992, were estimated at $10.2 billion, or 9.3% of total Canadian imports. Thus, there was a trade surplus of over $8 billion for nonfuel minerals and coal for the first three quarters of 1992.

BILATERAL AND MULTILATERAL DEVELOPMENTS

Bilateral and multilateral institutional developments are either ad hoc measures to cope with temporary expedients, or are necessary mechanisms for managing interdependence. From the perspective of the mineral industry, bilateral and multilateral developments in the areas of trade, finance and the environment are usually important because of their possible effects on production costs, as well as on the magnitude, pattern and direction of investment and mineral commodity trade flows.

In this context, some of the significant multilateral developments of 1992 were:

- the Uruguay Round of Multilateral Trade Negotiations;
- the United Nations Conference on Environment and Development (UNCED); and
- the North American Free Trade Agreement (NAFTA).

The Uruguay Round

Despite missed deadlines and political deadlocks, the Uruguay Round of Multilateral Trade Negotiations, which started in 1986, is still in progress. Negotiations have, at best, been tediously slow and often exasperating.

Broadly speaking, the lengthening of the time-frame of the negotiations can be attributed in large part to two factors:

- the characteristics of the international trading environment; and
- the number and complexity of the subject areas and issues being negotiated.

The Uruguay Round of negotiations has, to date, been conducted against a background of discordant trade policies, as well as the phenomena of emerging regional economic blocs. Trade conflicts emanated from protectionist measures that reflected concerns about such matters as:

- persistent high levels of unemployment;
- the continuous deterioration of trade deficits;
- resistance from declining industries to structural change; and
- the protection of real incomes in high-cost agriculture.

In summary, protectionist measures competed with actions to strengthen the open, multilateral trading system. Furthermore, recent trade conflicts have not generally been handled through the General Agreement on Tariffs and Trade (GATT) dispute settlement mechanisms but, rather, through bilateral negotiations, or else they have led to unilateral punitive action.

The Uruguay Round is the eighth round of multilateral trade negotiations that has been launched under the auspices of the GATT. The broad goal of all the rounds has been the same – to promote growth and development through the removal of trade distortions, and the development of a more open, predictable, and durable multilateral trading system – although the focus of the negotiations has sometimes differed. The first six rounds concentrated almost entirely on reducing tariffs and the seventh, the Tokyo Round (1973-79), moved on to tackle non-tariff barriers.

The Uruguay Round is by far the largest, most complex and demanding multilateral trade negotiations ever undertaken. It involves 108 countries in a negotiation process that addresses areas such as agriculture, textiles, subsidies and dispute settlement, services, intellectual property, and trade-related aspects of investment. It is also striving to create a Multilateral Trade Organization (MTO) that would provide a definitive legal status to the GATT.

The desired MTO would:

- ensure the effective implementation of the Uruguay Round agreement;
- provide the forum for further multilateral negotiations;
- administer the Trade Policy Review Mechanism; and
- achieve greater coherence in economic policy-making in cooperation with the International Monetary Fund and the World Bank.

The MTO would also provide for a ministerial conference at least once every two years to ensure more effective political involvement/oversight of the multilateral trading system.

The maintenance of an open, multilateral trading system is of great importance to all countries. It is vital for many developing countries, as well as for Central and Eastern European countries, that are undergoing a painful restructuring of their economies and economic systems and badly need a favourable environment in international trade. A retreat to protectionism and/or an exclusive focus on regional or bilateral arrangements would put the international trading system at considerable risk and could lead to a possible crisis of multilateralism.

Up to the end of 1992, the Uruguay Round had not concluded its negotiations. Unresolved issues include agriculture, market access services, intellectual property, subsidies, anti-dumping, and the creation of the Multilateral Trade Organization. Negotiations will continue in 1993, and possibly beyond. If the opportunities afforded by the Uruguay Round, despite all divergences, are missed, a severe blow will be dealt to the principle of multilateralism.

The United Nations Conference on Environment and Development

In June 1992, the United Nations Conference on Environment and Development (UNCED) – the Earth Summit – met in Rio de Janeiro. It was an event unprecedented in scale, scope and expectations. The participants included over 100 heads of state and their delegations, as well as non-governmental organizations, business executives, academics, religious groups, and indigenous peoples.

The outcome of the Conference, though disappointing for its lack of commitments to timetables for policy change and a specific increase in aid programs, was nevertheless remarkably successful in forging a consensus around the urgent need to integrate policies for development and the environment. When the 12-day meeting ended, the world's leaders adopted, by consensus, three major non-binding agreements, and more than 150 countries had signed two major binding conventions.

The three non-binding agreements are:

- the **Rio Declaration**, which is a brief statement of fundamental principles for guiding human behaviour toward the environment. It sets out the rights and responsibilities of countries, communities, and individuals.
- **Agenda 21**, which is an 800-page action plan for the 21st century. It covers more than 100 program areas to be addressed by governments, agencies and organizations of the United Nations systems, non-governmental organizations, and the public at large.

One of the major themes of Agenda 21, which is pertinent for the mineral industry, is that which deals with the efficient use of natural resources. It stresses action programs that are urgently required both to reverse the destruction of renewable resources and to implement an integrated approach to the planning and management of natural resources (soils, minerals, water, and biota). The broad objective, an "integrated approach to the planning and management of land resources," as enunciated in Agenda 21, is "to facilitate allocation of land to the uses that provide the greatest sustainable benefits and to promote the transition to a sustainable and integrated management of land resources. In doing so, environmental, social and economic issues should be taken into consideration. Protected areas, private property rights, the rights of indigenous people and their communities and other local communities, and the economic role of women in agriculture and rural development, among other issues, should be taken into account."

Agenda 21 also makes specific proposals regarding the environmentally sound management of toxic chemicals, including the prevention of illegal international traffic in toxic and dangerous products; the environmentally sound management of hazardous wastes, including the prevention of illegal international traffic in hazardous wastes; and the environmentally sound management of solid wastes and sewage-related issues.

- **A Statement of Forest Principles** – This legally non-binding document calls for accelerated progress in reforestation, afforestation, and conservation, along with more respect for the rights of forest dwellers and host nations in sharing the benefits.

The two binding conventions are:

- **A Framework Convention on Climate Change** – This Treaty aims at stabilizing concentrations of "greenhouse gases" (mainly carbon dioxide). Industrial countries recognize the desirability of returning to their 1990 emission levels by the year 2000. Although few specific measures or targets are included, a mechanism for deciding on stronger measures in the future, if warranted, was set up.

- **Biological Diversity Convention** – This Convention requires countries to adopt regulations to conserve biological resources, and to promote fair and equitable sharing of benefits derived from the biological diversity of developing countries.

A central concern throughout the negotiations, and especially with respect to the program areas under Agenda 21, was funding. Who pays? Funding will need to come from polluters (through charges and tradeable permits), commercial channels, and voluntary and official sources. Additional financing would have to come from:

- **Official Development Assistance (ODA)** from developed countries – Developed countries reaffirmed their commitment to reach the United Nations target of 0.7% of GNP (only the Netherlands and the Scandinavian countries now do this). France and Germany committed themselves to reach this target by the year 2000. The United States, now at 0.2%, disassociated itself from the target.

- **Global Environment Facility (GEF)** – The GEF, managed jointly by the World Bank, the United Nations Environment Programme (UNEP), and the United Nations Development Programme (UNDP), was specified as a major financing channel for projects providing benefits. When the GEF becomes a full-fledged facility, it will be restructured to encourage universal membership and a transparent decision-making system that provides a balanced and equitable representation of both recipient and donor interests.

- **The International Development Association (IDA)** – Agenda 21 advocates an "earth increment" to help the poorest countries address national environmental issues. The "earth increment" would be an increase in the replenishment of the IDA (the World Bank's concessionary lending arm) over and above the amount needed to maintain current funding in real terms. Understandably, this proposal was not sanctioned by the World Bank.

If governments, aid agencies, and private corporations live up to the commitments made in Rio de Janeiro, charges for goods and services will reflect scarcity and environmental values. Because some of these goods will be traded, the relationship between trade and environmental policies has become a controversial issue.

International trading rules are seen, by some, as limiting factors on the ability of countries to protect national and global environmental resources. On the other hand, trade policy analysts view trade restrictions for environment purposes as a new form of protectionism. Moreover, developing countries fear that industrial countries will rely on trade sanctions to force compliance with national and international environmental objectives, and here solutions are being sought within the framework of the articles of GATT.

There are, at present, several prominent multilateral environmental agreements[1] containing trade measures either as enforcement mechanisms or as enabling mechanisms. A critical issue is how these trade measures are treated by the GATT rules.

The two fundamental principles of the GATT are "non-discrimination" and "national treatment." Non-discrimination, or most-favoured-nation (MFN) treatment, obligates all countries that are contracting parties to the GATT to extend to all other contracting parties the terms extended to the most-favoured trade partner. National treatment obligates contracting parties to treat imports in the same way as "like products" produced within their own countries with respect to internal taxes, standards, and regulations.

GATT permits a number of exceptions. Article XX allows some trade restrictions provided they are not "arbitrary or unjustifiable" methods of discrimination nor act as disguised trade barriers. For example, Article XX(b) permits measures "necessary" to protect human, animal and plant life and health. Article XX(g) allows trade measures relating to conservation of a country's exhaustible natural resources provided they are made effective in conjunction with restrictions on domestic production and consumption.

The UNCED introduced the problem of making trade and environmental policies mutually supportive. In so doing, the UNCED has initiated a process that will no doubt unleash new and difficult trade issues for the GATT to resolve.

North American Free Trade Agreement

On August 12, 1992, the United States, Canada and Mexico concluded negotiations on a North American Free Trade Agreement (NAFTA). The legal text of this agreement was initialled by the trade ministers of the three countries in October 1992, and was signed by the three Heads of State in December 1992. The agreement now needs to be ratified by all three national legislative bodies before going into effect.

The objectives established by the three countries when the negotiations began were:

- to develop an agreement that is consistent with the terms of the GATT;
- to achieve a liberalization of internal barriers to trade without erecting any new barriers to trade with non-NAFTA countries; and
- to achieve an agreement that builds on the completed Canada-U.S. Free Trade Agreement and the ongoing work in the Uruguay Round of Multilateral Trade Negotiations.

It should be emphasized that NAFTA does not erect barriers to other countries and is not aimed at excluding anyone from the North American market. The agreement merely removes barriers among member countries. In short, NAFTA is a means of accelerating trade liberalization and freer trade in accordance with the Articles of the GATT.

NAFTA covers a broad range of economic and trade policy issues. Provisions relate to such matters as rules of origin, trade in goods and services, energy, agriculture, government procurement, technical standards, intellectual property, investment, financial services, environmental issues, and dispute settlement procedures.

SHORT-TERM PROSPECTS

On balance, 1992 was not a good year for the mineral industry. Mineral commodity prices were depressed, productive capacity was under-utilized, profits fell dramatically, and new institutional problems surfaced. Will these conditions persist? What are the prospects for the short term?

It is common knowledge that the future of the Canadian mineral industry as a viable commercial entity hinges largely on three factors:

- the level, and changes in the level, of global economic activity and associated patterns of demand for minerals and metals;[2]
- the cost and price competitiveness of the industry in all markets (domestic and international) for minerals and metals; and
- access to markets.

[1] Examples of such environmental agreements are the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES), the *London Guidelines for the Exchange of Information on Chemicals in International Trade*, the *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal*, and the *Montreal Protocol on Substances that Deplete the Ozone Layer*.

[2] The demand for minerals and metals is a derived demand. It derives from the demand for consumer and producer goods in the production of which minerals are essential factor inputs. Therefore, the growth or contraction of the amount of minerals and mineral materials demanded is a function of the pace of economic growth and the associated pattern of industrial activity.

At present, all these factors are sources of concern for the industry and will, in all probability, continue to be so for some time to come.

First, a slow economy recovery in the United States, weak economic growth in Japan and the European Community, the persistence of high levels of unemployment, and continued deflation in nearly all industrial economies imply very modest economic growth rates in the short term. Where unemployment is high and inflation is low, the question arises as to whether macro-economic policy can be adjusted to stimulate demand in the near term. But short-term policy adjustment should not compromise the objective of a sound and stable macro-economic environment to support growth over the medium term. In short, there are no quick fixes for the current international economic situation.

Secondly, increasing pressures are being placed on the mineral industry to comply with the dictates of sustainable development. Compliance will invariably increase production costs. At a time when commodity prices are very depressed, additional costs could lead to financial losses.

Thirdly, the outcome of the Uruguay Round to date, and the emergence of protectionist trading practices, could adversely affect market access. For industries as export-dependent as the Canadian mineral industry, this could be detrimental.

In summary, the mineral industry faces many challenges such as slow economic growth, increasing pressures to internalize environmental abatement costs, protectionist trade measures, and land access issues. These cannot be resolved quickly. They require considerable international cooperation in macro-economic policy implementation.

Note: Information in this review was current as of February 1, 1993.

Regional Outlook

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The Canadian mining industry continued to suffer the effects of the global recession as the value of production of metals, nonmetals, structural materials and coal in 1992 was $16.3 billion, a decrease of $920 million from 1991, or 5.4%. Significant declines were recorded for gold, coal, and elemental sulphur. When natural gas, natural gas by-products and crude petroleum are included, the value of mineral production was $35.4 billion, an increase of 0.6% over 1991.

Prices for most major mineral commodities continued to fall throughout the year, although prices spiked up briefly at mid-year. Nickel prices were particularly soft, falling some 25% over the year to US$2.60/lb at year-end.

New mine development remained slow due, in large part, to poor market conditions, difficulties arranging financing, and the lengthy time required for environmental regulatory processes. During 1992, mines in many regions closed, others curtailed production, and two mines were seriously affected by underground explosions with loss of life (Royal Oak Mines Inc.'s Giant gold mine at Yellowknife, Northwest Territories, and Curragh Inc.'s Westray coal mine at Plymouth, Nova Scotia). Consequently, employment in the industry declined by 8%, or some 5000 employees, to approximately 64 000 at year-end. The biggest declines were in metal mining and coal mining.

Exploration activity continued to decline across the country with the only real bright spot being diamonds, particularly the major diamond play in the Northwest Territories. Spurred on by the discovery of diamond-bearing kimberlites in 1991 and the confirmation of both micro- and macro-diamonds in the Lac de Gras area, the biggest staking rush in Canadian history has been taking place. By the end of 1992, nearly 5.4 million ha had been staked. As well, significant staking took place in Alberta. Diamond activity continued to be active in Saskatchewan and new interest was shown in Manitoba in the Snow Lake area. In central Canada, Kirkland Lake, Ontario, was the site of renewed exploration for diamonds.

New Mineral Development Agreements were signed by Canada with Nova Scotia, Quebec, Alberta and British Columbia during 1992. With the exception of Prince Edward Island, agreements pertaining to the mineral sector are now in place with all provinces and the two territories. The total value of these agreements is approximately $243 million, of which $133 million is federal funding and $110 million is provincial/territorial funding. The emphasis in all agreements is on geoscientific activities.

At the 49th Annual Mines Ministers' Conference held in Whitehorse, Yukon, in September 1992, ministers agreed to put in place a comprehensive multi-stakeholder initiative on the future of the Canadian mining industry. Based on a proposal from The Mining Association of Canada, ministers concluded that it was timely to develop a common vision for the industry and to develop proposals to address the specific issues facing the mineral sector, such as land access and tenure, environmental assessment and permitting, public perception concerns, land claims, and taxes and charges, among others. Furthermore, it was agreed that this plan, known as the Whitehorse Mining Initiative, would require input from all jurisdictions in partnership with the industry and other stakeholders, such as native groups, labour, and nature and wildlife organizations. A steering committee of three ministers (Manitoba, Yukon, and New Brunswick) was given the responsibility to develop an action plan framework and timetable for the Initiative and to report back to ministers at the annual convention of the Prospectors and Developers Association of Canada in March 1993.

Newfoundland and Labrador

In 1992, the estimated value of mineral production from Newfoundland and Labrador was $735.3 million, a decrease of some 4.8% from 1991. Iron ore accounted for approximately 93% of the total. All major indicators (claims staked, claims in good standing, diamond drilling and exploration expenditures) showed a decrease in activity from the previous year. Employment decreased by 10% to approximately 3038.

The mining industry suffered some setbacks in 1992. The Iron Ore Company of Canada (IOC) shut down its operations for five weeks during the summer and both IOC and Wabush Mines cut approximately 250 jobs in total. Newfoundland Resources and Mining Company Limited and Trinity Brick Products Limited closed in 1992 because of poor markets. However, both are scheduled to re-open in the spring of 1993.

On a more positive note, Royal Oak Mines Inc. reopened the gold mine at Hope Brook and poured its first gold bar in July 1992. Teranov Mining Corp. continued to operate the new wet process mill to recover asbestos from tailings at Baie Verte. The operation temporarily shut down for four months this winter because of difficulties operating in freezing conditions. Solutions to these problems are expected in 1993.

During the past decade, Newfoundland dimension stone has received a great deal of attention. This interest increased dramatically in 1992 with the first commercial production of anorthosite in Labrador and the construction of a large slate-processing plant by Newfoundland Slate Inc. at Burgoynes Cove. Newfoundland Slate Inc. officially opened in October 1992 and sold products in Europe, the United States, Japan, and other parts of Canada.

A large number of dimension stone deposits are also being prospected and evaluated for development. Of particular note are the marble deposits in the Deer Lake and Corner Brook area, the granites of central Newfoundland, and the slate deposits of eastern Newfoundland.

There were also other exploration and development highlights in 1992. NovaGold Resources Inc. was given environmental approval to proceed with the development of the Pine Cove gold deposit near Ming's Bight; the company completed approximately 2400 m of diamond drilling to further define its mineable reserves. Hillsborough Resources Limited completed a feasibility study of its Mainland limestone deposit on the Port au Port Peninsula. Drill-indicated reserves stand at 60 Mt grading 98.3% calcium carbonate. Both Falconbridge Limited and Noranda Exploration Company Ltd. completed diamond drilling programs for base metals on properties in Labrador. In addition, grassroots exploration also increased in Labrador.

NOVA SCOTIA

The value of mineral production in 1992, including coal, is estimated at $437 million, down approximately 5% from 1991 levels. Of this total, coal accounted for $265 million. If petroleum and natural gas are included, the total value of production is estimated at $540 million, up 17% from 1991.

Mineral exploration and development work in Nova Scotia showed a decrease in the level of activity from the previous year, with expenditures for 1992 estimated at $2.5 million compared to $4.1 million in 1991. A total of 12 000 new and re-issued claims were staked in 1991. The amount of exploration drilling was up slightly in 1992 with the completion of approximately 11 000 m, compared to a total of 10 450 m in 1991.

Nova Scotia had no producing metal mines at year-end. Therefore, there was a dramatic 99% decrease in metal production from 1991. Rio Algom Limited's East Kemptville tin mine closed in early 1992 and the Gays River lead-zinc mine of Westminer Canada Limited closed in 1991. However, these mines, and the Tangier gold mine, are being examined by interested investors. The province and private sector have been promoting the mineral investment opportunities that these mines represent.

With respect to coal production, the Cape Breton Development Corporation closed its Lingan mine at the end of 1992 after 20 years of operation. The Corporation has ongoing production at the Phalen and Prince mines. The Westray coal mine of Curragh Inc. was closed at mid-year as a result of an underground explosion that killed 26 miners.

A new *Mineral Resources Act* was proclaimed in March 1992, and it now includes a two-tier structure to deal with exploration and mining leases. Development licences were done away with and licensed ground may now be held for an indefinite period of time. Other highlights include the issuance of prospectors' identification cards and better definitions for reporting requirements.

The Canada-Nova Scotia Cooperation Agreement on Mineral Development (1990-1992) expired on March 31, 1992. However, a new Cooperation Agreement on Mineral Development (1992-1995) was signed on August 27, 1992. It is valued at $10 million ($7 million from Canada and $3 million from Nova Scotia).

NEW BRUNSWICK

In 1992, the value of mineral production in New Brunswick, including coal, is estimated at

$886 million, an increase of about 32% from 1991 levels. Production in 1991 was at depressed levels mainly due to the prolonged strike at Brunswick Mining and Smelting Corporation Limited (BMS), which affected the production of zinc and lead. As of December 31, 1992, 19 262 mineral claims and 8664 claim equivalents were in good standing in the province. Approximately $17 million was spent on exploration in 1992, with the Bathurst Camp being the focus of much of this activity.

Mine development in New Brunswick during 1992 was limited and it is expected that any recovery will have to be linked to positive changes in the economy over the coming year. However, BMS continued its program to increase productivity and reduce costs which, in 1992, resulted in a 30% increase in productivity and a 15% decrease in costs. The company also took important steps in energy conservation. In the Sussex area, Potacan Mining Company (PMC) Limited and the Potash Company of America increased production by about 10% over 1991. Both mines have initiated cost control programs.

Elsewhere in the province, in April 1992, Arimetco International Inc. purchased from Breakwater Resources Ltd. a 50% interest in East West Caribou Mining Limited's zinc property, which has been on care and maintenance since its closure in 1990. Arimetco has initiated studies in the United States for the extraction of zinc and copper by an ammonia leach process. In the Newcastle area, Stratabound Minerals Corp. reclaimed the Captain North Extension site, but continues its interest in exploration in the area.

Murray Brook Resources Incorporated (a wholly owned subsidiary of NovaGold Resources Inc.) ceased operations in August. However, two important developments are being considered by NovaGold for New Brunswick. It has acquired the technology rights from the Canada Centre for Mineral and Energy Technology (CANMET) for the development of the Ferric Chloride Leach process and is proposing a pilot program for 1993. Also, the province approved NovaGold's bioleach project for the recovery of copper and silver at Murray Brook. This plant operated briefly late in the year but was shut down because of low temperatures. Since then, NovaGold has struck a deal with Arimetco to process the remainder of the Murray Brook copper-silver ore at the Caribou mill. NovaGold is planning to restart the bioleach operation to process the ore that is presently on the heap; then it will be shut down permanently.

QUEBEC

The Quebec mining industry faced another difficult year in 1992. Quebec's mineral production reached only $2.630 billion, continuing its decline that began in 1991 following a record year of $3.037 billion in 1990. Production decreased by 10.2% from 1991, almost three times the drop of the previous year. This drop was especially significant in the metallic minerals sector (–13.7%) where several closures took place. The Chapais-Chibougamau region was particularly affected. The nonmetallic minerals sector experienced a slight increase of 3.5%, whereas the construction materials sector saw the value of its shipments decrease by 12.5%. As a result, mining employment declined by 8.3% compared to 1991.

According to preliminary data, investment in the mineral industry dropped by 17.6% in relation to 1991, and did not even reach the 1984 value. All areas of investment, such as exploration, development, capital assets and repairs, showed a decline. The drop in metal prices and the profits of major companies, and the lack of confidence by small investors in junior mining exploration companies, contributed to the decrease in investment.

The Chapais-Chibougamau region continued to be hit by mine closures. After the closure of its Opemiska Division at Chapais in June 1991, Minnova Inc. shut down its Lac Shortt Division in March 1992. Westminer Canada Limited also shut down its activities at the Copper Rand and Portage mines at Chibougamau in November 1992. There is now only one operating mine, whereas there were eleven five years ago. To help the region, the federal and provincial governments have set up the Special Assistance Program for the Mining Sector of the Chapais-Chibougamau Region, which will provide $12.5 million to mining companies and prospectors between 1992 and the end of 1996. Expenditures for fiscal year 1992/93 are estimated at $3.26 million. Despite the mine closures, mining exploration was particularly active in the region. Activities by Westminer Canada Limited delineated 165 000 t of ore grading 5 g/t gold in Cuvier Township and revealed a drill intersection of 8.9 g/t gold over 4.6 m in a drill-hole in Hazeur Township near the Joe Mann mine owned by Meston Resources Inc. Minnova Inc. delineated 8.3 Mt of ore grading 2 g/t gold in the Chevrier zone located northwest of the Joe Mann mine. In 1992, Minnova Inc. also undertook a feasibility study for putting into production the Troilus deposit situated 125 km northwest of Chibougamau.

In the Joutel region, two major discoveries were made near operating mines: one east of the Étang d'Or Est mine in the Casa Berardi area, and one west of the main mineral deposit of the Telbel mine at Joutel. However, because of the depletion of reserves, two underground mining operations (the Joutel Division of Agnico-Eagle Mines Limited and the underground division of Les Mines Selbaie) will be shut down by the beginning of 1994.

Three major discoveries were also made in the Matagami–Lebel-sur-Quévillon region: the Bell Allard-Sud polymetallic zone in Galinée Township, the Verneuil zone in Verneuil Township, and the Douay 531 zone in Douay Township. All three are gold mineralization deposits.

In eastern Quebec, the Financial Assistance Program for prospecting in Eastern Quebec enabled the continuation of some 30 projects involving about 100 prospectors; $1.3 million was committed for fiscal year 1992/93. The program resulted in the discovery of some occurrences, including a copper showing southeast of Marsoui near Cristal Lake. More significant exploration is planned for 1993.

In Ungava, Falconbridge Limited continued its development of the Katinniq nickel-copper deposit on its Raglan property. A production decision is expected in 1993. The North Shore region was hit by some production shut-downs in the iron mines; these closures resulted in temporary layoffs in July, August and December. Because of a weak demand and depressed markets for their products, the mining companies decreased their production.

The Abitibi region was affected by the closure of the Estrades, Mobrun, Camflo, Malartic-Hygrade, Kierens, Norlartic and Simkar mines. However, the Dumont, Ferderber, Sigma and Kiena mines took steps to make their activities more competitive. Major discoveries were made in the Val-d'Or region, including the Dubuisson-Est zone, which is expected to be mined shortly, and in Cadillac near the Laronde mine. The construction of surface infrastructure in the Louvicourt project continued all year and the sinking of two shafts has begun. Production at the Norita East mine started in August.

The renewal of the Canada-Quebec Subsidiary Agreement on Mineral Development was concluded in December 1992. The agreement, which expires on March 31, 1998, will provide $100 million to be funded equally by the two levels of government.

It is estimated that exploration expenditures for 1993 should remain at about the same level as for 1992. The mining of the "Lentille 1100" (lens) at the Mobrun mine and the development of the Grevet and Louvicourt projects will continue. The new mineral development agreement should promote mining exploration. No major production operations are expected to begin in 1993. Total gold and copper production will decrease because of the closure of gold and copper mines in 1992 and the depletion of the Ansil mine reserves in 1993. With the uncertainty that prevails in the steel sector, a rationalization of costs can be expected to increase the iron ore industry's competitiveness. This rationalization will have an adverse effect on the number of jobs.

ONTARIO

For 1992, the total value of Ontario's nonfuel mineral production is estimated at $4.7 billion, down 6.3% from 1991. Metals contributed $3.6 billion, down 5.9% from 1991; nonmetals were $233 million, down 0.1% from 1991, and structural materials accounted for $910 million, down 9.3% from 1991. The drop in the value of production can be attributed mainly to declining metal prices.

In 1992, there were production cutbacks and layoffs at the Sudbury operations of both Inco Limited and Falconbridge Limited and layoffs at several other mines across northern Ontario in order to reduce costs. There were mine closures at Elliot Lake (Denison Mines Limited), Timmins (Timmins Nickel Inc.), Wawa (Muscocho Explorations Limited/ McNellen Resources, Inc.), Kirkland Lake (Northfield Minerals Inc.) and Thunder Bay (Inco Limited).

The mine closures were partially offset by the opening of the Lower Coleman mine (Inco Limited), the Thayer Lindsley mine (Falconbridge Limited), and the Bell Creek mine and mill (Falconbridge Gold Corporation). In addition, Palin Granite Canada Inc. received a grant to open a granite quarry near Kenora.

Across the province there was a reduction in exploration activity. In 1992, exploration and development expenditures, including mine-site exploration, are estimated to have fallen by about 31% to $300 million. The year's highlights include increased resources that could soon boost reserves at the Dome, Dona Lake and Detour Lake mines of Placer Dome Inc.; dramatically increased possible reserves at the Stock Township mine of St. Andrew Goldfields Ltd.; the start of underground exploration at the Holloway project of Hemlo Gold Mines Inc./ Freewest Resources Inc./Teddy Bear Valley Mines Limited near Matheson; and the announcement of the start of pre-production activities at the Paymaster gold project of Placer Dome Inc. After a change of control, Madeleine Mines Ltd. has resolved its legal problems and has applied for permits to operate its Lac des Îles palladium-platinum-gold mine. Jarvis Resources Ltd., which is developing a marble quarry near Sudbury, received a grant to set up a marble cutting and polishing plant. The Kirkland Lake area benefited from the interest in diamond exploration following an announcement by Sudbury Contact Mines Limited that it had found microdiamonds in a kimberlite pipe east of the town.

The provincial government continued to encourage mineral exploration in the province through the Ontario Prospectors Assistance Program and the Ontario Mineral Incentive Program. Both programs were fully subscribed in 1992. This year, the Ministry of Northern Development and Mines published a discussion paper entitled *Improving Ontario's Mining Incentives*, which it is using to consult on several options to restore investor interest and confidence in the industry.

The year 1992 also saw the rise of "Save our North," a broadly based effort by Northern Ontario groups to convince government to promote and support mining, mineral exploration and other natural resource industries in their region. "Save our North" carried out a television advertising campaign in the fall.

MANITOBA

In 1992, the value of Manitoba's mineral production is estimated at $1 billion, a slight increase of about 1.2% from the previous year. The increased value of zinc and copper in 1992 was slightly more than the decrease experienced by nickel. If petroleum and natural gas are considered, the total value of production is estimated at $1.14 billion, up 0.8% from 1991. Mine employment decreased by about 6% from the previous year to approximately 4500 and is expected to decrease further in 1993.

Of the two major mining companies in the province, Hudson Bay Mining and Smelting Co., Limited (HBMS) continued with its program to modernize its zinc plant, which is expected to be completed by early 1993. Work on its copper smelter, which is also part of its modernization venture, has been delayed and is scheduled to be completed by the end of 1993. During the year, HBMS closed its Snow Lake Rod and Spruce Point mines. Inco Limited, the other major mining company in the province, continued with its cost-cutting efforts at its Thompson operation.

During 1993, the Government of Manitoba introduced incentive measures to boost mineral exploration and development activities in the province. Under "Mining Tax Holiday for New Mines," effective January 1, 1993, qualifying mining operators will not be required to pay mining taxes until their profits from mining activities equal their capital outlay in regard to the opening of a new mine. At the end of this "tax holiday," operators will inherit the undepreciated balance of book assets. The "Mining Tax Exploration Incentive" will permit mining companies to deduct 150% of the amount of exploration expenditures in a given year that exceeds the average amount spent in the preceding three years. The "Prospectors Assistance Program for Manitoba" may provide a maximum annual grant of $7500 to self-employed prospectors. Finally, under the new "Mineral Exploration Incentive Program," investors are offered a 25% grant on eligible investments from a total funding package of $10 million for metallic and nonmetallic minerals and $2.5 million for oil and gas.

Exploration expenditures in 1992 are projected at $27 million, a decline of about 10% from the previous year. However, in spite of this reduction, there was a marked increase in property acquisition (742 claims in the first 11 months of 1992 compared to only 580 claims during the whole period of 1991), which may be an indication of enhanced exploration work in the years to come. This increase in staking may, in part, be a response to the new provincial mineral exploration and development incentive programs. Major exploration efforts continued to be directed towards base metals and, to a lesser extent, for chromite in southeastern Manitoba's Bird River area and for diamonds in the Snow Lake and The Pas areas. The companies which were active in the exploration for base metals in the Flin Flon-Snow Lake, Lynn Lake, and Thompson nickel belt areas included HBMS, Granges Inc., Manitoba Mineral Resources Ltd., Minnova Inc., Cameco Corporation, Noranda Inc., Placer Dome Inc., and Canmine Resources Corporation. Some limited work on gold exploration was carried out by Cameco Corporation at Bakers Narrows, by Noranda Inc. at Elbow Lake, and by Granges Inc. near the Tartan Lake mine site. Tantalum Mining Corporation of Canada Limited was involved in pegmatite exploration activities in the Bird River area.

Cooperative government geoscientific initiatives funded under the Canada-Manitoba Partnership Agreement on Mineral Development (PAMD) and ongoing federal and provincial geoscience programs in the Flin Flon-Snow Lake-Rutton areas, such as the Exploration Science and Technology Initiative (EXTECH) and the National Geoscience Mapping Program (NATMAP), received very positive responses from both the mining industry and northern communities. These programs are aimed at assisting the industry in the location of prospective zones and orebodies to replace rapidly dwindling ore reserves.

SASKATCHEWAN

In 1992, the value of mineral production in Saskatchewan was estimated at $1.35 billion, up 1.4% from 1991. The major commodities produced were potash, uranium and coal, which collectively accounted for about 92% of the province's value, excluding oil and gas. If petroleum and natural gas are considered, the estimated value of mineral production in Saskatchewan is $3.1 billion, up 6.6% from 1991. Mine employment during 1992 was estimated to have decreased slightly to 5040.

The potash industry performed better in 1992 as the Potash Corporation of Saskatchewan Inc. announced that net income was up by approximately 29%. Although the company sold some 3.8 Mt in 1992, which is about 2% lower then 1991, higher prices and a weaker Canadian dollar enabled the company to increase revenue.

Saskatchewan remained the focus of uranium production, development and exploration in Canada. Uranium production was up by about 17% from the previous year to 8.07 million kg (uranium oxide). Test mining by Cameco Corporation for an advanced borehole mining method at its Cigar Lake uranium operation started in August 1992. As well, Cameco's proposed underground exploration program at McArthur River was referred by the Atomic Energy Control Board and the provincial government to the Canada-Saskatchewan uranium mine development review panel.

The announcement by the Government of Saskatchewan late in the year on its policy to support uranium development in the province appears to have eased the anxiety of the industry and to have created more certainty for foreign investors and purchasers of Saskatchewan uranium. In essence, the new policy follows a resolution adopted at the New Democratic Party (NDP) convention in November 1992 that "urges the government to proceed with uranium development with appropriate caution, and only after receiving the report of the federal/provincial panel and after all environmental safety and economic concerns have been addressed." This new NDP policy overturns its previous resolution of 1983 opposing expansion of uranium mining and the phasing out of existing mines.

Despite financial difficulties and a significant downward revision in ore reserves, Claude Resources Inc.'s Seabee mine continued to operate during the year. A small surface coal mine owned by the Saskatchewan Power Corporation (Shand coal mine) at Estevan in southern Saskatchewan was brought into operation in 1992.

Mineral exploration activities in Saskatchewan, which were mainly carried out in the northern part of the province, were projected by the province at about $24 million, which is identical to the previous year's level. Diamond exploration continued to be active. As of November 1992, 562 214 ha were staked for diamonds. Most of the reported exploration was on several large kimberlite pipes in the Prince Albert-Carrot River area and involved Cameco, Uranerz Exploration and Mining Limited, Monopros Ltd., and Rio Algom Exploration Limited. To the south, near Sturgeon Lake, and southwest of the Pasquia Hills, diamond exploration was undertaken by Rhonda Mining Corporation, Aaron Oil Corporation, and Rio Algom Exploration Limited. In the north, some 10 companies were involved in uranium exploration joint ventures in the Athabasca Basin area. Rio Algom Exploration Limited, Cameco and Granges Inc. continued their exploration of volcanic-based massive sulphide deposits in the Big Stone Lake and McIlvenna Bay areas.

ALBERTA

In 1992, the value of mineral production in Alberta was $17.5 billion (fuel and nonfuel), an increase of about 4.3% from the previous year. Fossil fuels accounted for approximately 97.7% of the total production value. The most important minerals in order of production value were crude petroleum, natural gas, natural gas by-products, coal and sulphur. There was an increase in production value for petroleum, natural gas and coal, whereas a decline was registered for natural gas by-products and sulphur. On the basis of non-fuel production, but including coal, the value of mineral production was approximately $959 million, down 17% from 1991.

Alberta is the major source of sulphur production in Canada, and accounts for about 81% of Canada's production. In 1992, the value of sulphur production in Alberta is estimated at $115 million, a large decline of about 62% from the previous year. This decline is attributed to steady decreases in the world sulphur price. Sulphur is recovered as a by-product from three different sources: natural gas processing plants (88%), oil sands plants (9%), and oil refineries (3%).

Mineral exploration expenditures were focused mainly on diamonds. Out of Alberta's total area of 660 000 km^2, of which only 520 000 km^2 are available for staking, 220 000 km^2 have been staked by several companies for diamonds. These include Prime Equities International Corporation, Golden

Ring Resources Ltd., and Dia Met Minerals Ltd. in partnership with Cameco and Uranerz Exploration and Mining, Limited. The staked area represents almost 45% of the area available for mineral exploration and development. Most of this area is focused in the Peace River area in northwestern Alberta, to a lesser degree in a belt stretching southeastward along the Foothills and, finally, in the Sweet Grass Hills area in southern Alberta. It was reported that gem-quality diamonds were found in the Sweet Grass Hills area.

The Environment Protection and Enhancement Act, 1992 was passed during the year. This act consolidated and replaced nine previous acts, including the *Department of Environment Act*, the *Clean Water Act*, the *Land Surface Conservation and Reclamation Act*, and the *Clean Air Act*, which have direct impact on mineral industry activities. The other important piece of legislation, the Metallic and Industrial Minerals Regulations, which will regulate the exploration, development and operation of the non-hydrocarbon minerals of the province, was prepared in draft form and is expected to be passed in 1993.

The first Canada-Alberta Agreement on Mineral Development (MDA), 1992-1995, was signed on October 8, 1992. This agreement provides funding of $10 million, which is cost-shared evenly by the two governments. The programs under this agreement are directed towards the development of the metallic and industrial minerals industry in Alberta. At present, metallic and industrial minerals account for less than 3% of total production, in spite of the substantial geological potential for these minerals in Alberta.

BRITISH COLUMBIA

In 1992, the value of British Columbia's mineral production was $2.6 billion, a decline of about 14% from the previous year, due mainly to a drop in coal production caused by prolonged strikes at two major coal mines in the southeastern part of the province. When petroleum and natural gas are considered, the estimated value of mineral production in British Columbia is $3.5 billion, down 10.5% from 1991.

The coal mining industry in British Columbia had a bad year in 1992. Coal production was down from 1991 by 32% to 17 Mt, with a decline in production value of about 29% to $700 million. The drop in coal production was mainly due to labour disputes in the province's two major metallurgical coal operations (with a combined production capacity of about 12 Mt/y), that is, Westar Mining Ltd.'s Balmer mine and Fording Coal Limited's Fording River operations. Furthermore, in September 1992, Westar Mining Ltd., the owner of the Balmer and Greenhills coal mines, was declared bankrupt with a debt of about $350 million. Before the end of the year, however, the two mines were purchased; Greenhills was bought by Fording and Balmer by Teck Corporation. The two new owners announced intentions to proceed with mining operations, but with a reduced work force.

Mineral exploration expenditures for 1992 were estimated by the British Columbia and Yukon Chamber of Mines at $55 million, compared to $87 million in 1991, a sharp decrease of about 37%. A decrease in metal prices, land use restrictions, and environmental review delays in the mine development process were among the contributing factors.

Although many important mineral properties were discovered during the past several years, such as Windy Craggy (copper-gold-silver-cobalt), Fish Lake (copper-gold), Mt. Polley (copper-gold), Eskay Creek (gold-silver), and Mt. Milligan (gold-copper), the development of many of these properties has been delayed due in part to the policy and process of environmental review and the difficulty in raising adequate finances for development. However, during 1992, the province issued development certificates (under the British Columbia Mine Development Assessment process) to Imperial Metals for its Mt. Polley copper-gold project and to Curragh Inc. for its Stronsay lead-zinc project. In essence, this means that the province has endorsed the two projects.

One of the more pressing issues for the mineral industry in British Columbia has been the settlement of land claim conflicts, including those related to the development of mineral resources. The provincial government has appointed Steven Owen as the first Commissioner of the Commission on Resources and the Environment (CORE) with a view to expediting the matter. As one of his first tasks, Mr. Owen was preparing a CORE report and recommendations to Cabinet on the Windy Craggy property in late 1992. As well, the provincial government has indicated that legislation will be introduced in 1993 to ensure that fair compensation is given to resource companies that lose their legally held resource interests as a result of government expropriation. Consultation with industry will be undertaken before the legislation is tabled.

In terms of mine openings and closures, only one mine opened (the Dome Mountain gold mine), while three were closed permanently (Noranda

Minerals Inc.'s Bell copper mine, Minnova Inc.'s Samatosum mine, and Cassiar Mining Corporation's McDame asbestos mine). Total mine employment was approximately 9000 at year-end, a decline of approximately 15% from 1991.

The Canada-British Columbia Agreement on Mineral Development (MDA), 1991-1995, was signed on September 8, 1992. This is British Columbia's second MDA; it replaces the former MDA which expired in 1990. The current agreement is a $10 million initiative with equal funding by the two governments to develop and diversify the province's mineral industry.

Mining is the second largest industry of British Columbia and, in recognition of this fact, a new group, "Share B.C.," an alliance of citizens' groups from rural communities throughout the province, was formed during 1992. This alliance organized a conference, the 1992 Share B.C. Conference, the main objective of which was "striking a balance, through multiple use of natural resources, between environmental protection and economic prosperity." This organization has continued to grow and to influence public opinion in a positive way with respect to issues concerning the industry.

YUKON TERRITORY

In 1992, the Yukon's value of mineral production was up 37% to $468 million. This reflects a higher production of lead and zinc over the previous year.

Approximately $10 million was spent on exploration, the lowest level in 20 years. The Yukon Chamber of Mines attributes this drop in exploration to the changing global metals industry. Much of the expenditure went toward advanced development projects. Western Copper Holdings Limited and Thermal Exploration Company conducted an extensive program on the Williams Creek oxide copper-gold property, northwest of Carmacks, where reserves in the Main zone are 11.6 Mt grading 1.08% copper and 0.34 g/t gold. Big Creek Resources Limited carried out an extensive diamond drilling program on its Casino property located at the northwest end of the Dawson Range. Present reserves of the porphyry deposit are estimated at 378 Mt grading 0.3% copper, 0.34 g/t gold and 0.04% molybdenum.

Bulk-tonnage, low-grade gold deposits were also the object of advanced development work in 1992. Loki Gold Corporation and Hemlo Gold Mines Inc. carried out a program involving geophysics, mapping and drilling on the Brewery Creek deposit near Dawson. Geological reserves of the deposit distributed over nine zones are 16.5 Mt grading 1.85 g/t gold. Meanwhile, Amax Gold Inc. continued an extensive drilling program on its Dublin Gulch and Haggart Creek gold properties north of Mayo.

The number of placer mining operations remained about the same as in 1991. However, there was a decline of 10% in gold production to 99 541 troy ounces. The drop is attributed to a combination of the depletion of reserves and low gold prices.

The only non-placer mining operations in the Yukon in 1992 were Curragh Inc.'s lead-zinc-silver mines in the Faro and Watson Lake areas. As a result of falling zinc prices and rising inventory levels during the latter part of the year, Curragh shut down its lead and zinc mine at Faro, Yukon, for several months at the end of 1992 and into early 1993. This shut-down will reduce the company's annual concentrate production by about 10%. In July, Curragh obtained $17 million in loan guarantees from the federal government's Northern Affairs program, along with another $17 million in guarantees from the Yukon government, in order to develop its Grum lead and zinc deposit near the Faro mine. Curragh had faced severe financial difficulties late in 1991.

The $9 million Canada-Yukon Mineral Resources Cooperation Agreement, signed in May 1991, is well under way with the completion of the first full year of field programs. Seven mapping projects were conducted under the Geoscience program of the agreement, while twelve projects were being carried out under the Technology component. Several information projects were also carried out, including a diamond seminar at the annual Geoscience Forum in late 1992.

Work has continued on the Council for Yukon Indians (CYI) land claim, which involves agreements and implementation plans with four bands. Completion is expected early in 1993. Hopefully, this will pave the way for the finalization of settlements with other bands in 1993.

At the request of the Minister of the Department of Indian Affairs and Northern Development (DIAND), the Yukon Mining Advisory Committee (YMAC), consisting of government and industry representatives, continued its review of options for modernizing parts of the *Yukon Quartz Mining Act* and the *Yukon Placer Mining Act*. In a report presented to the Minister of DIAND last April, the Committee recommended amendments to the acts to ensure that industry could work with the new regulations. Modernization of these acts will address environmental concerns during exploration, development, closure and abandonment of the Yukon's hardrock and placer deposits.

Amendments to the *Northern Inland Waters Act*, which create separate Northwest Territories and Yukon Water Acts, were passed in Parliament in June. Work is continuing on the regulations before final proclamation of these acts.

NORTHWEST TERRITORIES

In 1992, the estimated value of mineral production in the Northwest Territories was down 8% to $653 million. This includes $170 million for fuels. Four gold mines and two lead-zinc mines were producing in the Northwest Territories in 1992. The value of metals produced is only slightly lower than in 1991.

Diamonds were the highlight of the year in mineral exploration in the Northwest Territories. DIAND officials reported that fairly high levels of activity during 1992 focused on the staking rush and testing of diamond-bearing kimberlites. The rush follows the discovery of diamonds in the Lac de Gras area in 1991. This activity, coupled with renewed exploration of the northern Slave Province volcanogenic massive sulphide deposits, accounted for most of the exploration. Staking during the year of about 5.4 million ha was mostly concentrated in the southern half of the Slave Province. With respect to more advanced exploration, diamond drilling activity in the Northwest Territories remained at about the same levels as in previous years. Of the 40 drill projects reported during the year, most of these were on base-metal deposits or as part of operating mine exploration.

Continuing work on the Coronation Gulf transportation route constituted another bright spot in the Northwest Territories' mineral activity. This corridor is intended to develop increased access to support mineral resource development in the central Northwest Territories. There are several promising deposits in the region, including the IZOK Lake deposit, 80 km west of the Lupin gold mine, which could benefit from improved transportation. CanArctic Shipping Limited continued a study to identify possibilities and investigate the feasibility of a marine transportation system utilizing the Coronation Gulf. A study by the N.W.T. Power Corporation has suggested that there is local potential for hydro-electric power-generating facilities to supply potential mines in the Coronation Gulf area.

Production continued at six Northwest Territories' mines during the past year. The Nerco Con mine completed the installation of an autoclave that will enable treatment of refractory ore and arsenic sludges. Treminco Resources Ltd., as a result of lower reserves and grades at the Tom and Ptarmigan mines, has reduced its workforce to reduce mining costs. Violent labour problems have affected Royal Oak Mine's Giant gold mine in Yellowknife. Production continued at a 50%-70% rate despite an ongoing strike by the mine's 240 workers which began in May. In September, an underground explosion killed nine miners. Subsequent investigations by the RCMP have indicated that the explosion was deliberately set.

Further progress was made on native land claims, which should help reduce uncertainty in this area. The Gwich'in land claims agreement covering the Northern Mackenzie Valley has been finalized. It will serve as a model for the rest of the Dene/Metis claims in the Northwest Territories. The agreement gives the Gwich'in title to almost 24 000 km^2, including subsurface title to about one quarter of this area and the northeastern Yukon. The Gwich'in will also receive $75 million over 15 years.

Negotiations are continuing on the Sahtu claim, the next regional Dene/Metis land claim, located to the south of the Gwich'in. These negotiations are expected to be completed in mid-1993. Further south of the Sahtu, the Minister of DIAND has accepted a request for a regional claim with the newly formed Dogrib Treaty 11 Council. This council represents the four communities of Snare Lake, Lac la Marte, Rae Lakes, and Rae-Edzo.

The Tungavik Federation of Nunavut (TFN) land claim agreement was ratified by the Inuit late in 1992. However, final settlement awaits the completion of the implementation plan and approval by Cabinet and Parliament. Hopefully, this work will be completed early in 1993. Separate legislation will be tabled in Parliament, concurrently with the TFN claim, for the creation of Nunavut, a separate territory to include the eastern Northwest Territories. The legislation will establish Nunavut as a full legal government by 1999.

The $8.2 million Canada-N.W.T. Economic Development Cooperation Agreement, which includes a minerals component and was signed in February 1991, is well under way. Under the Geoscience initiative, encouraging results were obtained in 1992. These included the discovery of sulphide-bearing ultramafic sills, which may have potential for nickel-chrome-platinum group deposits; the discovery of chrome diopside in an area which could indicate an extension or a new zone of kimberlites; the discovery of komatiites in the Winter Lake area, which would indicate a higher potential than previously thought for platinum group elements and base metals; and the discovery of a previously unknown kimberlite intrusive.

Amendments to the *Northern Inland Waters Act*, which create separate Northwest Territories and Yukon Water Acts, were passed by Parliament in June. Work is continuing on the regulations before final proclamation of these acts.

Note: Information in this review was current as of February 1, 1993.

TABLE 1. VALUE OF LEADING MINERALS IN THE PROVINCES, TERRITORIES AND CANADA, 1991 AND 1992

	Value of Production			
	1991	1992p	Change 1992/1991	1992p Proportion of Provincial Total
	($ millions)		(percent)	
NEWFOUNDLAND				
Iron ore	714.9	680.2	–4.9	92.5
Gold	x	x	x	x
Cement	x	x	x	x
Sand and gravel	11.4	11.6	1.8	1.6
Stone	7.7	4.9	–36.4	0.7
Asbestos	3.3	4.6	39.4	0.6
Total	772.3	735.3	–4.8	100.0
PRINCE EDWARD ISLAND				
Sand and gravel	3.3	3.4	3.0	100.0
Total	3.3	3.4	3.0	100.0
NOVA SCOTIA				
Coal	245.2	265.0	8.1	49.1
Petroleum, crude	–	102.3	n.a.	18.9
Gypsum	49.9	55.2	10.6	10.2
Salt	x	x	x	x
Cement	x	x	x	x
Sand and gravel	21.7	20.4	–6.0	3.8
Stone	24.8	19.8	–20.2	3.7
Total	460.6	539.9	17.2	100.0
NEW BRUNSWICK				
Zinc	268.3	426.8	59.1	48.2
Potash (K_2O)	x	x	x	x
Lead	44.2	56.1	26.9	6.3
Copper	28.4	43.2	52.1	4.9
Silver	23.6	36.1	53.0	4.1
Total	671.5	885.8	31.9	100.0
QUEBEC				
Gold	692.8	590.0	–14.8	22.4
Iron ore	x	x	x	x
Copper	308.4	255.2	–17.3	9.7
Titanium dioxide	x	x	x	x
Asbestos	226.3	224.8	–0.7	8.5
Stone	208.8	205.8	–1.4	7.8
Total	2 930.0	2 630.4	–10.2	100.0
ONTARIO				
Nickel	1 219.3	1 112.9	–8.7	23.3
Gold	1 029.6	979.2	–4.9	20.5
Copper	708.9	716.2	1.0	15.0
Cement	348.6	305.9	–12.2	6.4
Zinc	273.2	276.1	1.1	5.8
Stone	238.4	218.6	–8.3	4.6
Total	5 101.5	4 780.5	–6.3	100.0
MANITOBA				
Nickel	588.3	567.0	–3.6	49.9
Copper	148.5	167.8	13.0	14.8
Zinc	113.2	123.4	9.0	10.9
Petroleum, crude	90.3	86.3	–4.4	7.6
Total	1 127.2	1 136.0	0.8	100.0

TABLE 1 (cont'd)

	Value of Production 1991	1992p	Change 1992/1991	1992p Proportion of Provincial Total
	($ millions)		(percent)	
SASKATCHEWAN				
Petroleum, crude	1 186.5	1 392.6	17.4	45.6
Potash (K_2O)	x	x	x	x
Uranium (U)	332.8	382.5	14.9	12.5
Natural gas	332.3	297.6	–10.4	9.7
Total	2 863.0	3 052.7	6.6	100.0
ALBERTA				
Petroleum, crude	8 675.4	9 231.4	6.4	54.1
Natural gas	4 435.4	4 674.5	5.4	27.4
Natural gas by-products	2 103.8	2 213.4	5.2	13.0
Coal	554.0	572.1	3.3	3.3
Sulphur, elemental	304.0	115.2	–62.1	0.7
Total	16 372.9	17 078.6	4.3	100.0
BRITISH COLUMBIA				
Copper	916.6	880.1	–4.0	25.5
Coal	990.0	700.0	–29.3	20.3
Natural gas	564.4	568.9	0.8	16.5
Petroleum, crude	266.1	262.4	–1.4	7.6
Gold	244.6	202.1	–17.4	5.9
Zinc	161.1	188.2	16.8	5.5
Cement	x	x	x	x
Total	3 851.2	3 447.7	–10.5	100.0
YUKON				
Zinc	191.2	302.8	58.4	64.7
Lead	79.8	91.3	14.4	19.5
Gold	51.6	50.7	–1.7	10.8
Silver	12.9	17.8	38.0	3.8
Total	340.7	467.9	37.3	100.0
NORTHWEST TERRITORIES				
Zinc	221.5	261.5	18.1	40.0
Gold	223.5	182.8	–18.2	28.0
Petroleum, crude	202.3	142.5	–30.0	21.8
Lead	30.1	28.4	–5.6	4.3
Total	711.1	653.3	–8.1	100.0
CANADA				(Proportion of Canadian Total)
Petroleum, crude	10 456.4	11 251.1	7.6	31.8
Natural gas	5 394.1	5 607.7	4.0	15.8
Natural gas by-products	2 178.1	2 296.8	5.4	6.5
Gold	2 349.9	2 086.8	–11.2	5.9
Copper	2 112.2	2 062.9	–2.3	5.8
Zinc	1 385.2	1 727.1	24.7	4.9
Nickel	1 807.6	1 679.9	–7.1	4.7
Coal	1 916.8	1 663.3	–13.2	4.7
Iron ore	1 228.2	1 129.4	–8.0	3.2
Potash (K_2O)	931.9	963.3	3.4	2.7
Grand total	35 205.2	35 411.5	0.6	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; n.a. Not applicable; p Preliminary; x Confidential.

Labour and Employment

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OVERVIEW

Several indicators heralded a slight improvement in Canada's economy in 1992. The Gross Domestic Product grew over the year by an estimated 0.9%, merchandise exports were strong, and housing activity increased. Rising unemployment, weak consumer spending and declining non-residential construction held down the modest economic gain.

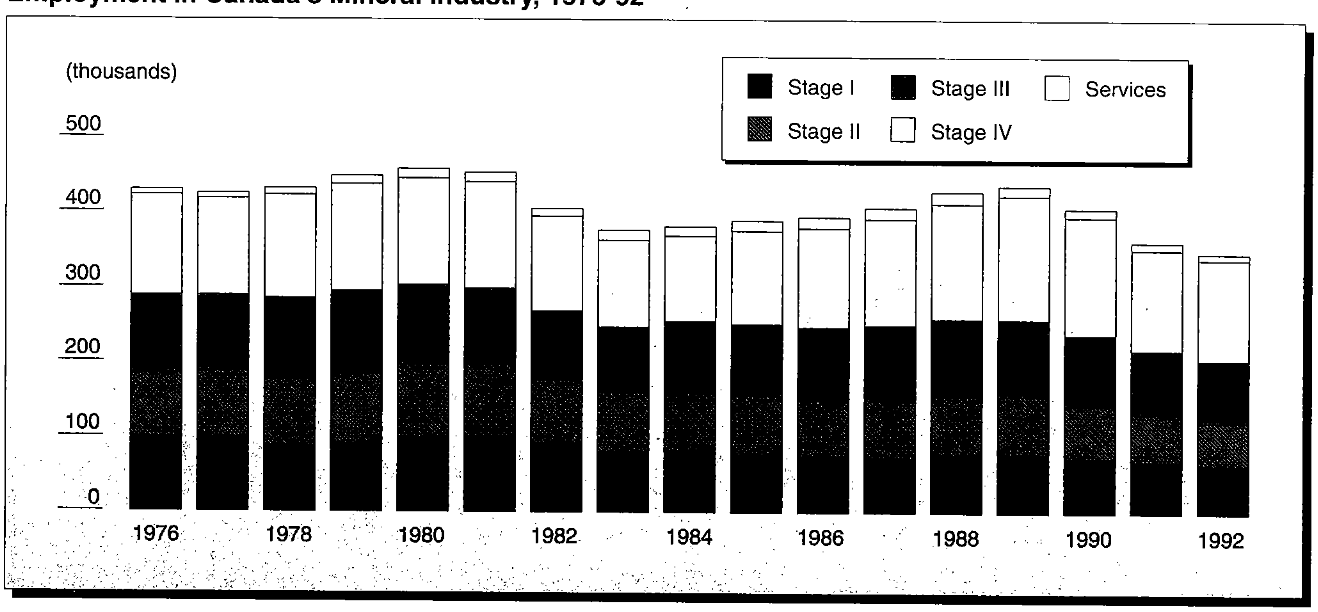
Despite some cautiously optimistic signals in Canada's mineral industry, the employment picture was gloomy. The total value of mineral exports increased in 1992. Commodity prices remained low and the value of nonfuel mineral production declined. Historically low employment levels at minerals and metals operations continued to slide as closures and workforce cuts continued. Collective agreements settled during the year reflected these realities. Low wage increases accompanied improvements to job security and non-wage benefits. Seniority-based layoff protection and recall rights improved, as well as severance, early retirement and pension benefits.

This chapter examines labour market developments in the minerals and metals industry. It reviews the year's events in labour earnings, industrial relations, and health and safety, and provides legislative highlights.

LABOUR MARKET DEVELOPMENTS

Mineral industry employment in Canada accounted for 2.8% of total national employment in 1992. Energy, Mines and Resources Canada (EMR) estimates show that total 1992 employment in the mineral

Figure 1
Employment in Canada's Mineral Industry, 1976-92



SOURCES: Annual Census of Mines; Annual Census of Manufactures; Energy, Mines and Resources Canada for 1992 forecast.

industry fell for the third consecutive year. The industry's four stages (mining, smelting and refining, semi-fabricating, and fabricating) employed 338 000 in 1992, the lowest level since 1963. As last year's review predicted, however, the decline flattened. The 1992 contraction of 12 954 mining industry jobs was a 4% drop compared with the previous year's 11% reduction.

Employment in mining and quarrying (Stage I) fell for the third year. The 8% decline in 1992 brought the number of workers to 64 036. Most miners work at metal mines, but this concentration is dropping. Sixty-one percent of Stage I employees worked in metal mines in 1992, down from 67% a decade earlier and 70% in 1971. At 39 305 in 1992, employment in metal mines was at its lowest level in 30 years. This figure represents a 6% decline from the 1991 level. Nonmetal mining employed 10 455 people in 1992, a 3% drop from the previous year. All metal and nonmetal commodities showed a decrease in employment in 1992. Coal employment decreased sharply by 17% to 9585, while structural materials employed 4690, 7% fewer than in 1991.

Primary metals (Stage II) include iron and steel mills and nonferrous smelting and refining. This stage decreased its workforce for the fourth consecutive year, employing 57 898 in 1992, 9% fewer than the previous year.

Workforce reduction was flatter in nonfuel semi-fabrication and metallic mineral manufacturing (Stages III and IV). The 1992 workforce in semi-fabrication fell to 82 160, a one-year decline of 1%. A 1% drop brought mineral fabrication jobs to 133 993. Forecast 1992 employment in services incidental to mining declined by 14% to 8561.

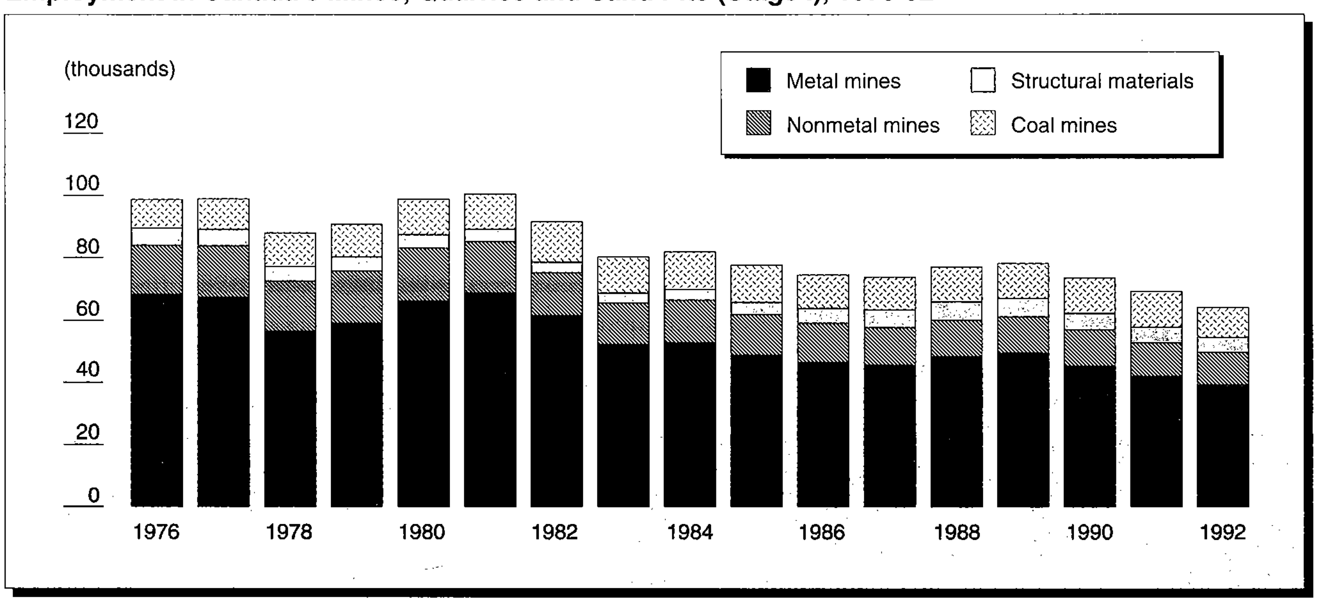
The 4% decline in mineral industry employment in 1992 was somewhat sharper than the 2% drop reported for all goods-producing industries. Technological change, downsizing, and mine and plant closings contributed to mining industry workforce reductions.

Twenty-eight mines suspended operations or closed permanently during 1992, ending over 6300 jobs. Most of these closures and suspensions involved metal and coal mines in Atlantic Canada, Quebec, Ontario and British Columbia. Offsetting adjustments were new and re-opened mines, most of them metal mines in the same regions. Eight mining operations entered production during the year, providing jobs for over 500 employees. There was, however, a net loss of 5800 jobs.

In addition, workforce reductions continued at mines and mineral products plants that remained in operation. Companies eliminated at least 4600 jobs through attrition, transfers, early retirement

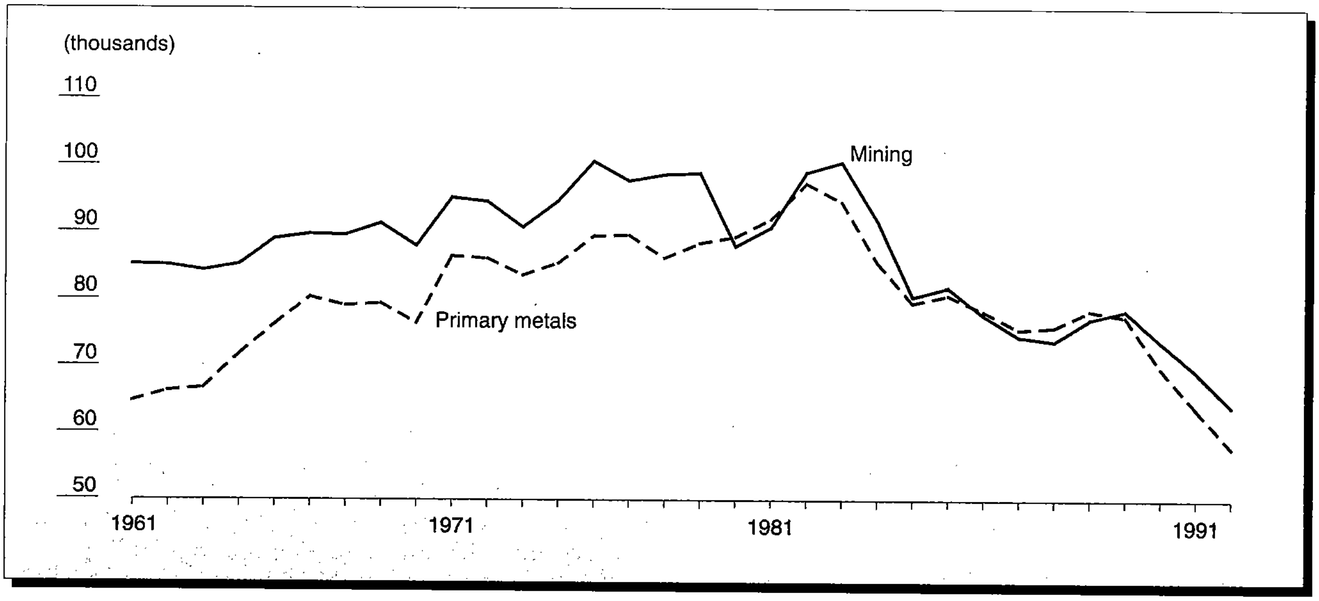
Figure 2

Employment in Canada's Mines, Quarries and Sand Pits (Stage I), 1976-92



SOURCES: Annual Census of Mines; Annual Census of Manufactures; Energy, Mines and Resources Canada for 1992 forecast.

Figure 3
Employment in Mining and Primary Metals, 1961-92



SOURCES: Annual Census of Mines; Annual Census of Manufactures; Energy, Mines and Resources Canada for 1992 forecast.

incentives and layoffs. Most of these losses were at iron and steel mills and nonferrous smelting and refining plants. Expansions at existing mineral and metal operations are important in retaining existing jobs, but do not always increase the number of jobs.

HUMAN RESOURCE PLANNING

The steering committee of a major study of human resources in Canada's mining industry plans to release its report in mid-1993. The government-industry study began in June 1991. Its main goal is to determine possible courses of action to ensure that the Canadian mining industry has the human resource capability to compete globally. Consultants conducting the study are guided by a steering committee of business, labour, education and government representatives.

Preliminary findings report that the industry requires people with a higher education and a broader set of skills than is currently seen. At the same time, the mining workforce is shrinking and aging. Too few new hirings will take place to change the demographic and skill profile significantly. Therefore, continued training and development for employees at all levels of the present workforce is important.

Early funding from the Government of Canada is available to help industry and labour in each sector follow through on action plans arising from such sector studies. For example, the printing, broadcasting and aircraft maintenance industries have completed sector studies. Employment and Immigration Canada has committed $250 million over the next five years to create up to 55 permanent sectoral skills councils. The joint labour-management councils will implement training and human resource development strategies. Selective seed funding will help industry begin a training process aimed at making Canada a leader in terms of its skilled workforce. The Government of Canada's 1993 labour market programming will also strengthen assistance such as counselling, training and mobility for displaced workers.

COMPENSATION

Average earnings in mining are amongst the highest of all industrial classifications. For 1991, average weekly earnings (including overtime) for hourly paid employees were $887.30 for metal mines and $712.13 for the nonmetals, in contrast to $565.11 in manufacturing, $653.29 in construction and $409.98 for industrial aggregate.

At the time of writing, data for 1992 were available to the end of November. Over the one-year period ending in November 1992, average weekly earnings were up by 3.6% in metal mines, by 3.3% in non-metals, and by 8.1% in the coal industry.

The data indicate that real average weekly earnings (based on the Consumer Price Index, All Items, 1986=100) showed an increase in all of the three sub-sectors over the reporting period. For the period November 30, 1991 to November 30, 1992, real earnings increased by 1.9% in metal mining, by 1.6% in nonmetals, and by 6.4% in the coal industry. Over the same period, real earnings in all industries increased by 1.8%.

In 1991, the last year for which data are available, average annual labour income in current dollars (wages and salaries plus supplementary labour income) in mines, quarries and oil wells was $51 022. This was well above the average labour income of $30 715 for all industries. The revised labour income annual averages for 1990 are $47 327 for mines, quarries and oil wells, and $29 321 for all industries. The 1991 figures represent increases of 7.8% and 4.8% respectively, over 1990 revised estimates.

INDUSTRIAL RELATIONS

Preliminary 1992 data show that fewer minerals and metals employers signed collective agreements with their employees than in previous years. Those agreements covered fewer employees and included lower average annual wage increases than contracts signed in the last two years. Employers and unions signed some 21 agreements between January 1 and August 31, 1992. The contracts covered over 17 000 employees at metal, nonmetal and coal mines, and at ferrous and nonferrous smelting and refining operations. One contract was signed in Atlantic Canada, seven in Quebec, nine in Ontario, three in the Prairie provinces, and one in British Columbia.

Labour Canada reported that minerals and metals bargaining achieved 11 major settlements, each covering over 500 employees, during the first eight months. They represent over half of the total minerals and metals agreements reached. Major settlements also applied to over 80% of total employees covered by minerals and metals agreements signed during the period. One nonmetal mine in Saskatchewan, International Minerals & Chemical Corporation (Canada) Limited (IMCC), signed a major settlement, as did Ontario steel producer Algoma Steel Inc. Several smelting and refining plants signed major agreements. Alcan Aluminium Limited signed agreements with four bargaining units. Noranda Inc. CCR Division, QIT-Fer et Titane Inc., and Canadian Reynolds Metals Company Limited in Quebec also signed major contracts. In addition, the Royal Canadian Mint in Ontario and Sherritt Gordon Limited in Alberta also reached major agreements.

Average wage increases in mining and smelting and refining agreements dropped in 1992 for the second year. Mining increases, however, exceeded those in manufacturing and the all-industry average in 1988, 1991 and 1992.

In contrast to recent years, only one mine reached a major agreement during the first eight months of 1992. The agreement at the IMCC potash mine in Saskatchewan included an average annual increase of 3.8%. Also atypical was the absolute decrease of 0.1% in average annual wages at iron and steel mills in 1992, down sharply from 2.9% in 1991. This reflects the wage gain that Algoma Steel Inc. employees gave up in exchange for company shares. Nonferrous smelting and refining averaged 2.5%, slightly lower than the 3.0% 1991 average. Combined mining, milling, smelting and refining averaged 1.7%, below the 2.8% average for all primary industries and that of 2.3% for all manufacturing. Corresponding averages in 1991 were all higher: 4.3% in combined mining, milling, smelting and refining; 4.9% in primary industries; and 3.8% in manufacturing. Preliminary wage results in smaller minerals and metals bargaining units during the same period reflected the 1992 wage settlements in major agreements.

The 45-month average length of major 1992 minerals and metals agreements exceeded last year's 33-month average. It also surpassed the 34-month average length of major manufacturing agreements and the 22.9-month average duration of contracts in all industries. Three-year agreements were common among smaller minerals and metals units this year.

Changes in non-wage provisions for major and smaller bargaining units in 1992 reflected changes in economic and labour force realities of the time. Improvements to severance, early retirement and pension benefits were common. Provisions enhanced seniority-based layoff protection and recall rights. Traditional benefits, such as group medical, dental, optical, disability and life insurance, also improved.

The year's most innovative non-wage changes were those negotiated by Algoma and the United Steelworkers of America. Employees gained the right to veto certain decisions of the Board of Directors and, within five years, will own 60% of Algoma stock. The Board of Directors includes four nominees of hourly paid workers, one from salaried employees, seven independents, and a Chief Executive Officer. The contract provides for a joint labour-management steering committee to oversee several new joint subcommittees. Separate subcommittees will address training, employee development, problem-solving, cost reduction, technology, and increased employee participation in worksite decision-making through workplace redesign. A new article provides laid-off older workers with an adjustment allowance until age 65.

Most collective agreements in Canada are signed without strikes or lockouts. Preliminary Labour Canada data show that the 1992 level of strike activity in all industries was the lowest in a half century. Canadian mines experienced fewer, shorter stoppages involving fewer workers during the 1980s than during the 1970s. This trend continued in the early 1990s. The number of stoppages and the number of workers involved are down in recent years, but some especially long strikes have kept the number of lost person-days high. Although the dispute at Royal Oak Mines Inc.'s Giant gold mine in Yellowknife received the most publicity, more person-days were lost at Fording Coal Ltd.'s British Columbia coal mine. No strikes or lockouts occurred at nonmetal mines in the last two years (Table 1).

In 1992, work stoppages at Canadian mines involved 2618 workers and 275 510 person-days were lost. Labour disputes stopped work at two coal mines in British Columbia. Gold mines in Quebec and the Northwest Territories, and gold refining and coin minting operations in Ontario and Manitoba, experienced work stoppages. In addition, office and technical workers were on strike briefly at an Ontario nickel-copper mine (Table 2).

Labour organizations restructured for greater analytical and bargaining strength. In November 1992, three Canadian unions merged to form the new Communications, Energy and Paperworkers Union of Canada (CEP). The CEP is now the seventh largest union in Canada. Its 135 000 members include 35 000 members of the former Energy and Chemical Workers Union (ECWU), many of whom work at mining and minerals operations. Two mining and minerals unions joined Canada's sixth largest union, the National Automobile, Aerospace, and Agricultural Implement Workers Union of Canada (CAW). The former Canadian Association of Industrial, Mechanical and Allied Workers (CAIMAW) represented some British Columbia miners. The previous 9000-member United Electrical, Radio and Machine Workers of Canada (UE) represented 750 employees at Stelco Inc.'s Page-Hersey works in Welland, Ontario.

The bargaining calendar predicts that more major minerals and metals agreements will expire in 1993 although, as in 1992, many will end late in the year. Metal mine employees will be negotiating in Newfoundland, Quebec, Ontario, Manitoba and British Columbia. Contract talks will occur at iron and steel operations in Nova Scotia, Quebec, Ontario and Saskatchewan. In addition, nonferrous smelters and refineries in Quebec, Ontario and British Columbia will engage in collective bargaining.

SAFETY AND HEALTH

Once again in 1992, the issue of health and safety in the workplace was a priority for the mining industry and for government authorities responsible for legislation and regulations in this area. A number of efforts were made by the mining companies, in cooperation with workers of the mining sector and the union organizations representing them, to improve the industry's performance in terms of occupational health and safety. In addition, several governments amended their legislation and regulations applying to occupational health and safety.

An EMR survey of Chief Inspectors of Mines in the provinces and territories indicated that there were 47 fatalities in mining accidents in 1992 (Table 3). This total figure includes 26 men killed in an explosion at the Westray coal mine in Pictou County, Nova Scotia, on May 9, 1992. The number of mining fatalities in 1992 is among the highest reported over the last 15 years. It equals numbers reported for 1979 and 1987, and was only exceeded in 1980 when 63 fatalities were reported. Consequently, in terms of number of fatalities, 1992 compares unfavourably with 1991, when only 26 fatalities were reported. Had it not been for the Westray accident, the number of fatalities in 1992 would have been the lowest since 1978.

The latest available statistics for time-loss injury and illness claims (including fatalities) accepted by Workers Compensation Boards suggest that claims in mines, quarries and oil wells fell by about 15.6% from 1990 to 1991 (Table 4). This reduction is greater than the 4.8% decline observed in employment data reported by Statistics Canada's Survey of Employment, Payrolls and Hours. The 8146 time-loss injuries and illnesses recorded in 1991 represent a reduction of 23.7% in the annual average of 10 680 accepted claims, calculated over the preceding five years (1986-90), which is more than four times the decline of 5.6% in employment calculated for the same period. Also, there were 4185 injuries and illnesses in the metal and nonmetal mines in 1991. This was 14.7% less than the 4906 claims recorded in 1990 (compared to a decline of 7.1% in employment according to Census of Mines), and 15.8% less than the annual average of 4969 claims calculated over the preceding five years, 1986-90 (compared to a corresponding decline of 10.4% in employment according to Census of Mines).

Estimated rates per one hundred workers express time-loss injuries and illnesses in terms of level of employment (Table 5). The statistics indicate a downward trend in time-loss injuries and illnesses for mines, quarries and oil wells. The estimated rate dropped 2.3 percentage points over the 1983-91 period, a reduction of 29% in the rate. Estimated rates show that the mines, quarries and oil wells sector advanced in 1991 to fifth position, ahead of forestry, construction, manufacturing and transportation, communication and other utilities industries. Its 1990 position was sixth. The series of rates estimated for mines, quarries and oil wells is significantly above that for the industrial aggregate, which can be considered as a nationwide industrial average. Yet the gap between rates for mines, quarries and oil wells and those for all industries has narrowed over the nine-year period. That difference fell by 77% from 2.6 injuries and illnesses per one hundred workers in 1983 to 0.6 per one hundred in 1991.

LEGISLATIVE HIGHLIGHTS

The federal jurisdiction for labour matters relating to the mining industry is narrowly defined, as responsibility for most labour legislation, including safety and health, industrial relations and conditions of work, rests with the provinces and territories. A broad range of labour laws and regulations apply to employers and workers across Canada, and specific provisions vary widely across the jurisdictions.

Each year a wide range of labour legislation amendments may affect the mining industry. This section does not attempt to review all such legislation; it outlines developments at the federal level in 1992, with very brief reference to selected provincial initiatives.

Wage Protection Bill

The federal government gave royal assent to Bill C-22, *An Act to amend the Bankruptcy Act and to amend the Income Tax Act* in consequence thereof, on June 23, 1992. Among other things, this act increases from $500 to $2000 the amount of the preferred claim for unpaid wages provided in section 136(1) (d) of the *Bankruptcy Act*. This modification came into force on August 1, 1992.

Amendment of the Canada Occupational Safety and Health Regulations under the Canada Labour Code

This regulation amends Part XI of the Canada Occupational Safety and Health Regulations, which prescribe worker safety in confined spaces. New provisions have been added to require consultations with the safety and health committee or representatives in the development of safe entry procedures, to expand the requirement for an initial hazard assessment, prior to developing entry procedures to regulate "hot work" in confined spaces, and to provide for the distribution and retention of records of hazard assessments and entry procedures. A definition of "class of confined space" has been added and the sequence of the provisions has been rearranged to make the regulation easier to read and understand. The new regulation was gazetted on October 7, 1992.

An Act to Provide for Government Expenditure Restraint

The federal government introduced Bill C-105, the *Government Expenditures Restraint Act, 1993*, on December 10, 1992, in view of implementing a number of the spending reduction measures announced in the December 2, 1992, Economic and Fiscal Statement. This omnibus bill proposed a number of measures to restrain government expenditures, including amendments to the *Unemployment Insurance Act*. Bill C-105 was then replaced by Bill C-113, *An Act to Provide for Government Expenditure Restraint*, bringing clarifications to some of the provisions proposed earlier in Bill C-105. Bill C-113 was introduced on February 17, 1993.

The main proposals contained in Bill C-113 that affect the *Unemployment Insurance Act* are:

- people who quit their jobs without "just cause" or are fired for misconduct would be disqualified from receiving any benefits;
- the UI benefit rate would be 57% of average weekly insurable earnings for the next two years beginning April 4, 1993;
- the list of reasons for "just cause" in the act has been further spelled out, to provide greater certainty to workers;
- Boards of Referees would be given clear authority to protect the privacy of victims of sexual or other harassment;

- workers who leave their jobs to preserve jobs for their co-workers would be eligible for UI benefits; and
- in the case of quitting voluntarily, UI agents are required to allow both the claimant and the employer the opportunity to provide information and to take this information into account when making a decision.

Among the other measures in the Bill are: a two-year salary freeze for some 390 000 personnel in the federal public sector; a 10% reduction in transport subsidies paid under the *Western Grain Transportation Act*, the *Atlantic Region Freight Assistance Act*, and the *Maritime Freight Rates Act*; and a 10% cut in payments under the *Public Utilities Income Tax Transfer Act*.

Employment Equity

The fifth annual report to Parliament on employment equity outlines employers' progress towards achieving an equitable workforce. Despite difficult economic conditions and downsizing, employers recognized the economic advantage of broadening the pool of qualified people through employment equity strategies. The report quotes the Canadian Bankers' Association remark, "It makes good business sense to tap all pools of labour market potential, including groups of people who, historically, have not been part of the economic mainstream."

The report assessed federally regulated firms for employment status of designated groups and progress in equitable employment practices during the reporting year, 1991. Included were eight minerals and metals companies employing 8978 workers. All minerals and metals sector employers received the lowest rank (C) for status of women's employment. Three companies raised their progress rating to the highest level (A) for progress in 1991. Companies also raised their status and progress rankings for employment of members of visible minorities. Ranking for status and progress of employment of workers with disabilities dropped slightly. Aboriginal employees remained well-represented at western Canadian operations, and particularly at uranium mines.

Groups and individuals who contributed their views to the parliamentary review of the *Employment Equity Act* expressed general support for the act's objectives and principles. The Parliamentary Committee tabled its report in the House of Commons in 1992. The report, entitled *A Matter of Fairness*, includes 31 recommendations.

Provincial/Territorial Developments

A number of changes to labour and employment standards legislation took place in 1992. Several jurisdictions (Alberta, British Columbia, Nova Scotia, Ontario and Quebec) legislated increases in minimum wages. Two jurisdictions, Ontario and Manitoba, amended their employment standards regulations to improve workers' wage protection. New Brunswick and Newfoundland adopted restraint legislation.

There were several changes to legislation on occupational health and safety. In New Brunswick, a general regulation under the *Occupational Health and Safety Act* became effective March 1, 1992. This regulation repeals and replaces New Brunswick Regulations 77-1 and 89-66, as well as that part of the mining regulation under the *Mining Act* dealing with pits and quarries. The purpose of this regulation is to change the wording of the occupational health and safety regulation to make clear where the onus lies in each case where rights or obligations are created. Among other things, the regulation requires that an employer develop a Code of Practice before performing any dangerous work. It also contains provisions regarding confined spaces and specific blasting technique requirements. A new regulation under the *Occupational Health and Safety Act* was gazetted on August 26, 1992. This regulation requires that employers and employees who work with or disturb material containing asbestos adopt and follow the "Code of Practice for Working with Materials Containing Asbestos in New Brunswick" dated March 19, 1992. Also, a new regulation on a Code of Practice for Workers Working Alone under the *Occupational Health and Safety Act* was gazetted on October 14, 1992. This regulation requires an employer to establish a Code of Practice to ensure, so far as reasonably practicable, the health and safety of an employee who works alone from the risks associated with the work assigned.

In Quebec, *An Act to amend the Act respecting industrial accidents and occupational diseases*, the *Act respecting occupational health and safety*, and the *Health Insurance Act* received Royal Assent on June 17, 1992. This act provides for the distinct appointment of both a chairperson of the Board of Directors and Chief Executive Officer and of a Chief of Operations of the Occupational Health and Safety Commission. It also provides for other changes of an administrative nature.

In Ontario, two new regulations (Reg. 171/92 and Reg. 571/92) amending the Mines and Mining Plant Regulations were adopted on April 11 and

October 3, 1992, respectively. Both regulations establish new requirements with respect to mine designs, ground support systems, power supply for equipment and machinery, blasting, drilling and sampling, self-propelled underground equipment vehicles and hoists, and other machinery, among others. Also, on September 12, 1992, a series of regulations (Reg. 507/92 to Reg. 523/92) on designated hazardous substances were gazetted. Asbestos, coke oven emissions, lead, mercury and silica are among the substances covered by these regulations.

In Alberta, new Chemical Hazards Amendment Regulations under the *Occupational Health and Safety Act* were adopted on October 31, 1992. These regulations repeal the asbestos, silica and coal dust regulations in order to incorporate their subject matter into the Chemical Hazards Regulations. Some substantive changes have been made to the content of the provisions (i.e., a change in the definition of a "restricted area" with respect to asbestos).

In the Northwest Territories, Asbestos Safety Regulations under the *Safety Act* were gazetted on March 27, 1992. These regulations put a ban on the use of crocidolite (blue asbestos) in any asbestos process, and on the application of asbestos by spraying. It also prescribes several safety measures which must be taken by employers conducting an asbestos process.

OUTLOOK

Employment is expected to continue to decrease. New and developing technologies will demand that employees increase their education and skill levels. Industry, labour, government and educational institutions continue to study and plan for adjustment to the increasingly higher education and skill requirements in a shrinking mining labour force.

Unless more ore can be found, 14 mines will close in 1993. These include New Brunswick's Stratmat copper-lead-zinc-silver mine, and Quebec's Ansil copper-zinc-silver-gold mine and Telbel, Pierre Beauchemin, Lucien C. Beliveau and Norlartic gold mines. Jobs will be lost at Ontario's Dona Lake gold mine and Winston Lake zinc-copper mine, and at Manitoba's Stall Lake and Chisel Lake zinc-copper mines and the Namew Lake nickel-copper mine. The Nickel Plate gold mine in British Columbia and the Vangorda zinc-lead mines in the Yukon could also close.

Workforce reductions involving early retirements, transfers and layoffs have been announced at several mines and steel operations. The mines include Iron Ore Company of Canada's (IOC) Newfoundland and Quebec operations, Dickenson Mines Ltd.'s Arthur W. White mine, Falconbridge Limited's gold mines, and Inco Limited's Thompson mine. Sydney Steel Corporation, Sidbec-Dosco Inc., Dofasco Inc. and Algoma Steel Inc. plan to reduce their steel workforces.

Other responses to weak prices, high inventories and rising costs include intermittent or extended shutdowns. Atlas Specialty Steels, a division of Sammi Atlas Inc., Falconbridge Limited, Inco Limited, and Cominco Ltd. plan to limit or avoid job cuts while reducing production this way.

Mining companies also plan to open or re-open more than a dozen mines in 1993. These include the Astoria gold deposit, the Casa Berardi Est and Sleeping Giant gold mines, and the Estrades zinc-gold mine in Quebec. The Komis gold deposit in northern Saskatchewan is scheduled to come on stream. In British Columbia, the Erickson gold mine and the Balmer and Greenhills coal mines are slated for re-opening.

More major minerals and metals agreements will expire in 1993. Metal mine employees will be negotiating at Iron Ore Company of Canada, Quebec Cartier Mining Company, Placer Dome Inc., Hudson Bay Mining and Smelting Co., Limited, Highland Valley Copper Corporation, and Westmin Resources Limited. Contract talks will occur at steelmakers Sydney Steel Corporation, Ivaco Inc., Slater Industries Inc., Stelco Inc., and Ipsco Inc. In addition, collective bargaining will take place at the following nonferrous smelters and refineries: Reynolds Metals Company, the Royal Canadian Mint, and Alcan Smelters and Chemicals Limited.

Note: Information in this review was current as of February 1, 1993.

TABLE 1. STRIKES AND LOCKOUTS IN CANADIAN MINING, 1973-92

Year	Metal Mines		Nonmetal Mines		Coal Mines	
	Strikes and Lockouts	Person-Days Not Worked	Strikes and Lockouts	Person-Days Not Worked	Strikes and Lockouts	Person-Days Not Worked
1973	22	159 230	9	49 440	1	300
1974	34	314 710	11	6 890	11	49 590
1975	19	454 740	18	693 800	4	4 830
1976	27	294 340	5	36 180	6	148 910
1977	15	99 870	6	4 470	4	11 050
1978	16	1 521 540	12	137 550	8	14 930
1979	17	1 506 980	10	22 980	7	54 650
1980	18	189 570	6	120 640	5	99 450
1981	24	242 810	5	16 130	8	300 190
1982	2	248 300	–	–	2	4 670
1983	6	91 500	2	5 540	3	80 950
1984	6	36 240	2	570	–	–
1985	5	40 760	3	37 260	2	13 030
1986	7	50 470	3	67 080	3	110 870
1987	10	149 270	1	6 210	2	1 000
1988	8	93 430	3	40 460	–	–
1989	7	113 510	5	36 100	4	36 320
1990	11	292 270	2	44 430	2	59 810
1991	5	151 360	–	–	–	–
1992**p**	3	39 810	–	–	2	235 700

Source: Labour Canada.
– Nil; **p** Preliminary.

TABLE 2. LABOUR DISPUTES, 1992

Employer	Location	Products	Union[1]	Period of Work Stoppage	Employees Involved
QUEBEC					
Lac Minerals Ltd. Doyon mine	Rouyn-Noranda	Gold	USWA	April 23-July 13	25
ONTARIO					
Falconbridge Limited Office and technical workers	Sudbury	Nickel, copper	USWA	June 5-15	360
Royal Canadian Mint	Ottawa	Refined gold	PSAC	December 5, 1991 - February 4, 1992	350
MANITOBA					
Royal Canadian Mint	Winnipeg	Coins	PSAC	October 24, 1991 - February 4, 1992	130
BRITISH COLUMBIA					
Fording Coal Ltd.	Elkford	Coal	USWA	May 8 - December 23	885
Westar Mining Ltd. Balmer mine	Sparwood	Coal	UMW	May 1	1 100
NORTHWEST TERRITORIES					
Royal Oak Mines Inc. Giant mine	Yellowknife	Gold	CASAW	May 23 -	240

Sources: Labour Canada; Canadian Labour Views Reports.

1 CASAW Canadian Association of Smelter and Allied Workers
PSAC Public Service Alliance of Canada
UMW United Mine Workers of America
USWA United Steelworkers of America

TABLE 3. FATALITIES IN THE MINING SECTOR,[1] 1992

Jurisdiction	Employer		Location			Total
	Company	Contractor and Misc.	Underground	Open Pit	Other	
Newfoundland	1	–	–	1	–	1
Nova Scotia	26	–	26	–	–	26
Cape Breton Development Corporation	–	–	–	–	–	–
New Brunswick	1	–	1	–	–	1
Quebec	3[a]	1	2	1	1	4
Ontario	2	5	–	–	7	7
Manitoba	2	–	–	1	1	2
Saskatchewan	1	–	–	–	1	1
Alberta	–	–	–	–	–	–
British Columbia	3	–	–	–	3	3
Northwest Territories	1	–	1	–	–	1
Yukon	–	1	–	–	1	1
Total Canada	40	7	30	3	14	47

Source: Mine fatalities as reported by chief inspectors or corresponding authority of every mining jurisdiction in Canada. Compiled by EMR Canada, February 1993.
– Nil.
a These fatalities were workers employed in quarries (preliminary data from the Commission de la santé et de la sécurité du travail).
1 For the purpose of this table, the mining sector is understood to include quarries and sand pits, with the exception of Newfoundland, New Brunswick and Northwest Territories, which have not reported under that category.
Notes: The table provides the number of work-related fatalities in 1991 caused by a traumatic accident. It does **not** include deaths resulting from occupational illnesses. Also, off-property and commuting transportation accidents, such as highway traffic accidents, are not included.

TABLE 4. NUMBER[1] OF TIME-LOSS INJURIES AND ILLNESSES ACCEPTED BY WORKERS' COMPENSATION BOARDS, MINING, 1982-91

	Mines, Quarries and Oil Wells	Metal and Nonmetal Mines	Mineral Fuels	Quarries and Sand Pits	Services Incidental to Mining
	(SIC 051-099)	(051-059, 071-079)	(061-064)	(083-087)	(096-099)
1982	12 425	5 603	3 541	557	2 724
1983	11 717	5 114	3 153	635	2 815
1984	12 322	5 595	2 286	677	3 764
1985	13 471	5 411	3 175	929	3 956
1986	11 105	5 024	2 191	779	3 111
1987	11 103	4 766	1 931	880	3 526
1988	11 258r	4 888r	1 857	921	3 592
1989	10 282	5 263	1 485	997	2 537
1990	9 655r	4 906r	1 565r	925	2 259r
1991	8 146	4 185	1 656	664	1 641

Source: Statistics Canada, National Work Injuries Statistics Program (special tabulations).
r Revised.
1 Includes fatalities.

TABLE 5. ESTIMATED RATE OF WORK-RELATED TIME-LOSS INJURIES AND ILLNESSES[1] PER 100 WORKERS BY INDUSTRY,[2] 1983-91

	Forestry	Mining, Quarries and Oil Wells	Manufacturing	Construction	Transportation, Communications and Other Utilities	Trade	Finance	Service	Public Administration	Industrial Aggregate
1983	16.8	7.9	9.2	11.7	5.4	4.1	0.7	2.8	5.1	5.3
1984	17.4	7.8	10.0	11.8	5.6	4.4	0.7	3.0	4.7	5.6
1985	13.8	8.3	10.9	12.1	5.9	4.7	0.7	3.1	5.7	5.9
1986	16.6	7.3	11.1	12.2	6.6	5.0	0.6	3.3	5.5	6.0
1987	15.8	7.3	11.1	12.5	6.5	4.8	0.6	3.2	5.4	5.9
1988	14.4	7.1	11.3	12.1	6.0	5.0	0.6	3.3	5.6	5.9
1989	13.1	6.6	10.9	11.7	6.2	4.8	0.6	3.2	5.2	5.7
1990	12.6	6.3	10.3	11.3	6.0	4.6	0.6	3.2	5.1	5.4
1991	11.9	5.6	9.3	10.1	5.8	4.3	0.6	3.2	4.8	5.0

Source: Statistics Canada, National Work Injuries Statistics Program (special tabulations) for number of work-related injuries and illnesses and Survey of Employment, Payrolls and Hours (SEPH) (special tabulations) for employment series. SEPH employment data for the period 1983-91 have been historically revised. NWISP injury and illness data for 1990 have also been revised. Rates have been re-estimated accordingly.
1 Includes fatalities. 2 Agriculture and fishing and trapping industries are not covered by SEPH; consequently, rates were not calculated for these sectors.

Canadian Reserves, Mine Investment, New Projects and Promising Deposits

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RESERVES

In January 1992, mine reserves of base metals and precious metals in Canada were lower than in the previous year (Figure 1).

Canadian reserves were derived from the responses of mining companies to the Federal-Provincial Survey of Mines and Concentrators, and from information contained in annual and other corporate reports. Reserves include only metal contained in ores that are classified by companies as "proven" or "probable" or their equivalents at producing mines and in deposits that are committed to production. Metal contained in mineralized material that is classified as "possible" is not included in the national totals reported here, nor is metal contained in deposits that are under exploration. Where available, only metal in "mineable" ore is included so as to exclude metal lost in the mining process.

The reserves reported here 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 1992 reserves, but also on additional reserves yet to be developed from new discoveries, from extensions to known orebodies, and from known but currently marginal or uneconomic material. Energy, Mines and Resources Canada publishes an annual mineral bulletin[1] on Canadian mines that discusses Canada's capability for metal production.

In most mines, reserves change slightly from year to year. It is the relatively small number of mines with large changes that usually affects the overall direction of national trends.[2]

Reserves by Commodity

Gold

In January 1992, some 1430 t of gold were contained in Canadian reserves of proven and probable mineable ore at operating mines and in deposits committed to production. Compared with revised totals for 1991, this represents a decrease of more than 100 t. Canadian reserves of gold have decreased for the third year in a row.

Overall, mine-site exploration and additions to reserves resulting from new mines committed to production did not replace all of the gold mined during 1991. During the 1980s, in contrast, Canadian gold reserves experienced strong and sustained growth.

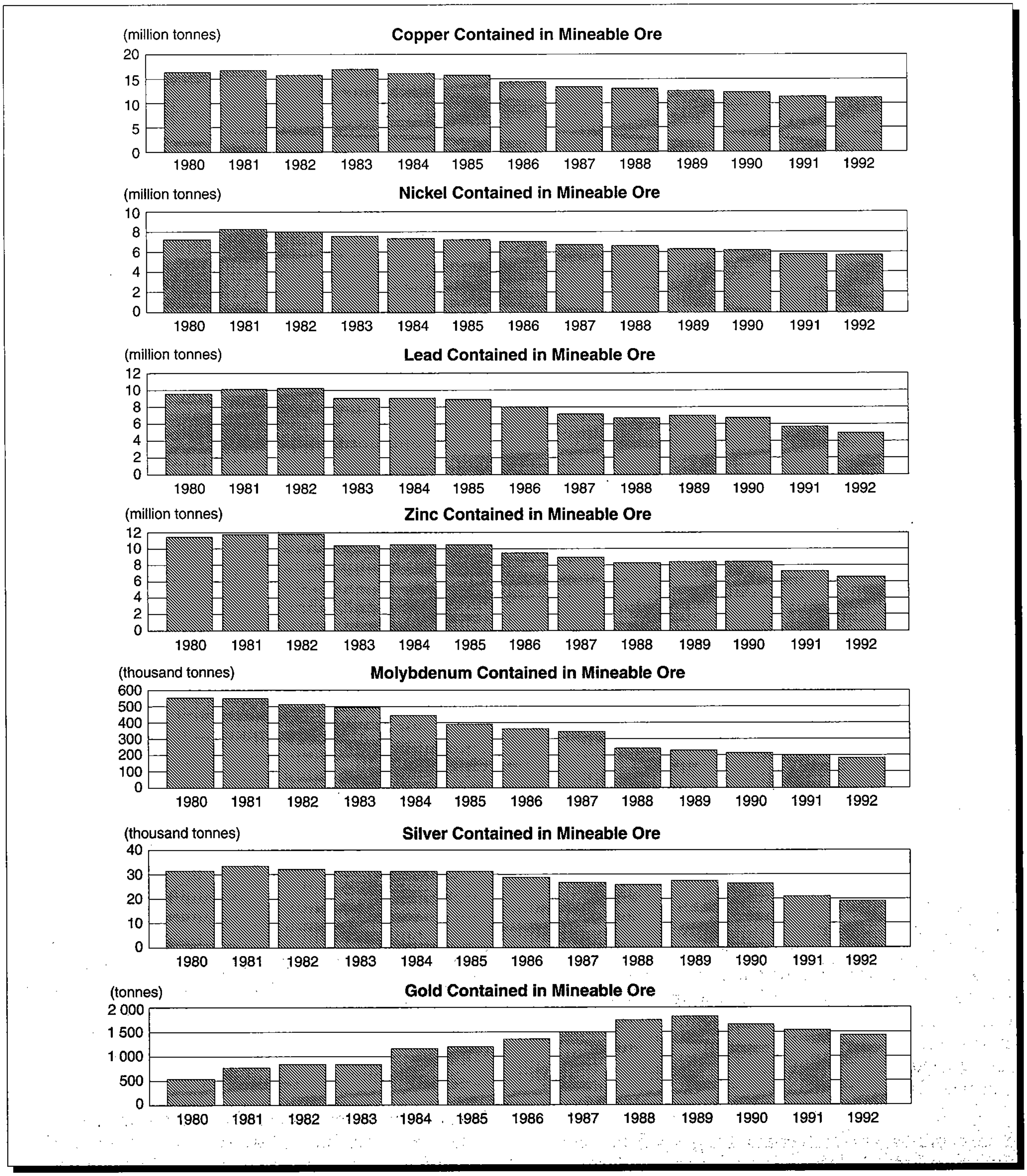
Cambior inc.'s Mouska operation in Quebec, which attained commercial production in July 1991, was the only new precious-metal mine whose reserves were added to Canadian totals as at January 1992 (Table 1).

The largest single gross addition to Canadian reserves (27 t) resulted from the inclusion for the first time of the by-product gold from the Louvicourt copper-zinc project in Quebec, which Aur Resources Inc., Louvem Mines Inc. and Teck Corporation are preparing for production in late 1994.

There were significant additions to gold reserves at a number of established gold mining operations. These include Royal Oak Mines Inc.'s Giant mine in the Northwest Territories, as a result of substantial increases in mineable tonnages; Placer Dome Inc.'s Dome mine in Ontario, where a new large open pit is planned; and Lac Minerals Ltd.'s Bousquet No. 2 mine in Quebec where, on the basis of new information, some of the ore previously classified as possible was upgraded to the probable category and counted in Canadian totals.

In contrast, several operations recorded reductions in gold reserves beyond what is accounted for by the quantity of gold mined during 1991. The single largest reduction (19 t) was the result of no longer counting in Canadian totals the gold contained at

Figure 1
Canadian Reserves, 1980-92
Metal Contained in Proven and Probable Mineable Ore in Operating Mines and Deposits Committed for Production, as at January 1 of Each Year



SOURCE: Energy, Mines and Resources Canada.

the Colomac mine, in the Northwest Territories, where production was suspended in July 1991. Other notable reductions occurred at Hemlo Gold Mines Inc.'s Golden Giant mine and at Teck and Homestake Mining Company's Williams mine, both in Ontario, where the ore tonnages were down by about 1 Mt and 2 Mt respectively compared with the previous year; at Teck and Homestake Mining Company's David Bell mine, also in Ontario, where the average grade of gold ores dropped to 11.2 g/t (0.328 oz/short ton) at the end of 1991, compared to 12.4 g/t (0.363 oz/short ton) a year earlier; at Claude Resources Inc.'s Seabee mine in Saskatchewan, where tonnages are down substantially, in part because the width of some gold veins are narrower than was expected at the time the production decision was made; and at Agnico-Eagle Mines Limited's Eagle-Telbel mine in Quebec, where some tonnages are no longer counted in reserves because of poor ground conditions, loss of mining access, or because it is uneconomic to mine at expected gold prices.

The net effect of all the changes that occurred at individual mines was a reduction in Canadian gold reserves of almost 7% from January 1991 to January 1992.

Silver

In early 1992, Canadian reserves of silver stood at over 19 000 t, down by 9% from the previous year. In aggregate, more silver was either mined or is no longer counted in company reserves than was found in operating mines or added as a result of production decisions made during 1991.

The most noteworthy gross addition to Canadian silver reserves (some 700 t) resulted from the first-time inclusion in national totals of the reserves of the Louvicourt deposit in Quebec. Other operations with significant net additions to silver reserves were Billiton Metals Canada Inc.'s Selbaie A1 mine in Quebec, and Westmin Resources Ltd.'s Myra Falls operations in British Columbia, where significant tonnages of silver-bearing ore were added to reserves.

Among the operations with the largest decreases in reserves of silver were, in New Brunswick: Brunswick Mining and Smelting Corporation Limited's No. 12 mine, in part because of allowances made for material difficult to treat and because of more conservative estimates assumed for the recovery of metal in pillars, and its Heath-Steele Stratmat mine, in part because of ongoing economic and engineering reassessment of stopes; in Ontario: Falconbridge Limited's Kidd Creek operations and Noranda Minerals Inc.'s Geco operations where ore tonnages are down; in British Columbia: Equity Silver Mines Limited's open-pit operations at Houston, where ore mined during 1991 was not replaced; Cheni Gold Mines Inc.'s Lawyers mine, as a result of new development and infill drilling information; Samatosum, owned by Minnova Inc. and Rea Gold Corporation, in part because of additional definition drilling, mining experience and an increase in the lowest ore grade (cutoff grade) that the companies plan to mine; and in the Yukon: Curragh Inc.'s Faro operations, in part because of re-interpretation based on additional drilling, revised estimation techniques and modifications to the mine design required to improve operations; and at Curragh and Hillsborough Resources Limited's new Sa Dena Hess mine (Mt. Hundere), where ore tonnages were reported as mineable rather than as geological (in place) as in the previous year.

Zinc

A number of mines contributed noteworthy gross additions to Canadian reserves of zinc during 1991. The largest resulted from the inclusion, for the first time, of the reserves of the Louvicourt deposit. Others came as a result of an increase in ore tonnages at Selbaie A1 and at Myra Falls, and as a result of the inclusion, for the first time, of Noranda's Norita East deposit.

During 1991, there were notable reductions in zinc reserves at several mines in Canada. Ore tonnages were down at Cominco Ltd.'s Polaris mine in the Northwest Territories and at its Sullivan mine in British Columbia. In Manitoba, reserves were reduced at the Trout Lake mine, owned by Hudson Bay Mining and Smelting Co., Limited, Manitoba Mineral Resources Limited and Granges Inc., in part because of lower recoveries associated with a new mining method, a new geological interpretation of a portion of the orebody, and a re-evaluation of the economics of certain mining blocks. Reserves were also down at Brunswick No. 12, Faro, Kidd Creek, Heath-Steele and Sa Dena Hess.

Overall, Canadian reserves of zinc decreased to 16 448 000 t in January 1992, some 1 756 000 t (almost 10%) less than in 1991.

Lead

Canadian reserves of lead fell to 4 955 000 t in January 1992, down by almost 13% compared with revised totals for 1991.

Decreases in lead reserves at individual mine sites were far more numerous than additions. The largest decreases took place at Faro, Brunswick No. 12, and Sa Dena Hess.

Nickel

In January 1992, there were some 5 691 000 t of nickel contained in Canadian mine reserves.

Inco Limited, Canada's largest producer, replaced more than half of the nickel that it mined during 1991. Inco's aggregate reserves of nickel in the Sudbury area of Ontario and at Thompson, Manitoba, decreased by about only 70 000 t.

Overall, Canadian reserves of nickel were down by only slightly more than 1% from 1991 to 1992. In Canada, the ratio of reserves to production continues to be substantially higher for nickel than for most other metals.

Copper

In January 1992, Canadian reserves of copper amounted to 11 115 000 t, down from 11 349 000 t a year earlier.

The only notable gross addition to copper reserves during 1991, over 900 000 t, resulted from the first-time inclusion of the Louvicourt deposit in Canadian reserve totals. There were less than a dozen mining operations with apparent net additions to their copper reserves.

Two notable decreases in copper reserves were recorded during 1991: one in British Columbia at the Highland Valley mine, owned by Cominco, Rio Algom Limited, Teck Corporation and Highmont Mining Company, and the other at Kidd Creek.

Taking all changes into account, copper reserves at the beginning of 1992 were 2% lower than at the beginning of the previous year.

Molybdenum

Canadian reserves of molybdenum stood at 182 000 t in early 1992, about 8% less than in early 1991. None of the four Canadian mines that produced molybdenum in 1991, all located in British Columbia, appears to have replaced the molybdenum extracted from ore reserves. As well, some mineralized material was deleted from reserves at the Highland Valley mine as a result of an increase in the cutoff grade of the molybdenum ore that the company plans to mine in the foreseeable future.

Canadian Reserves by Province and Territory

At the beginning of 1992, three provinces held dominant positions in terms of Canada's proven and probable reserves of major metals (Table 2). New Brunswick had 50% of the lead, 37% of the zinc and 37% of the silver; Ontario had 73% of the nickel, 53% of the gold and 42% of the copper; and British Columbia had all of the molybdenum and 37% of the copper. There were no significant shifts in the standing of these provinces in 1992 compared to revised figures for 1991.

Quebec posted a considerable increase in zinc, copper and silver reserves during 1991 as a result of the first-time inclusion of the Louvicourt deposit in Canadian totals. Reserves fell in all other provinces and in the territories.

Reserve Trends

Reserves of base metals and precious metals generally rose from the mid-1970s to the early 1980s (Figure 1). Afterwards, reserves of base metals generally declined as a result of unreplaced production, write-offs of unprofitable portions of orebodies, the closure of uneconomic mines and the focus on exploration for gold. In contrast, gold reserves continued to rise until 1989. Since then, reserves of gold have been falling as well.

Compared to 1981, Canada's reserves of copper and nickel in January 1992 were down by about one third. They were down by over 40% for zinc and silver, down by half for lead, and down by more than two thirds for molybdenum. Although gold reserves have decreased in each of the past three years, their level in early 1992 was still about 90% higher than in 1981.

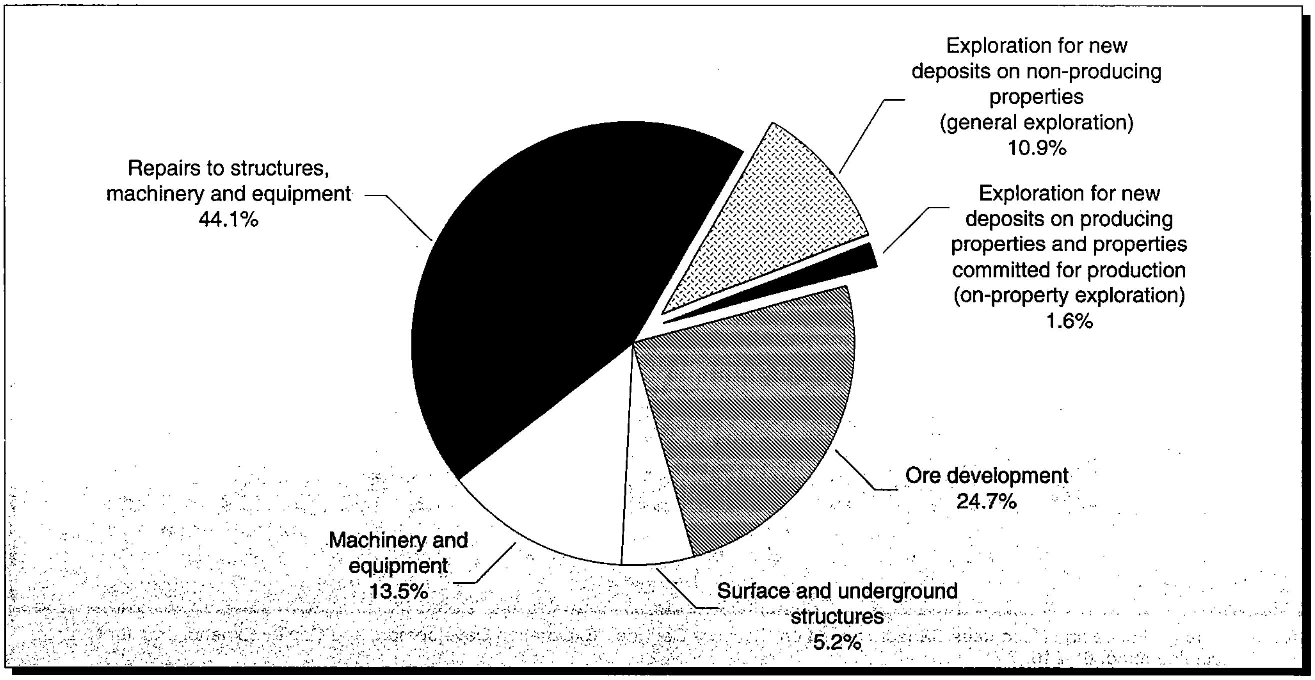
MINE INVESTMENT

In 1991, mine investment (including uncapitalized repairs) in Canada amounted to some $3.7 billion, more than 85% of the $4.3 billion (Figure 2) spent in total at all mines and on all exploration projects during that year. Compared with revised estimates for 1990, mine investment in 1991 (in constant dollars) was down by 17%.

Investment by Commodity

Producers of all nonmetallic mineral commodities invested $1.4 billion at Canadian mines during 1991. Coal producers alone invested $803 million

Figure 2
Mine and Exploration Investment in Canada, 1991
$4.3 Billion



SOURCE: Energy, Mines and Resources Canada, based on Statistics Canada, "Exploration Development and Capital Expenditures for Mining," catalogue no. 61-216.

and regained their position as the leading investors on a commodity basis (Figure 3). Investment by coal producers represents more than 20% of the Canadian total.

Producers of all metallic commodities invested $2.4 billion, with producers of base metals accounting for half of that amount. Producers of gold invested $556 million, down significantly from $837 million the previous year. Gold had been the leading commodity between 1987 and 1990.

Investment by Province and Territory

During 1991, some $2.4 billion in mine-site investment, about two thirds of the Canadian total, was made in Ontario, British Columbia and Quebec (Figure 4). These three provinces are the country's leading producers (in that order) of non-petroleum mineral commodities. In 1991, they accounted for 25%, 24% and 17% respectively of total mine-site investment in Canada.

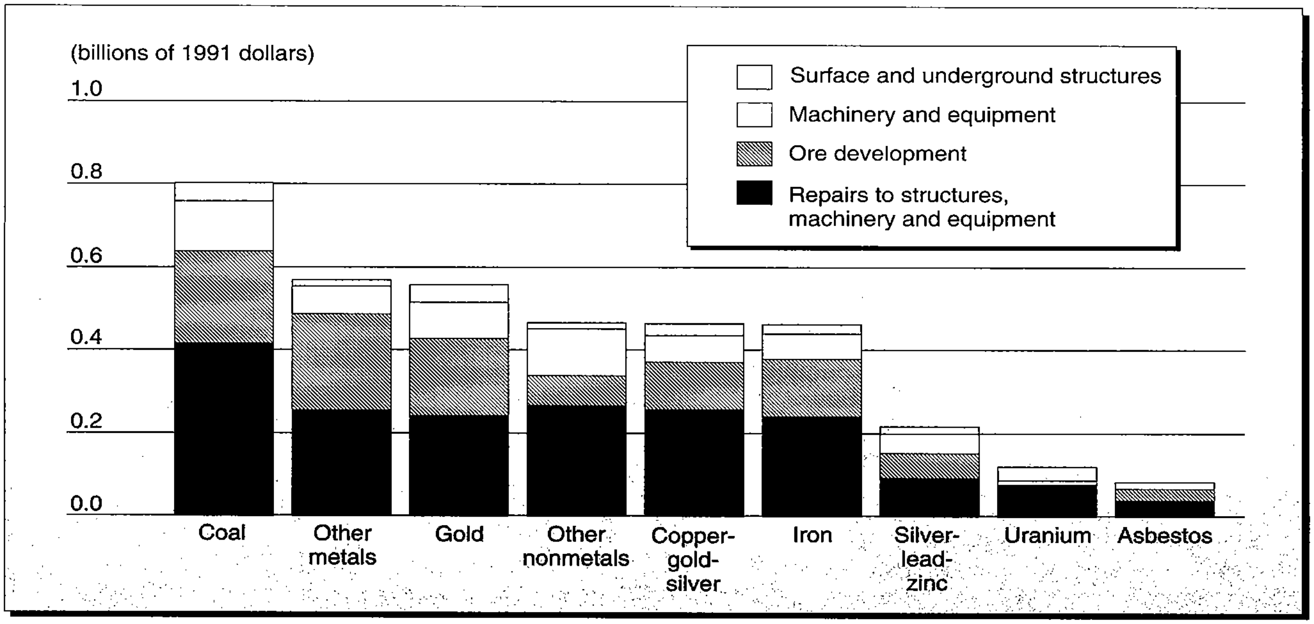
Investment by Category

Four categories are used to record mine-site investment in Canada: i) surface and underground structures, ii) machinery and equipment, iii) ore development, and iv) repairs (uncapitalized) to existing structures, machinery and equipment.

The repairs category is, by far, the largest of the four mine-site investment categories (Figure 5). In 1991, repairs amounted to about $1.9 billion, down by 11% compared with 1990. Repairs were more than half of total Canadian mine-site investment in 1991, the highest proportion in more than 20 years. Ore development (over $1 billion) held second place at 28%, new machinery and equipment ($579 million) accounted for 15%, and new structures ($221 million) made up the remaining 6%.

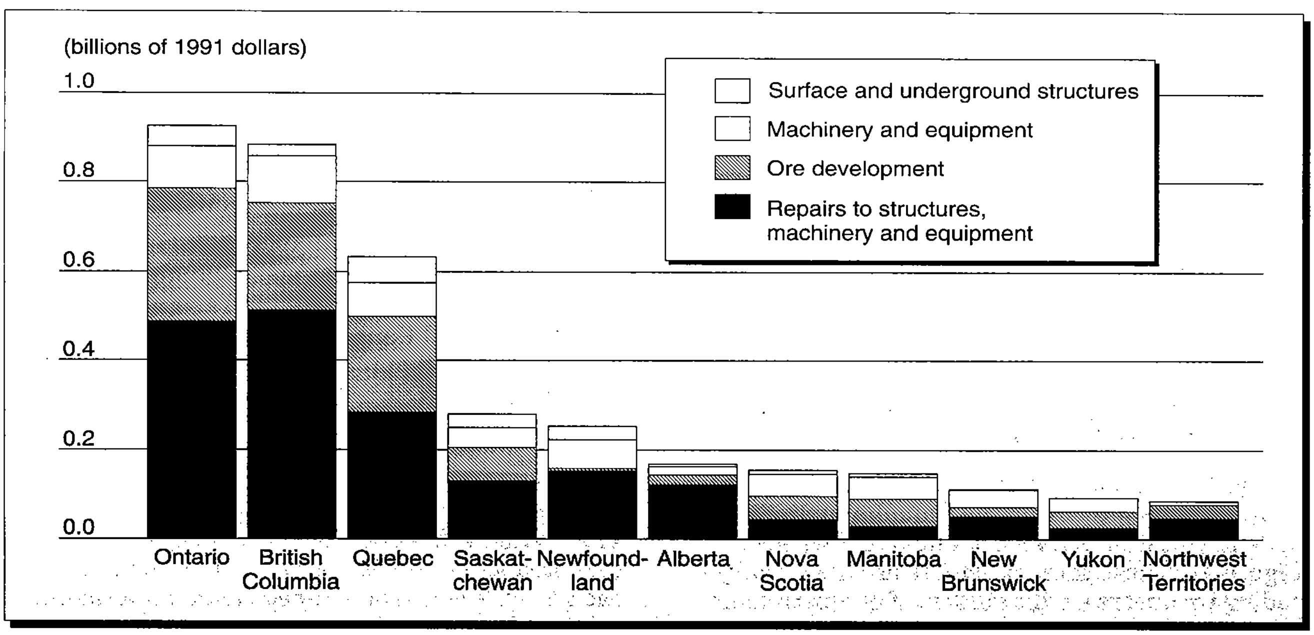
The revised value of Canada's non-petroleum mineral production in 1991 is some $17 billion. For each dollar's worth of non-petroleum mineral production, the mineral industry invested about 22 cents at mine sites, the same proportion as in the previous year (11 cents in repairs, 6 cents in development,

Figure 3
Mine Investment in Canada, 1991, by Industry Groups
$3.7 Billion



SOURCE: Energy, Mines and Resources Canada, based on Statistics Canada, "Exploration Development and Capital Expenditures for Mining," catalogue no. 61-216.

Figure 4
Mine Investment in Canada, 1991, by Province and Territory
$3.7 Billion



SOURCE: Energy, Mines and Resources Canada, based on Statistics Canada, "Exploration Development and Capital Expenditures for Mining," catalogue no. 61-216.

slightly more than 3 cents in machinery and equipment, and 1 cent in structures).

Investment Trends

Total annual mine-site investment in Canada (adjusted for inflation) has fallen over the last 10 years (Figure 5). In 1991, it was about half of the level of 1981, the year with the highest level of investment during the 1980s. This has occurred largely because investment in new structures, machinery and equipment, which is characteristic of the construction of new mines and of expansion to existing capacity, has been decreasing.

Investment in structures fell from $1.7 billion in 1981 to less than $1 billion annually after 1983. Investment in machinery and equipment, which generally stood at over $1 billion each year between 1980 and 1984, has also been falling, except for the 1988-89 period, when it rose temporarily to $900 million. By 1991, investment in machinery and equipment had fallen to less than $600 million annually.

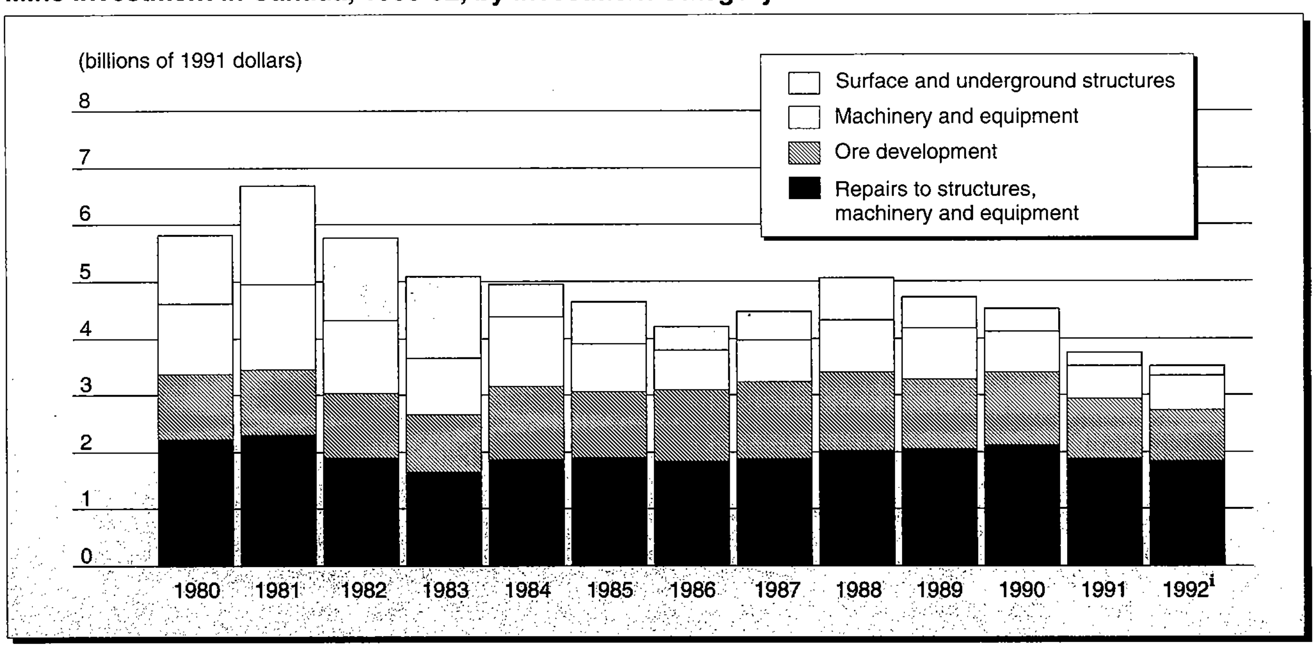
Investment in repairs and in ore development, which is more characteristic of ongoing mining operations, has been relatively constant since 1980. Together, repairs and development have hovered around $3 billion annually.

There was a considerable rise in total investment for nonmetallic minerals at the beginning of the 1980s. It reached some $2.6 billion in 1982. Based on statistics only available starting with the year 1983, coal producers were responsible for the increase in investment in 1983 and 1984. Subsequently, investment in nonmetallic mines fell steadily to $1.5 billion by 1987. Since then, total annual investment in nonmetallic mines has been falling more slowly.

There were two recent periods of exceptionally high investment in metallic minerals in Canada. The first occurred between 1980 and 1981, and the second between 1987 and 1990. Gold producers accounted for most of the temporary increase in metallic mine investment in the late 1980s, with gold investment reaching a high of $1.4 billion in 1988.

Company investment intentions (Figure 5) published in April 1992 suggest that, relative to 1991, total mine investment in Canada in 1992 is likely to have fallen a further 6%.

Figure 5
Mine Investment in Canada, 1980-92, by Investment Category



i Intentions.
SOURCE: Energy, Mines and Resources Canada, based on Statistics Canada, "Exploration Development and Capital Expenditures for Mining," catalogue no. 61-216.

Projects Announced During 1992

Fewer than a dozen new precious-metal and base-metal mine projects were announced in Canada during 1992 (Table 4). These projects are relatively small in size. Most of them are precious-metal mines.

Promising Deposits

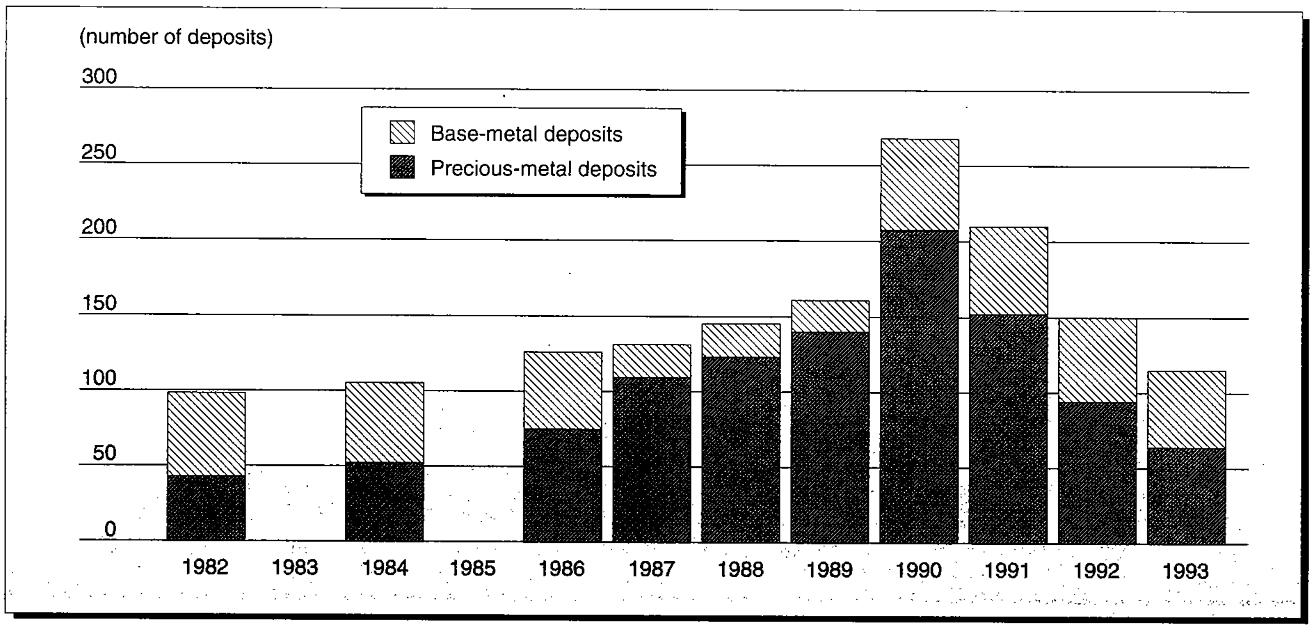
At the end of 1992, there were some 4600 active mineral properties in Canada. The lengthy process of exploration and economic evaluation that could lead to an eventual production decision is incipient on many of these properties. Compared with the total number of active properties, those that host a mineral deposit that has been substantially delineated and where economic mineability has been determined by a full and independent feasibility study are relatively few in number. At the end of 1992, the number of active mineral properties in Canada was down significantly from about 6700 in mid-1991.

In early 1993, 115 deposits containing base metals and precious metals appeared particularly promising for possible development into mines in the foreseeable future (Table 5). This assessment was made on the basis of the results of recent exploration programs reported by companies. Such an assessment is inherently subjective, and it may be biased in favour of those companies that are the most informative. Implicit in this assessment is the assumption that companies are focusing a good portion of their current resources on those properties that they believe have the best short-term prospect for production. Apart from the 115 metallic mineral deposits considered promising here, there are many more in Canada for which there are no published reports of exploration progress. Some of these deposits are also very likely to be developed into mines in the future.[3]

The number of precious-metal (mostly gold) and base-metal (mostly polymetallic) mineral deposits in Canada assessed as promising for possible future production has increased each year from 98 in early 1982 to 268 in early 1990 (Figure 6). Since 1991, the number of such deposits has been falling gradually because some companies are finding it difficult to raise the funds needed to continue their exploration programs.

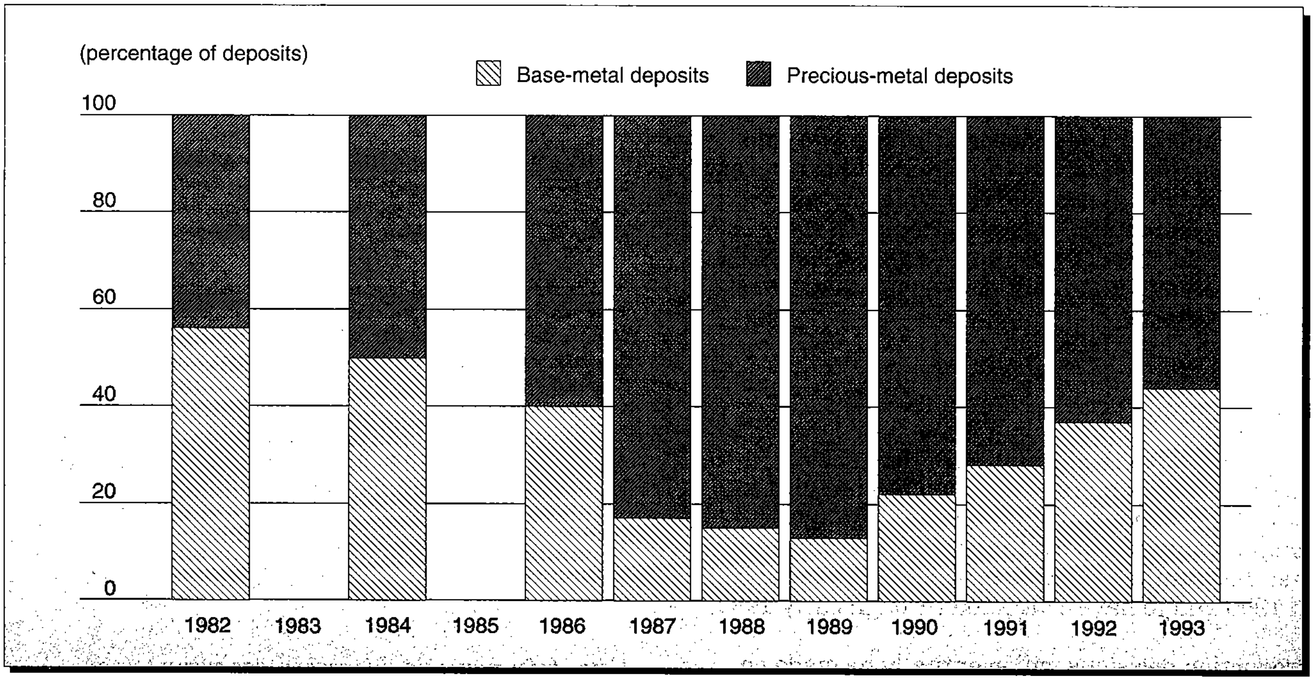
Of the 115 deposits assessed as promising in early 1993, Quebec accounts for 32 (29%), British Columbia for 30 (26%), and Ontario for 23 (20%).

Figure 6
Canadian Precious-Metal and Base-Metal Deposits Considered Promising for Future Production, 1982-93



NOTE: Data for 1983 and 1985 are not available.
SOURCE: Energy, Mines and Resources Canada, based on company reports.

Figure 7
Canadian Precious-Metal and Base-Metal Deposits Considered Promising for Future Production, 1982-93



NOTE: Data for 1983 and 1985 are not available.
SOURCE: Energy, Mines and Resources Canada, based on company reports.

In early 1993, there were 51 promising base-metal deposits in Canada. They accounted for 44% of all promising deposits, up from 37% in early 1992, and up from a low of 13% in early 1989 (Figure 7). In early 1982, base-metal deposits accounted for a high of 56% of all promising deposits. The number of promising base-metal deposits has returned to the level of the early 1980s. In the 1987-89 period, when gold was the main focus of exploration companies in Canada, the number of promising base-metal deposits had declined to slightly more than 20 annually.

There were 64 promising precious-metal deposits in early 1993. The number of these deposits increased steadily each year from 1982 to 1990 when it reached a high of 208. However, since 1991, it has fallen each year. Nonetheless, it remains above the level of the early 1980s.

Based on the in-situ value of contained copper, nickel, lead, zinc, molybdenum, silver and gold (or, where available, on the mineable value), the largest promising Canadian metallic mineral deposits are, in **British Columbia**: Kemess South (zinc, gold, copper), Windy Craggy (copper, gold, silver, cobalt), Fish Lake (copper, gold), Stronsay, previously called Cirque (zinc, lead, silver), Red Dog (zinc, copper, gold, molybdenum), Mt. Milligan (gold, copper), Kerr (copper, gold, silver), Expo, Hushamu Zone (copper, gold, molybdenum), Tulsequah Chief (zinc, gold, copper, silver, lead), Eskay Creek (gold, silver), Copper Canyon (copper, gold, silver), Kemess North (copper, gold), J&L (gold, zinc, lead, silver), and Mt. Polley, S19 pit (copper, gold); in **Quebec**: Dumont Nickel (nickel), Raglan (nickel, copper), MacLeod Lake (gold, copper, molybdenum), Grevet "M" (zinc, copper, silver), and Troilus, also known as Lac Frotet (gold, copper); in **Ontario**: McCreedy, new discovery (nickel, copper, precious metals), McCreedy East (nickel, copper, precious metals), Victor, 1991 discovery (nickel, copper, precious metals), Moss Lake (gold), Hemlo Interlake (gold), and Holloway, Lightning Zone (gold); in **Manitoba**: Minago (nickel); in the **Yukon**: DY, underground (zinc, lead, gold, silver); in the **Northwest Territories**: Izok Lake (zinc, copper, silver, lead), High Lake (copper, zinc, gold), and Inukshuk (gold, zinc, copper); in **Saskatchewan**: Hanson Lake, also known as McIlvenna Bay (zinc, copper, gold, silver); and in **New Brunswick**: Half-Mile Lake (zinc, lead, silver, copper).

These 31 properties account for over 90% of the estimated in-situ value of all deposits considered promising for future production in January 1993. Each of these deposits has an estimated in-situ value of at least $0.5 billion. Based on average metal prices for December 1992, zinc and copper each account for roughly 27% of the gross in-situ value of the estimated mineral inventory reported by companies for these deposits; nickel and gold account for about 22% each. In-situ value is a very rough indicator of possible economic interest. It does not take capital and operating costs into account, nor does it make any allowance for losses that are inherent in mining, concentrating, smelting and refining.

OUTLOOK

Compared with the beginning of the 1980s, reserves of base metals are down by one third to two thirds, depending on the metal. However, company interest in evaluating polymetallic base-metal deposits appears to have risen appreciably in 1990 and to have continued through early 1993.

Production decisions will eventually be made on some of these deposits. This could significantly change the mineral investment outlook for the next few years and contribute to the additional reserves required to sustain Canadian base-metal production in the coming years.

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1 A. Lemieux, L.S. Jen, D.A. Cranstone and G. Bouchard, *Canadian Mines: Perspective from 1992 – Production, Reserves, Development, Exploration*, Mineral Bulletin, 1993, Energy, Mines and Resources Canada, Ottawa, in preparation.

2 For the distribution of mine-by-mine net changes in gold reserves during 1988, see: A. Lemieux, "Canadian Reserves, Mine Investment, New Projects and Promising Deposits" in *Canadian Minerals Yearbook 1989*, Energy, Mines and Resources Canada, pp. 5.1-5.28.

3 See, for example, *Canadian Mineral Deposits Not Being Mined in 1989*, Mineral Bulletin MR 223, Energy, Mines and Resources Canada, 1990, Ottawa.

Note: Information in this review was current as at February 1, 1993.

TABLE 1. NEW MINING OPERATIONS AND COMMITMENTS TO PRODUCTION ADDED TO CANADIAN RESERVE TOTALS AS AT JANUARY 1, 1992

Operators and Major Partners	Operation	Province	Metals
Stratabound Minerals Corp.	Captain North Extension (CNE)	N.B.	Zinc, lead, silver
Louvem Mines Inc., Aur Resources Inc., and Teck Corporation	Louvicourt	Que.	Copper, zinc, silver, gold
Cambior inc.	Mouska	Que.	Gold, silver
Noranda Minerals Inc.	Norita East	Que.	Zinc, copper, silver, gold

Source: Energy, Mines and Resources Canada.

TABLE 2. CANADIAN RESERVES BY PROVINCE AND TERRITORY, JANUARY 1, 1992
(Metal Contained in Proven and Probable Mineable Ore[1] in Operating Mines[2] and Deposits Committed for Production)

Metal	Units[3]	Nfld.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	B.C.	Y.T.	N.W.T.	Canada[5]
Copper	000 t	–	–	238	1 601	4 695	422	3	4 156	–	–	11 115
Nickel	000 t	–	–	–	–	4 162	1 529	–	–	–	–	5 691
Lead	000 t	–	–	2 463	23	63	9	–	908	1 093	397	4 954
Zinc	000 t	–	–	6 156	1 732	2 213	887	4	1 889	1 957	1 609	16 448
Molybdenum	000 t	–	–	–	–	–	–	–	182	–	–	182
Silver	t	2	–	7 003	2 074	4 422	654	3	2 838	1 953	121	19 069
Gold[4]	t	27	–	46	342	766	29	14	103	24	95	1 433

Source: Energy, Mines and Resources Canada.
– Nil or less than one unit.
1 No allowance is made for losses in milling, smelting and refining. Excludes material classified as "possible." Includes "geological reserves" for some mines that do not report mineable ore. 2 Includes metal in mines where production has been suspended temporarily. 3 One tonne (t) = 1.1023113 short tons = 32 150.746 troy ounces. 4 Excludes metal in placer deposits. 5 May not balance due to rounding.

TABLE 3. CANADIAN RESERVES BY STANDARD INDUSTRIAL CLASSIFICATION, JANUARY 1, 1992
(Metal Contained in Proven and Probable Mineable Ore[1] in Operating Mines[2] and Deposits Committed for Production)

Metal	Units[3]	Gold Mines (0611)	Copper, Copper-Zinc Mines (0612)	Nickel-Copper Mines (0613)	Silver-Lead-Zinc Mines (0614)	Molybdenum Mines (0615)	Canada[5]
Copper	000 t	44	7 246	3 502	323	–	11 115
Nickel	000 t	–	–	5 691	–	–	5 691
Lead	000 t	–	129	–	4 825	–	4 954
Zinc	000 t	–	4 527	–	11 921	–	16 448
Molybdenum	000 t	–	76	–	–	106	182
Silver	t	387	6 495	2 123	10 064	–	19 069
Gold[4]	t	1 147	140	64	82	–	1 433

Source: Energy, Mines and Resources Canada.
– Nil or less than one unit.
1 No allowance is made for losses in milling, smelting and refining. Excludes material classified as "possible." Includes "geological reserves" for some mines that do not report mineable ore. 2 Includes metal in mines where production has been suspended temporarily. 3 One tonne (t) = 1.1023113 short tons = 32 150.746 troy ounces. 4 Excludes metal in placer deposits. 5 May not balance due to rounding.

TABLE 4. PRECIOUS-METAL AND BASE-METAL MINING PROJECTS ANNOUNCED IN CANADA DURING 1992

Companies	Projects	Metals	Start-Up Year	Incremental Project Budget
				($ milllions)
PRECIOUS METALS				
Cambior inc. and Aurizon Mines Ltd.	Reactivation of **Sleeping Giant**[1] underground mine at 400 t/d, Amos area, Quebec.	Gold, silver	1993	5.6
Deak Resources Corporation and Yorbeau Resources Inc.	New 450-t/d **Astoria** underground mine, Rouyn-Noranda area, Quebec.	Gold, silver	1992	..
Western Quebec Mines Inc.	New 160-t/d **Joubi** underground mine,[2] Val-d'Or area, Quebec.	Gold, silver	1992	..
Deak Resources Corporation and Northfield Minerals Inc.	Reactivation of **Cheminis** mine,[3] at 450 t/d, Kirkland Lake area, Ontario.	Gold, silver	1992	..
Royal Oak Mines Inc.	Reactivation of **Porcupine Peninsular**[4] (Nighthawk Lake) mine at 600 t/d, Timmins area, Ontario.	Gold, silver	1993	..
Equity Silver Mines Limited	New 1100-t/d **Equity Silver** underground mine, Houston area, British Columbia.	Silver, gold, copper	1992	1.2
Subtotal				..
BASE METALS AND BY-PRODUCTS				
NovaGold Resources Inc.	New 250-t/d **Murray Brook** open-pit mine and biological heap leaching operation, Bathurst area, New Brunswick.	Copper	1992	0.5
Falconbridge Limited	New 500-t/d **Thayer Lindsley** underground mine, Sudbury area, Ontario.	Copper, nickel, silver, gold, cobalt, platinum, palladium	1992	..
Subtotal				..
Total, all metals				..

Source: Energy, Mines and Resources Canada, based on press reports.
. . Not available.
[1] The Sleeping Giant mine was previously in operation from May 1988 to May 1991. [2] Includes the Dubuisson East property. [3] The Cheminis mine produced 37 kg (1200 ounces) of gold in late 1991. [4] The Porcupine Peninsular mine produced more than 840 kg (27 000 ounces) of gold from 1924 to 1927.

TABLE 5

TONNAGE AND GRADE OF BASE-METAL AND PRECIOUS-METAL DEPOSITS CONSIDERED, IN JANUARY 1993, PROMISING FOR FUTURE PRODUCTION
(These deposits are not included in Canadian reserves.)

- DEPOSITS: Individual deposits have been selected on the basis of public information available during 1992. Deposits committed for production as at January 1, 1993, are not included.
- TONNAGE and GRADE: As reported by companies or, where necessary, from the secondary source that appeared to be the most reliable. Imperial units reported were converted to metric units and rounded. Tonnage and grade descriptions such as "probable and possible" are those reported by companies.
- COMPANIES: Where two or more companies are identified with a deposit, the first is usually the operator.

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE[1]	GRADE[2] Cu	Ni	Pb	Zn	Mo	Ag	Au
			(tonnes)	(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
NEWFOUNDLAND										
Rambler - Ming West	Newfoundland Exploration Company Limited Teck Corporation	Drill indicated geological	100 000	5.6	–	–	0.37	–	–	2.4
Rambler - tailings	Newfoundland Exploration Company Limited	Potential mineable	1 163 671	0.31	–	–	–	–	–	1.7
Rendell-Jackman	Major General Resources Ltd.	Mineable	363 000	–	–	–	–	–	–	12.5
NEW BRUNSWICK										
Half-Mile Lake	Noranda Minerals Inc. Conwest Exploration Company Limited	Undiluted geological	5 300 000	0.08	–	3.25	10.26	–	29.	–
Restigouche	Marshall Minerals Corp.		1 570 000	0.34	–	5.36	6.94	–	112.	1.2
QUEBEC										
Abitibi Copper	Aur Resources Inc. Consolidated Abitibi Resources Limited		1 200 000	0.75	–	–	–	–	–	–
Aiguebelle-Fayolle zone	Ressources Orco Inc. Minnova Inc. Cameco Corporation		207 825	–	–	–	–	–	–	7.26
Aldermac	Deak Resources Corporation	Diluted inventory	1 373 000	1.8	–	–	4.6	–	35.0	0.55
Arntfield	Deak Resources Corporation Noranda Minerals Inc. Nova-Cogesco Resources Inc.	Diluted inventory	633 000	–	–	–	–	–	–	4.83
Benoît (Lac Pusticamica)	Minnova Inc. Freewest Resources Inc.		3 000 000	0.14	–	–	–	–	7.30	2.6

Casa Berardi - Principal (including Domex claims)	TVX Gold Inc. Golden Knight Resources Inc.	Mineable	2 188 000	–	–	–	–	–	–	6.2
Chevrier (Obatogamau)	Minnova Inc. Fancamp Resources Ltd.	Inventory	8 800 000	–	–	–	–	–	–	2.11
Dalquier - Main and Lower zones	Aur Resources Inc. Jonpol Explorations Limited	Geological	2 699 000	1.26	–	–	0.9	–	38.4	0.09
Douay - 531 zone	Société d'Exploration Minière Vior Inc.	Drill indicated	538 000	–	–	–	–	–	–	4.8
Douay - Main zone	Société d'Exploration Minière Vior Inc.		220 000	–	–	–	–	–	–	9.6
Douay - West zone	Société d'Exploration Minière Vior Inc.		583 000	–	–	–	–	–	–	9.9
Doyon - Warrenmac zone	Lac Minerals Ltd. Cambior inc.	Mineral inventory	170 000	–	–	–	3.2	–	27.	6.9
Doyon - Westwood zone	Lac Minerals Ltd. Cambior inc.	Mineral inventory	417 000	–	–	–	–	–	–	9.3
Dumont Nickel (Launay-Trecesson)	Timmins Nickel Inc. Dumont Nickel Corporation (NPL)		486 000 000	–	0.39	–	–	–	–	–
Duquesne mine	Radisson Mining Resources Inc.	Probable and possible	678 822	–	–	–	–	–	–	8.56
Eastmain	Meston Lake Resources Inc. MSV Resources Inc.	Proven and probable	863 988	–	–	–	–	–	–	11.94
Goldex - Extension zone	Goldex Mines Limited Ormico Exploration Ltée	Bulk inventory	12 000 000	–	–	–	–	–	–	3.1
Grevet "B"	VSM Exploration Inc. Sérem-Québec Inc.	Diluted probable mining reserves	477 000	0.58	–	–	9.67	–	24.00	–
Grevet "M" - zones III, IV and 97	VSM Exploration Inc. Sérem-Québec Inc.	Diluted probable and possible mining reserves	12 264 000	0.49	–	–	8.92	–	36.70	–
Hebecourt (New Insco)	Deak Resources Corporation Noranda Minerals Inc.	Diluted inventory	658 000	2.80	–	–	–	–	–	–
MacLeod Lake - Main zone	Windy Mountain Explorations Ltd.		37 000 000	0.44	–	–	–	0.05	–	–
Magusi (West, East, FW zones)	Deak Resources Corporation	Diluted inventory	2 459 777	1.9	–	–	2.85	–	34.	0.98
Pelletier Lake - Zones 1, 2, 3 and 4	Thunderwood Resources Inc. Falconbridge Limited	Drill indicated	490 100	–	–	–	–	–	–	8.6
Raglan (several deposits)	Falconbridge Limited		16 800 000	0.88	3.13	–	–	–	–	–
Scott Lake	Thunderwood Resources Inc. Greenstone Resources Ltd.	Geological	705 000	0.41	–	6.87	–	–	12.	0.3
Taché - Main zone	Teck Corporation Bitech Corporation Greenstone Resources Ltd.	Probable and possible	1 399 000	–	–	–	3.31	–	–	1.9

TABLE 5 (cont'd)

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE[1]	GRADE[2] Cu	Ni	Pb	Zn	Mo	Ag	Au
			(tonnes)	(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
QUEBEC (cont'd)										
Troilus (Lac Frotet)	Minnova Inc.	Open-pittable drill indicated geological	36 000 000	0.2	–	–	–	–	–	1.6
Val St. Gilles mine	Ressources Minières Canaco Ltd. First Standard Mining Ltd.	Estimated	92 500	–	–	–	–	–	69.	12.
Vezza	Agnico-Eagle Mines Limited	Preliminary	1 940 000	–	–	–	–	–	–	5.04
West MacDonald (Gallen)	Deak Resources Corporation Noranda Minerals Inc.	Diluted inventory	1 052 000	0.20	–	–	7.50	–	32.	1.3
Yasinski Lake - copper, nickel	Resources Minières Platinor Inc. Ressources Minières Augyva Inc.		357 000	0.28	0.55	–	–	–	–	–
Yasinski Lake - gold	Resources Minières Platinor Inc. Ressources Minières Augyva Inc.		92 000	–	–	–	–	–	–	3.11
ONTARIO										
Beatty Hislop	Hemlo Gold Mines Inc. Glimmer Resources Inc.	Preliminary	968 190	–	–	–	–	–	–	11.6
Buffonta (New Buffonta)	Gwen Resources Ltd. Deak Resources Corporation	Drill indicated	363 000	–	–	–	–	–	–	5.1
Craig-Ulster	Stralak Resources Inc. Coexco Petroleum Inc.		748 553	0.33	–	0.61	4.51	–	68.2	–
Duport (Shoal Lake)	Consolidated Professor Mines Limited	Geological	1 800 000	–	–	–	–	–	–	12.
Edwards (Jacobson Twp.)	Spirit Lake Explorations Limited		251 629	–	–	–	–	–	–	19.
Garrison Twp.	Jonpol Explorations Limited T & H Resources Ltd.	Drill indicated	465 000	–	–	–	–	–	–	9.6
Hemlo-Interlake	Hemlo Gold Mines Inc. Teck Corporation Franco-Nevada Mining Corporation Limited		8 600 000	–	–	–	–	–	–	6.34
Hislop	Hemlo Gold Mines Inc. Glimmer Resources Inc.	Geological	983 699	–	–	–	–	–	–	11.6
Hislop - Creek and Main zones	Stroud Resources Ltd.	Drill proven and drill indicated	1 014 465	–	–	–	–	–	–	6.31

Halloway (Lightning zone)	Hemlo Gold Mines Inc. Freewest Resources Inc. Teddy Bear Valley Mines Ltd.		5 000 000	–	–	–	–	–	–	9.6
Lac des Iles[3]	Madeleine Mines Ltd. Boston Bay Mines Ltd.	Probable	6 700 000	0.1	0.1	–	–	–	–	0.34
Madsen mine	Madsen Gold Corp.	Geological	635 000		–	–	–	–	–	11.6
Marathon[4]	Fleck Resources Ltd.	Near surface	32 000 000	0.37	0.047	–	–	–	1.57	0.09
McCreedy East[6]	Inco Limited		23 100 000	0.76	1.74	–	–	–	..	..
McCreedy[7] (New Discovery West of McCreedy East)	Inco Limited	Proven-probable	5 400 000	0.63	8.83	–	–	–	..	..
Moss Lake	Hemlo Gold Mines Inc. Central Crude Limited Storimin Exploration Limited Tandem Resources Ltd.	Probable and possible	74 583 172	–	–	–	–	–	–	1.1
Omega	Hemlo Gold Mines Inc. Greater Lenora Resources Corporation		244 880	–	–	–	–	–	–	5.49
Owl Creek West	Falconbridge Gold Corporation Thunderwood Resources Inc.		148 000	–	–	–	–	–	–	8.6
Pick Lake	Minnova Inc.		1 600 000	1.1	–	–	17.7	–	–	–
Robertson Twp.	Queenston Mining Inc. Strike Minerals Inc.	Preliminary	363 000	1.1	–	–	3.8	–	–	–
Rundle	Rundle Gold Mines Inc.	Inventory	535 000	–	–	–	–	–	–	6.5
Springpole	Akiko-Lori Resources Ltd. Gold Canyon Resources Ltd.		607 826	–	–	–	–	–	–	7.2
Victor (1991 discovery)[5]	Inco Limited	Proven-probable	6 200 000	7.e	2.e	–	–	–	..	..
MANITOBA										
Bucko Lake	Falconbridge Limited		2 500 000	0.17	2.23	–	–	–	–	–
MacBride Lake	Bellex Mining Inc. Eastmin Resources Inc. Kancana Ventures Ltd.	Drill indicated	1 800 000	0.35	–	–	8.77	–	..	..
Minago	Black Hawk Mining Inc.	Geological	10 502 000	–	1.19	–	–	–	–	–
Puffy Lake mine	Pioneer Metals Corporation	Proven, probable and possible	2 150 000	–	–	–	–	–	–	7.2
San Antonio	Rea Gold Corporation	Diluted proven, probable and possible	1 361 000	–	–	–	–	–	–	7.41
Snow Lake (tailings)	Sikaman Gold Resources Ltd.		274 000	–	–	–	–	–	–	12.

TABLE 5 (cont'd)

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE[1]	GRADE[2]						
				Cu	Ni	Pb	Zn	Mo	Ag	Au
			(tonnes)	(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
SASKATCHEWAN										
Bigstone Lake	Granges Inc. Cameco Corporation		3 583 000	1.8	–	–	1.1	–	–	–
Contact Lake - Bakos zone	Cameco Corporation Uranerz Exploration and Mining Limited Westward Explorations Ltd.	Mineable	1 065 000	–	–	–	–	–	–	7.8
Contact Lake - Pap zone	Cameco Corporation Uranerz Exploration and Mining Limited Westward Explorations Ltd.	Geological	365 000	–	–	–	–	–	–	12.1
Hanson Lake	Cameco Corporation Billiton Resources Canada Inc.	Probable mineable	13 182 000	0.83	–	–	4.66	–	..	..
Komis	Waddy Lake Resources Inc.	Probable drill indicated geological	509 000	–	–	–	–	–	–	15.
Weedy Lake - B zone	Tyler Resources Inc. Golden Rule Resources Ltd. Cameco Corporation	Geological	314 000	–	–	–	–	–	–	4.8
Weedy Lake - Golden Heart	Tyler Resources Inc. Golden Rule Resources Ltd. Cameco Corporation	Geological	687 010	–	–	–	–	–	–	10.
BRITISH COLUMBIA										
Bralorne Pioneer mine	Avino Mines & Resources Ltd.	Proven, probable and possible	292 000	–	–	–	–	–	–	12.
Copper Canyon	Fairhaven Resources Ltd. Canamax Resources Inc.	Preliminary geological	32 400 000	0.75	–	–	–	–	17.	1.2
Debbie and Yellow	Westmin Resources Limited	Probable and possible geological	471 956	–	–	–	–	–	–	6.27e
Eskay Creek	Prime Resources Group Inc. Stikine Resources Ltd.	Indicated probable geological	1 080 000	–	–	–	–	–	2931.	65.5
Expo - Hushamu zone	Jordex Resources Inc. Moraga Resources Ltd. BHP-Utah Mines Ltd.	Mineable open pit	173 000 000	0.25	–	–	–	0.010	–	0.3
Fish Lake	Taseko Mines Ltd. Cominco Ltd.	Preliminary	670 000 000	0.28	–	–	–	–	–	0.51

Frasergold	ASARCO Incorporated Eureka Resources, Inc.	Drill indicated reserve base	11 000 000	–	–	–	–	–	–	2.e
Gibraltar North	Newcoast Silver Mines Ltd. Gibraltar Mines Ltd.	Mineable	45 000 000	0.4	–	–	. .	–	. .	. .
J&L - Main and Yellowjacket	Cheni Gold Mines Inc. Equinox Resources Ltd. Pan American Minerals Corp.	Probable and possible	5 677 000	–	–	2.7	4.8	–	69.	6.0
Kemess-North	El Condor Resources Ltd.	Geological	116 000 000	0.19	–	–	–	–	–	0.38
Kemess-South	St. Philips Resources Inc. El Condor Resources Ltd.	Mineable	207 000 000	0.23	–	–	–	–	–	0.65
Kerr	Placer Dome Inc.	Mineral-bearing material	125 700 000	0.62	–	–	–	–	2.4e	0.3
Mascot Fraction	Caledonia Mining Corporation		756 296	–	–	–	–	–	–	4.5
Mt. Milligan	Placer Dome Inc.	Mineable	298 000 000	0.22	–	–	–	–	–	0.45
Mt. Polley (S-19 Pit)[8]	Imperial Metals Corporation	Mineable	49 000 000	0.383	–	–	–	–	–	0.556
Polaris Taku	Suntac Minerals Corporation Canarc Resource Corp. Rembrandt Gold Mines Ltd.	Probable and possible geological	2 587 000	–	–	–	–	–	–	14.6
Porcher Island - AT zone	Cathedral Gold Corporation	Proven, probable and possible	1 332 263	–	–	–	–	–	–	6.96
Red Dog - Red Dog Hill zone	Crew Natural Resources Ltd.	Preliminary pit layout	41 050 000	0.26	–	–	–	0.006	–	0.3
Red Mountain - Marc zone	Lac Minerals Ltd.	Geologic resource	846 000	–	–	–	–	–	–	13.
Seneca (Agassiz-Weaver)	Minnova Inc. International Curator Resources Ltd.		1 506 400	0.65	–	–	3.57	–	41.	0.82
Similco Mine - Alabama	Princeton Mining Corporation	Possible	9 000 000	0.32	–	–	–	–	–	. .
Siwash North (Elk)	Fairfield Minerals Ltd.	Drill indicated	308 000	–	–	–	–	–	25.	22.2
Ski (Eskay Creek)	Adrian Resources Ltd.		238 000	–	–	–	–	–	987.	22.
Spectrum	Columbia Gold Mines Ltd. Norcal Resources Ltd. International Northair Mines Ltd.		591 000	–	–	–	–	–	–	11.
Stronsay (Cirque)[9]	Curragh Inc.	Drill indicated	52 200 000	–	–	2.	8.	–	. .	–
Tam - Boundary	Varitech Resources Ltd. Major General Resources Ltd.		6 500 000	0.55	–	–	–	–	. .	. .
Tulsequah Chief	Redfern Resources Ltd.	Geological	7 800 000	1.60	–	1.18	6.47	–	110.	3.
Vine	Consolidated Ramrod Gold Corporation Cominco Ltd.	Proven and probable	545 000	–	–	4.65	2.39	–	51.83	1.82

TABLE 5 (cont'd)

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE[1]	GRADE[2] Cu	Ni	Pb	Zn	Mo	Ag	Au
			(tonnes)	(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
BRITISH COLUMBIA (cont'd)										
Windy Craggy[10]	Geddes Resources Limited	0.50% Cu cutoff grade	297 439 000	1.38	–	–	. .	–	. .	0.20
NORTHWEST TERRITORIES										
Con mine - tailings	NERCO, Inc.		5 173 000	–	–	–	–	–	.3[e]	1.
High Lake	Aber Resources Ltd. Kennecott Canada Inc.		4 500 000	3.5	–	–	2.5	–	–	0.79
Inukshuk	Minnova Inc.	Preliminary	2 000 000	2.	–	–	8.	–	–	–
Izok Lake	Minnova Inc.	Geological	13 600 000	2.5	–	1.6	14.6	–	77.7	–
Nicholas Lake - main showing	Athabasca Gold Resources Ltd. Royal Oak Mines Inc.	Probable and possible	858 000	–	–	–	–	–	–	16.
Prairie Creek Mine	San Andreas Resources Corp.	Proven, probable and possible	1 809 000	0.42	–	10.8	11.75	–	182.	–
Ren	Westview Resources Inc. Cominco Ltd.	Potential	2 000 000	–	–	–	–	–	–	9.9
YUKON TERRITORY										
Brewery Creek	Loki Gold Corporation Hemlo Gold Mines Inc.	Geological	14 739 600	–	–	–	–	–	–	1.9
DY (underground)	Curragh Inc.	Diluted probable	11 300 000	–	–	5.82	6.84	–	83.0	0.93
Mt. Nansen	B.Y.G. Natural Resources Inc.	Proven, probable and possible	953 383	–	–	–	–	–	190.	9.39
Mt. Skukum and Skukum Creek - Rainbow, Kuhn and Lake zones	Wheaton River Minerals Ltd.		522 627	–	–	–	–	–	24.9	9.57
Williams Creek (oxide)	Thermal Exploration Company Western Copper Holdings Limited	Mineable	10 500 000	1.08	–	–	–	–	–	0.45

Source: Energy, Mines and Resources Canada. Based on public company reports.
– Nil; . . Not available; [e] Author's estimate.
[1] One tonne = 1.1023113 short tons. [2] One gram per tonne (g/t) = 0.02916668 troy ounces per short ton. [3] The Lac des Isles deposit also contains palladium and platinum. [4] The Marathon deposit also contains cobalt, platinum, palladium and rhodium. [5] The Victor deposit also contains palladium and platinum. [6] McCreedy East is Inco's largest known undeveloped nickel-copper deposit in the Sudbury Basin. This deposit is expected to be in production in 1993/94. It also contains precious metals. [7] The new McCreedy discovery is expected to be in production in 1993/94 along with the McCreedy East deposit. It also contains precious metals. [8] A mine development certificate was issued in 1992 by the government of British Columbia to Imperial Metals Corp. for the development of the Mt. Polley deposit. [9] A mine development certificate was issued in 1992 by the government of British Columbia to Curragh's subsidiary, Stronsay Corporation, for the development of the Stronsay deposit. [10] The Windy Craggy deposit also contains cobalt.

Canadian Mineral Exploration

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The Federal-Provincial Exploration Survey

The year 1991 is the third year in which Energy, Mines and Resources Canada (EMR) coordinated the collection of all statistics for expenditures on general exploration, while Statistics Canada coordinated the collection of statistics for on-property (mine-site) exploration that are required for the preparation of Canada's National Accounts. Both federal agencies cooperate with the provinces to assemble and publish the comprehensive national exploration statistics that are presented in this chapter.

Activity

Exploration Expenditures, 1991

In 1991, there were 732 companies that were project operators of Canadian non-petroleum exploration projects, down from 936 companies in 1990. Exploration expenditures in Canada totalled $532 million, down from $775 million in 1990. Expenditures by senior companies were $416 million and by junior companies, $116 million. General exploration expenditures totalled $465 million. The remaining $67 million was for on-property (mine-site) exploration, defined as the search for new mines on the properties of existing mines.

Flow-Through Shares as a Source of Financing

EMR estimates that companies listed on Canadian stock exchanges sold about the same dollar value of flow-through shares in 1992 as they did in 1991 ($40 million). In 1991, funds raised through the issue of flow-through shares (Table 1) financed about 8% of Canadian exploration expenditures. In 1992, the funds financed an estimated 9% of such outlays.

Claim Staking

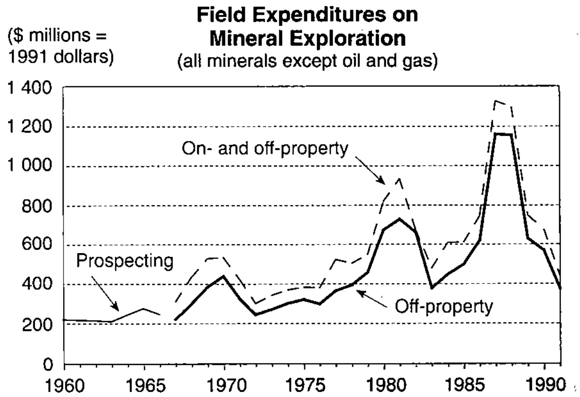
The area of mineral claims staked in Canada in 1992 was almost 36.7 million hectares (ha), an area that probably constitutes an all-time annual Canadian record for claim staking. The area staked in 1992 (Table 2, Figure 1) was up in all provinces and territories except for Newfoundland, New Brunswick and British Columbia; with the possible exception of northeastern British Columbia, none of these three provinces appear to have potential for the discovery of diamond deposits, which may constitute part of the explanation for the declines.

Almost 7.2 million ha were staked in the Northwest Territories in 1992, up from 2.2 million ha in 1991 and 355 000 ha in 1990. The increases in the area staked in the Northwest Territories in 1991 and 1992 were related to a general upsurge in Canadian diamond exploration over the past few years, but principally to the discovery of a number of kimberlite intrusions in Canada (a significant number of which contain diamonds) and to the discovery in the Northwest Territories of at least one diamond deposit (in kimberlite) that may prove to be an economic diamond mine.

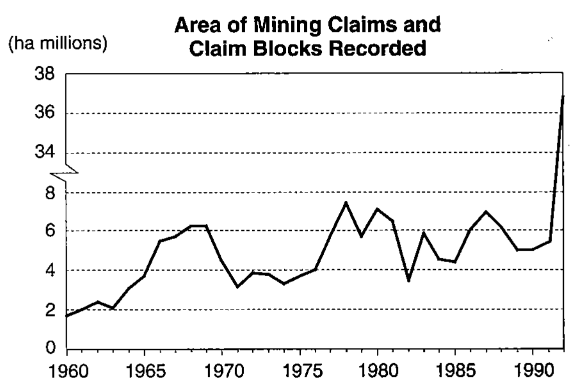
In Saskatchewan, 897 315 ha were staked in 1992, an area more than three times the 274 242 ha staked in 1991. As in the Northwest Territories, this increase is explained by the search for diamonds, as several dozen kimberlite intrusions have been found in the province to date, a significant number of which contain micro-diamonds, macro-diamonds, or both. The promising Point Lake diamond deposit discovered in the Northwest Territories has also strongly affected staking and diamond exploration in nearby provinces.

An incredible staking rush in Alberta in December 1992 resulted in at least 26.1 million ha of mining claims being taken up by various companies in the rush to find diamonds. The 26.1 million ha constitutes almost 40% of the total area of Alberta.

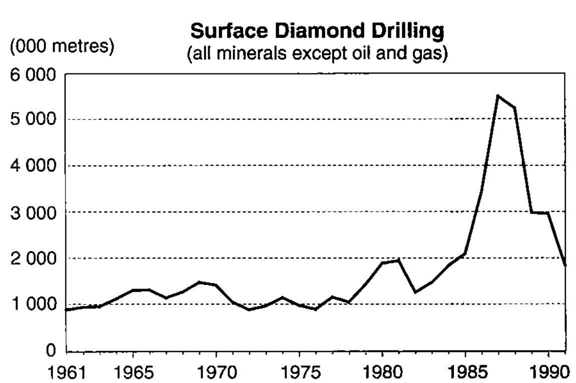
Figure 1
Selected Measures of Exploration Activity



NOTE: Adjusted to 1991 dollars using Gross National Product deflator series.
SOURCES: 1960-66, Statistics Canada, General Review of the Mineral Industries, Mines, Quarries and Oil Wells (cat. no. 26-201), and Energy, Mines and Resources Canada; 1967-87, Statistics Canada, Exploration, Development and Capital Expenditures for Mining and Petroleum and Natural Gas Wells, Intentions (cat. no. 61-216, formerly cat. no. 61-007); 1988-91, Federal-Provincial Survey of Mining and Exploration Companies.



SOURCES: Information gathered annually by Energy, Mines and Resources Canada from Provincial and Territorial Mining Recorders.



NOTE: Drilling statistics for 1961-84 are not strictly comparable to and may be understated relative to those for 1985-91.
SOURCES: 1961-84, Statistics Canada, General Review of the Mineral Industries, Mines, Quarries and Oil Wells (cat. no. 26-201); 1985-91, Federal-Provincial Exploration Survey.

Exploration Drilling

In 1991, 2 094 843 m of surface exploration drilling were drilled in Canada (Table 3, Figure 1), down by 34% from the 3 191 936 m drilled in 1990. Diamond drilling (1 861 993 m) constituted 89% of the total metres drilled. Exploration drilling expenditures (for surface and underground diamond and other types of drilling) accounted for 43% of 1991 Canadian field exploration expenditures and for 35% of total 1991 Canadian exploration expenditures (including overhead costs). Underground exploration drilling (diamond drilling plus other types of exploration drilling) totalled 480 166 m, significantly less than the 751 600 m of such drilling in 1990.

Exploration Expenditures by Province and Territory, 1991

Measured in terms of exploration expenditures, the most active exploration areas in 1991 (Tables 7 and 14, Figure 2) were Quebec ($138.1 million), British Columbia ($135.7 million), and Ontario ($109.7 million). These three provinces accounted for 72% of total Canadian mineral exploration expenditures in 1991.

In 1991, exploration expenditures were down in all provinces and territories relative to 1990. The percentage decreases in expenditures were as follows: Nova Scotia, 59%; Newfoundland, 48%; British Columbia, 40%; Alberta, 38%; Quebec, 30%; Ontario and Manitoba, 28%; Saskatchewan, 25%; the Yukon Territory, 10%; and the Northwest Territories, 8%. There was only an insignificant decline in New Brunswick. For the exploration time series beginning with 1985, measured in constant 1991 dollars, exploration expenditures were at their lowest level since 1985 or earlier for Newfoundland, Nova Scotia, Quebec, Ontario, Manitoba, Saskatchewan and the Northwest Territories. For many provinces and territories, it is not possible to make such comparisons prior to 1985 because data for those provinces and territories were published by Statistics Canada in groups such as "Atlantic Provinces," "Prairie Provinces" and "Territories." For some provinces, to preserve the confidentiality of corporate data, provincial totals for on-property exploration were kept confidential.

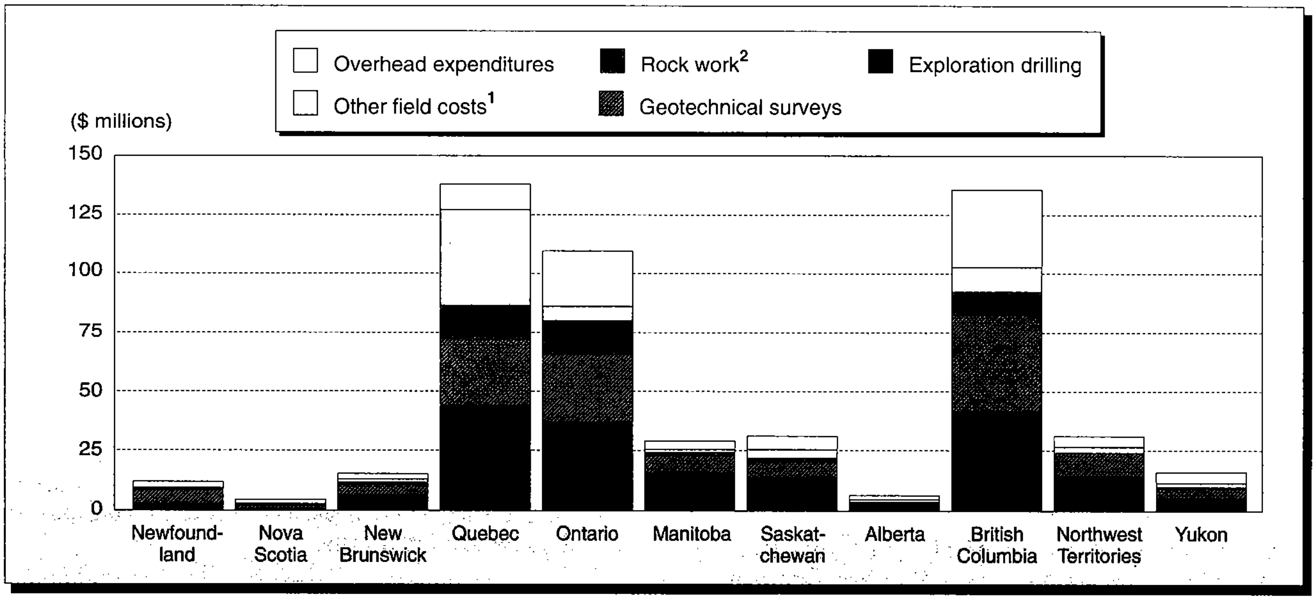
Expenditures by Commodity Sought, 1991

Precious metals and base metals remained the principal Canadian exploration target in 1991 (Tables 4 and 5, Figure 3). Some $274 million, an

Figure 2

Exploration Expenditures, by Province and Territory, 1991

Physical Work and Surveys



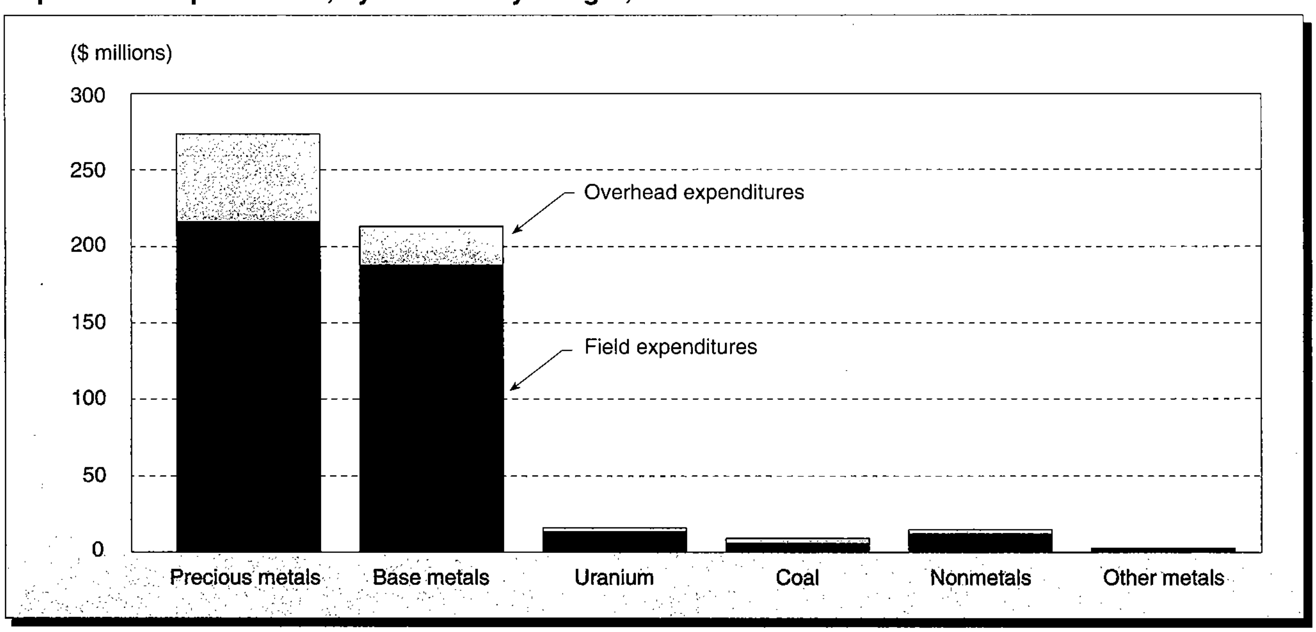
1 Such as field supervision and line cutting.

2 Such as stripping, trenching, shaft-sinking and underground work.

SOURCE: Federal-Provincial Survey of Mining and Exploration Companies.

Figure 3

Exploration Expenditures, by Commodity Sought, 1991[1]



1 Some $2.9 million of exploration expenditures were for unspecified commodities. This amount has been pro-rated among the six commodity groups shown here.

SOURCE: Federal-Provincial Survey of Mining and Exploration Companies.

amount equal to 52% of total Canadian exploration expenditures, was directed at precious metals exploration, mainly at gold. Exploration expenditures for the platinum group of precious metals amounted to $7.8 million, up from $5.4 million in 1990. In comparison, exploration expenditures for the platinum group were $8.0 million in 1989 and $19.5 million in 1988. Exploration expenditures for base metals ($214 million) accounted for 40% of total Canadian exploration expenditures in 1991. Some $7 million was spent on exploration for diamonds in 1991, about the same as the $7.7 million spent in 1990.

Relative to 1990, exploration expenditures in 1991 were down by 41% for precious metals, by 11% for base metals, by 34% for uranium, and by 23% for coal.

Regional Expenditures by Commodity Sought, 1991

Precious metals (almost entirely gold) were the principal exploration targets in Quebec, Ontario, British Columbia, the Yukon Territory and the Northwest Territories. Base metals were the principal exploration target in Manitoba, New Brunswick, Newfoundland and Nova Scotia. Uranium was the principal exploration target in Saskatchewan (38% of exploration expenditures) followed by diamond exploration (24%). The main targets for diamond exploration in 1991 were Saskatchewan, Alberta, the Northwest Territories and Ontario, in order of declining explorations expenditures. As in 1990 and earlier years, coal remained the principal exploration target in Alberta.

Regional Expenditures by Type of Company, 1991

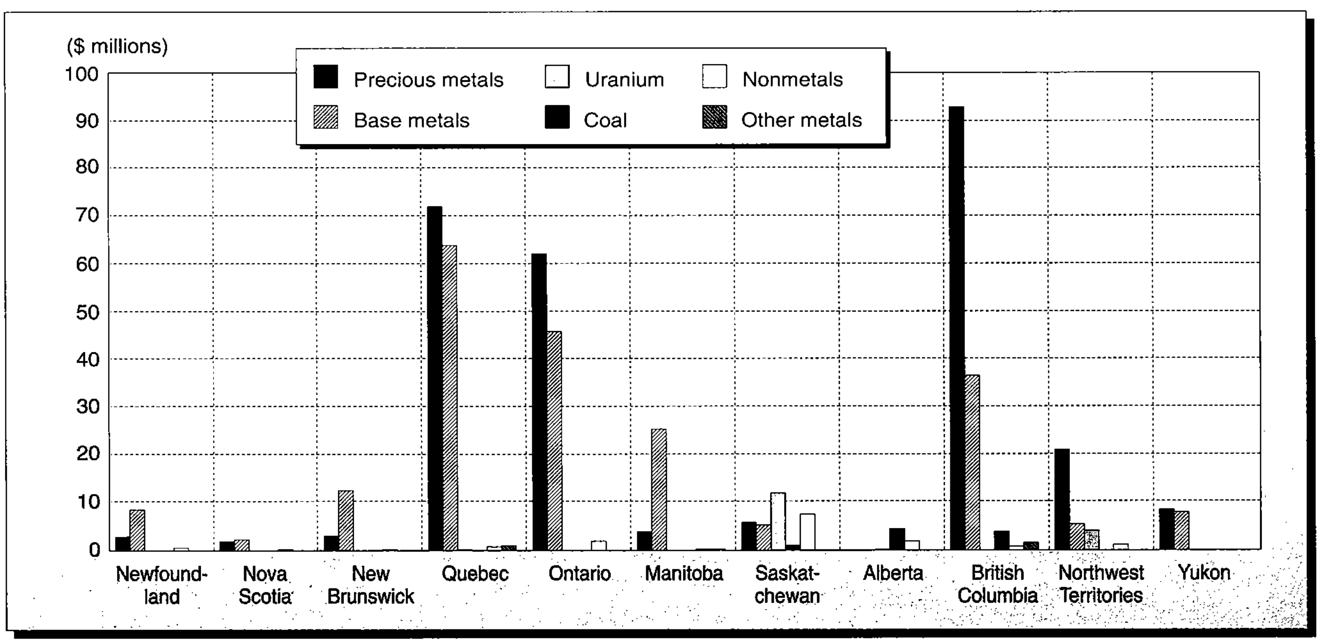
Companies are classified into six groups, as follows:

1. **Companies with a producing mine (or part ownership in a producing mine) in Canada (producers):** This group includes companies that own more than 50% of the shares of a producing mining company. It also includes any oil companies or foreign companies that have such a mine.

2. **Corporate affiliates of producing mining companies (affiliates):** This group includes wholly owned or majority-owned incorporated subsidiaries of producers (above).

Figure 4

Regional Exploration Expenditures, by Commodity Sought, 1991[1]



1 Some $2.9 million of exploration expenditures were for unspecified commodities. This amount has been pro-rated among the six commodity groups shown here.

SOURCE: Federal-Provincial Survey of Mining and Exploration Companies.

3. **Oil companies:** This group includes only oil companies with non-petroleum exploration projects in Canada. Oil companies with producing mines are included with producers. The group also includes foreign oil companies.

4. **Foreign companies:** This group excludes foreign companies with a producing mine in Canada and foreign oil companies.

5. **Junior companies (and prospectors).**

6. **Other companies:** This group includes any Canadian-owned companies engaged in mineral exploration that do not fall into categories 1 to 5 above, such as forestry, construction and consulting firms, and government-owned mining companies that do not own a mine.

A company (and its exploration statistics) is placed into the first of these groups it fits. For example, exploration statistics reported by an oil company or a foreign company that operates a producing Canadian mine is included in producers, rather than in Category 3 (oil companies) or Category 4 (foreign companies). Similarly, exploration statistics for a foreign company that is an oil company appear in Category 3 (oil companies), not in Category 4 (foreign companies), and so on.

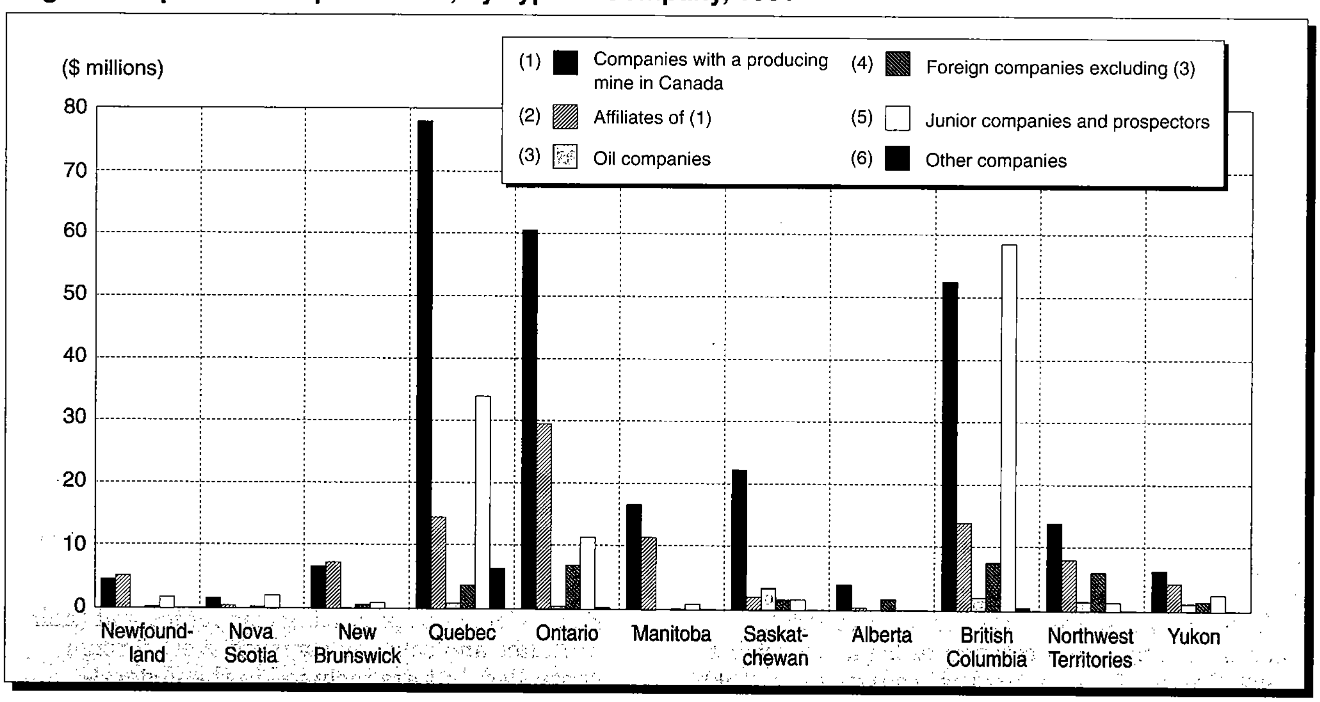
In 1991, as in 1989 and 1990, producing companies and their affiliated companies together were the principal exploration spenders in all provinces and territories but Nova Scotia (Table 13, Figure 5). In Nova Scotia, junior companies accounted for 49% of exploration expenditures in 1991.

In Quebec, in each of 1989, 1990 and 1991, producers and their affiliates spent more than twice as many exploration dollars as did junior companies, in contrast to 1985, 1986, 1987 and 1988, when junior companies were the dominant exploration spenders in the province.

Expenditures by Type of Company and Commodity, 1991

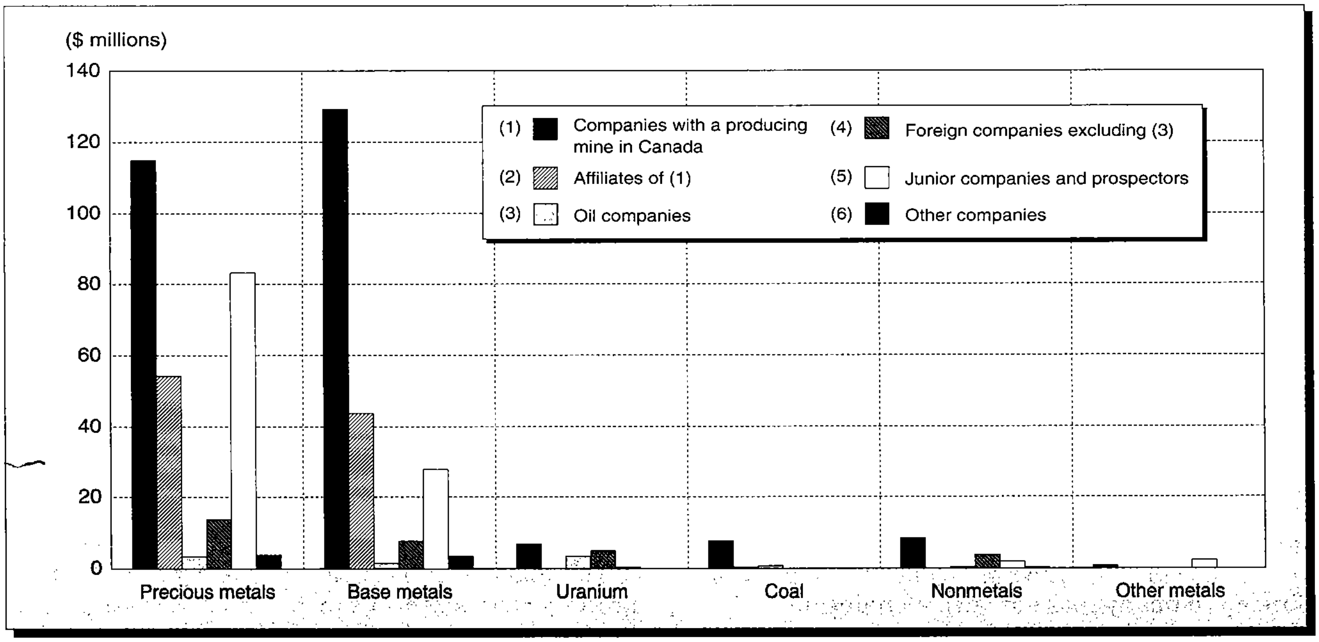
Junior companies (Table 10, Figure 6) directed 72% ($83 million) of their exploration expenditures at precious metals and 24% ($28 million) at base metals in 1991, compared to 77% ($185 million) at precious metals and 17% ($40 million) at base metals in 1990. Producing companies and their affiliates directed 46% ($168 million) of their exploration expenditures

Figure 5
Regional Exploration Expenditures, by Type of Company, 1991



SOURCE: Federal-Provincial Survey of Mining and Exploration Companies.

Figure 6
Exploration Expenditures, by Type of Company and Commodity, 1991[1]



1 Some $2.9 million of exploration expenditures were for unspecified commodities. This amount has been pro-rated among the six commodity groups shown here.
SOURCE: Federal-Provincial Survey of Mining and Exploration Companies.

at precious metals and 47% ($172 million) at base metals in 1991, compared to 51% ($233 million) at precious metals and 40% ($182 million) at base metals in 1990.

In 1991, foreign companies directed 44% ($13.8 million) of their exploration expenditures at precious metals, 27% ($7.7 million) at base metals, 17% ($5.2 million) at uranium, and 13% ($3.9 million) at nonmetallic minerals. Relative to 1990, foreign companies increased their expenditures on exploration for base metals, while decreasing their expenditures on exploration for gold, uranium and nonmetallic mineral commodities.

Type of Company Engaged in Exploration, 1991

The proportion of total exploration expenditures accounted for by junior companies rose during the 1980s, especially after the income tax regulations for flow-through shares were changed in 1983. Expenditures by junior companies began to decline in 1988 (Figure 7), a decline that continued in 1990 and 1991 (Table 6) and which likely continued in 1992.

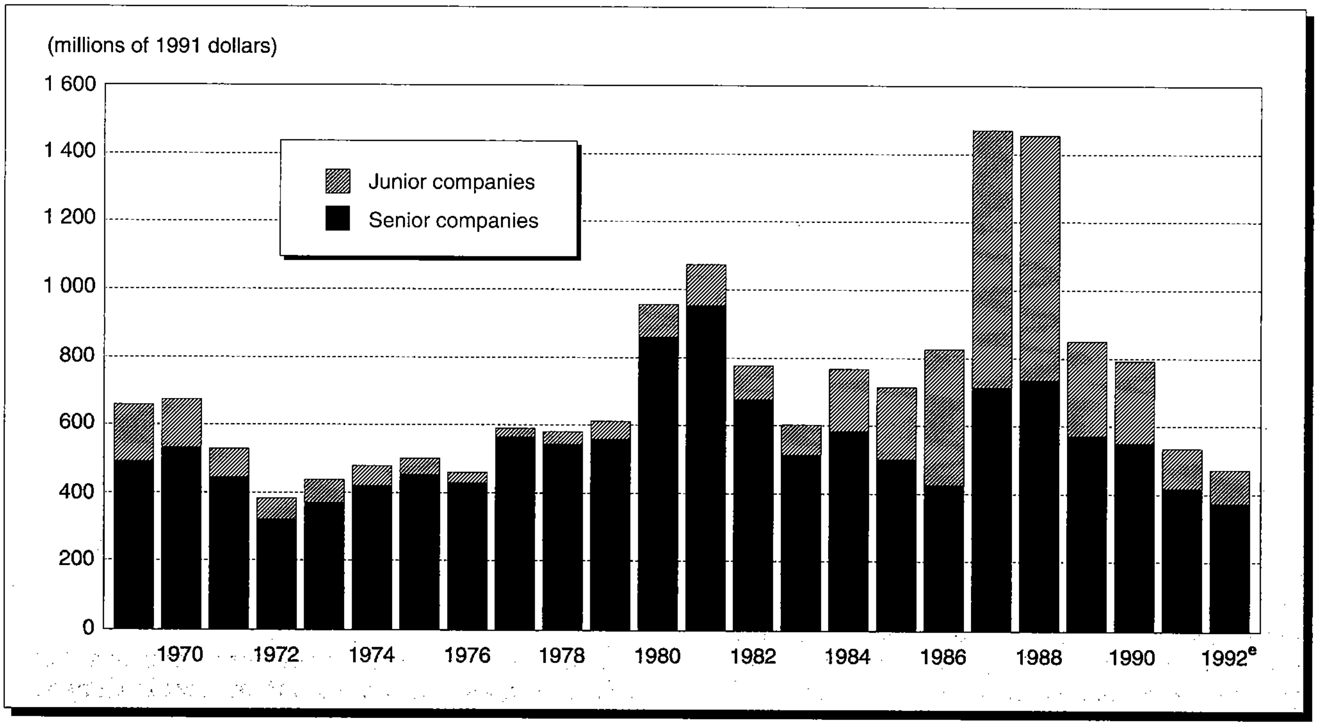
A recent foreign investment study conducted by the Mineral Policy Sector's (MPS) Economic Policy Analysis Division, based on data from the Federal-Provincial Exploration Survey on company ownership and/or control gathered by Statistics Canada under the *Corporations and Labour Unions Return Act* (CALURA) and on data concerning company ownership and control from other sources, revealed that foreign controlled companies, as project operators, spent some $188 million exploring for non-petroleum minerals in Canada in 1991. Foreign-controlled exploration expenditures amounted to more than 35% of total 1991 Canadian mineral exploration expenditures. In contrast, in 1990, the foreign contribution to Canadian mineral exploration had been lower in percentage terms (26%), but slightly higher in actual dollars spent, at $192 million.

These totals are much higher than the exploration expenditures reported by the Federal-Provincial Exploration Survey for foreign companies in 1991 and 1990 for a number of reasons:

- Some Canadian producing companies and their affiliates and some oil companies are foreign controlled, but are included in the Federal-Provincial Exploration Survey categories of producer, affiliate and oil company rather than

Figure 7

Canadian Exploration Expenditures, by Junior and Senior Companies, 1969-92[1]



e Estimated.

1 The total exploration expenditures for 1975 to 1981 are overstated by an average of about 17% relative to earlier and later years because of different methodologies used by Statistics Canada for those years.

SOURCE: Federal-Provincial Survey of Mining and Exploration Companies.

in the foreign company category because of the system of category priorities used in that survey.

- The Federal-Provincial Exploration Survey classified as foreign companies only those companies with more than 50% of their shares held by foreign companies or foreign individuals. The CALURA survey classifies a company as foreign if a single large block (which could be only 20% of total issued shares) is owned by a single foreign shareholder with the remaining shares (80%) widely held by Canadians but with no controlling block of Canadian-owned shares.
- In the Federal-Provincial Exploration Survey, companies listed on a Canadian stock exchange have generally been classified as being Canadian. CALURA has access to information concerning Canadian versus foreign ownership of the shares in such companies and may well have classified some companies as foreign that are classified as Canadian in the Exploration Survey.

Therefore, comparability is not to be expected between the Federal-Provincial Exploration Survey totals for exploration expenditures by foreign companies and those based on CALURA and other statistics on ownership of individual companies, because the classification criteria used are not the same.

Exploration Expenditures, 1992 Intentions

Planned exploration expenditures for 1992, gathered from companies early in 1992, were $498 million. However, we now anticipate that actual 1992 exploration expenditures may have been as low as $440 million because some companies have not been able to obtain all the money they had intended to spend on Canadian mineral exploration. After adjustment for inflation, Canadian mineral exploration expenditures in 1991 and 1992 were the lowest since the mid-1970s and are not expected to increase in 1993. The results for the Preliminary 1992/Intentions 1993 Exploration Survey are expected to be available by April 1993.

Effectiveness of Recent Canadian Mineral Exploration Efforts

Canada has been a producer of base metals and precious metals for almost 150 years. Measured by current standards of large-scale production, Canada has been a major producer of most of these metals for some 30 to 60 years now, depending on the metal.

For most metals, the period of major Canadian mineral discovery started in the early 1950s. The value of metal discoveries in Canada, calculated by multiplying tonnages of metal discovered in three-year periods by an appropriate set of metal prices, is one measure of exploration success.

Preliminary results of an MPS analysis of Canadian mineral exploration and discoveries over the 1946-90 period show that the gross value of metals discovered in Canada in the 1988-90 period exceeds the average gross value discovered per three-year period over the past 45 years. In fact, the value of metals discovered in the most recent three-year period is almost as great as that of the best three-year period since the end of World War II. Much more metal was discovered between 1988 and 1990 than in the two previous three-year periods 1982-84 and 1985-87. There was also a notable improvement in 1988-90 in the value of metal discovered per dollar spent on exploration relative to the 1982-84 and 1985-87 periods.

A count of the total number of metal deposits discovered annually in Canada since 1846 (from the same preliminary exploration/discovery analysis) shows that the number of deposits discovered per three-year period during the second half of the 1980s was at a record high. However, the average size of the deposits discovered, measured in constant dollars, was much smaller in 1982-87 than it had been in previous years. One explanation for the small average discovery size is that most of the Canadian mineral exploration effort during that portion of the 1980s was directed at gold, with the gross value of Canadian gold deposits being inherently lower, on average, than that of Canadian base-metal deposits. The much smaller average discovery size in 1982-87 may also be related to the nature of the exploration targets selected by junior companies during this period. It was important to such companies that they find targets on which they could spend all of their flow-through share money by the end of February of the next year. If they were to continue to be able to raise additional funding, it was also important that the companies make an immediate discovery that would provide interesting news to shareholders and prospective shareholders. As a result, such companies may have tended to concentrate their exploration efforts on known showings with relatively low tonnage potential (which may explain why such showings had not been more thoroughly explored in the past). Therefore, the majority of Canadian exploration programs during the flow-through share period 1983-90 inclusive were not concentrated on longer-term grassroots exploration programs of the type that tend to yield major new discoveries.

Diamond Exploration and Discoveries

The discovery of diamonds in kimberlite pipes and perhaps also in lamproite intrusions in Canada clearly constitutes the Canadian exploration highlight of 1991 and 1992. A number of gemstone-quality diamond-bearing kimberlite pipes of possible economic grade were discovered in the Northwest Territories in addition to the as-yet uneconomic diamond-bearing kimberlite intrusions found in Canada since the late 1980s.

There have been various previous indications that economic diamond deposits might exist in Canada. A few dozen diamonds have been found in glacial overburden deposits in the Great Lakes area of the United States. The materials from which the glacial overburden was formed may well have been carried south from Canada by continental glaciers. In addition a diamond of about 33 carats, but broken and of little value as a gem, was found near Peterborough, Ontario, prior to 1920. A second diamond of about 0.255 carats in size was found in an esker near Timmins, Ontario, by Reno Jarvi. This diamond is of gemstone quality and is housed in the Royal Ontario Museum. The sources of these two diamonds have yet to be discovered.

Kimberlite intrusions containing micro-diamonds were found some years ago on Somerset Island in the Northwest Territories, in Ontario near Kirkland Lake, in western Quebec, and elsewhere, but they did not yield diamonds of economic significance. In 1988, exploration turned up at least several dozen kimberlite pipes intruding post-Precambrian Cretaceous and older rocks in Saskatchewan. At least 15 of these kimberlites were reported to contain diamonds, but most of them were micro-diamonds of no economic value. Several of the intrusions have yielded 160 larger macro-diamonds, most of them of gem quality. However, these are apparently all small diamonds. The average diamond content of all of the Saskatchewan pipes tested to date is less than 10 carats per 100 tonnes and is too low to be economic.

Following the discovery of diamond-bearing kimberlite pipes in Saskatchewan, diamond exploration soon spread to Alberta and the Northwest Territories. The significant diamond discovery was made in 1991 by BHP Minerals and Dia Met Minerals Ltd. at Point Lake in the Lac de Gras area of the Northwest Territories (about 200 km northwest of Yellowknife). A 145-t sample, taken by drilling into one kimberlite pipe on the property, yielded 101 carats of diamonds, one quarter of which appear to be of gem quality. A few of them are 1-3 carats in size. The surface area of the pipe appears to be about 20 ha. Much larger bulk samples will have to be tested before it is known whether the deposit is mineable. Subsequently, a stock exchange listing report stated that a kimberlite resource of 73 Mt grading 69 carats per 100 t had been outlined to a depth of 220 m. In December, it was announced that core and surface samples of nine new kimberlite pipes indicated that all these pipes contain macro-diamonds. At least six of the new pipes are as large as, or larger than, the Point Lake kimberlite.

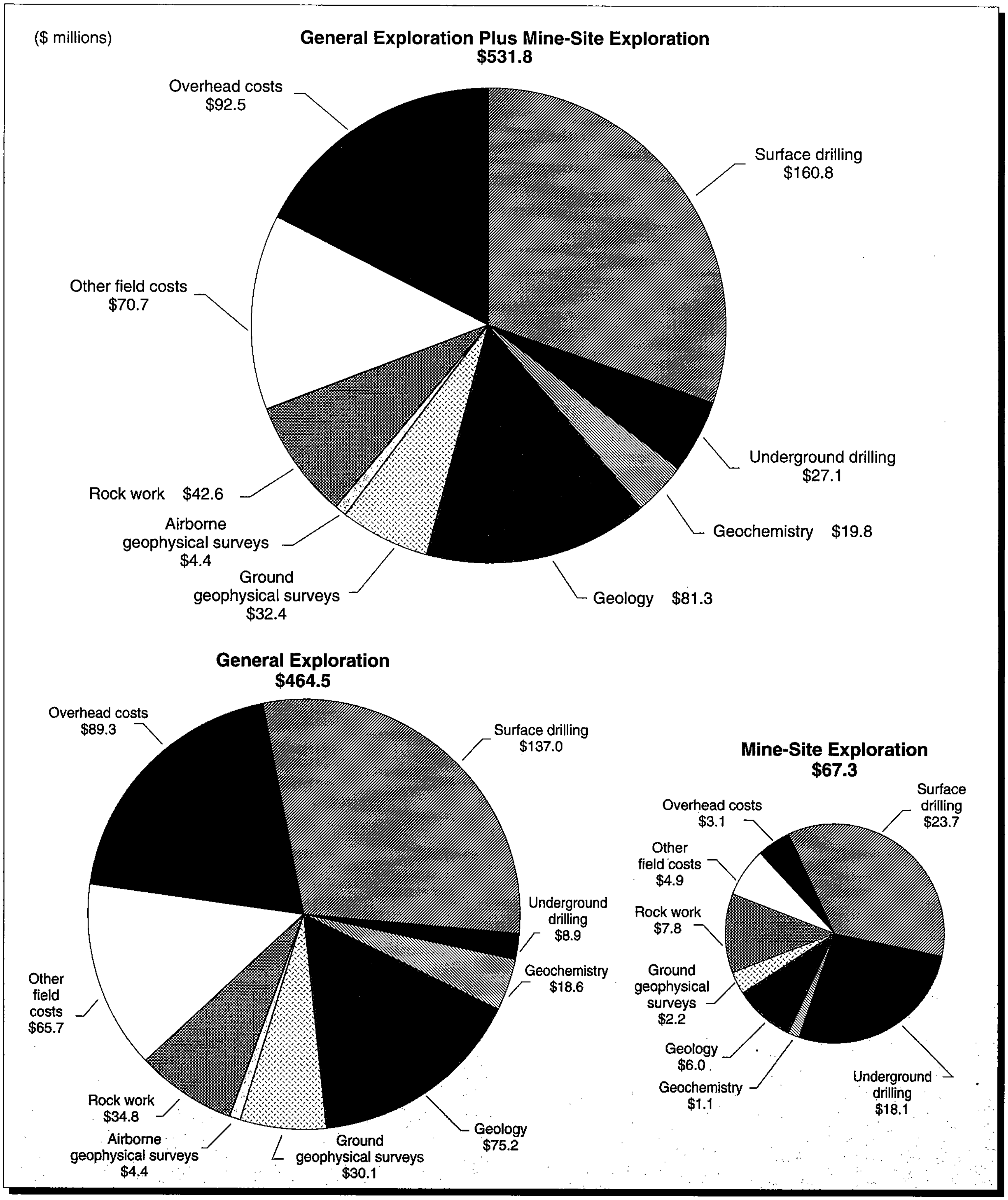
In November 1992, several micro-diamonds were also reported from kimberlite intrusions about 15 km southeast of Point Lake on a property owned by other companies. Kimberlite intrusions are also reported on various other properties in the Point Lake area, but, as yet, there is no information concerning whether or not they contain diamonds.

The Point Lake discoveries led to unprecedented staking in the Northwest Territories where some 7.2 million ha had reportedly been staked, up from 2.2 million ha in 1991 and 356 000 ha in 1990. In Alberta, the December staking rush referred to earlier increased the area staked in 1992 to at least 26.1 million ha, approximately 40% of the total area of the province.

Diamond exploration was also reported in northeastern British Columbia; near Kirkland Lake, in the James Bay lowlands, and elsewhere in Ontario; near Snow Lake, Manitoba; and in both northwestern and southwestern Quebec.

Note: Information in this review was current as of February 1, 1993.

Figure 8
Canadian Mineral Exploration Expenditures for 1991, with Expenditures by Category



SOURCE: Federal-Provincial Survey of Mining and Exploration Companies.

TABLE 1. FUNDS RAISED BY COMPANIES LISTED ON CANADIAN STOCK EXCHANGES THROUGH THE ISSUE OF FLOW-THROUGH SHARES, 1983-92

Year	Value of Funds Raised	
	(current $ millions)	(1992 $ millions)
1983	34	45
1984	139	180
1985	274	345
1986	703	865
1987	1 183	1 390
1988	850	954
1989	350	375
1990	250	259
1991	40	40
1992	40e	40

Sources: Mineral Policy Sector, Energy, Mines and Resources Canada, from Montreal, Toronto and Vancouver Stock Exchange records.
e Estimated.

TABLE 2. AREA[1] OF NEW MINERAL CLAIMS STAKED IN CANADA, 1986-92

	1986		1987		1988		1989		1990		1991		1992	
	(hectares)	(%)	(hectares)	(%)	(hectares)	(%)	(hectares)	(%)	(hectares)	(%)	(hectares)	(%)	(hectares)	(%)
Newfoundland	258 605	4.3	376 362	5.4	419 184	6.7	275 040	5.4	163 568	3.3	127 748	2.4	96 423	0.3
Nova Scotia	577 260	9.6	624 508	8.9	423 019	6.7	174 456	3.4	176 609	3.5	126 833	2.3	205 941	0.6
New Brunswick	44 872	1.0	72 748	1.0	110 976	1.8	139 776	2.8	69 776	1.4	73 136	1.4	55 104	0.2
Quebec	1 165 262	19.4	890 977	12.7	537 217	8.6	823 452	16.3	483 289	9.7	456 810	9.2	555 323	1.5
Ontario	983 386	16.4	949 231	13.5	598 632	9.6	390 619	7.7	419 259	8.4	317 568	5.9	497 800	1.4
Manitoba	301 974	5.0	212 139	3.0	162 264	2.6	209 483	4.1	127 342	2.5	127 935	2.4	140 379	3.8
Saskatchewan	467 051	7.8	700 459	10.0	741 944	11.8	418 832	8.3	184 939	3.7	274 242	5.1	897 315	2.4
Alberta	48 664	0.8	9 408	0.1	20 757	0.3	50 240	1.0	807 910	16.2	4 400	0.1	26 100 000[c]	71.1
British Columbia	1 613 775	26.9	2 269 925	32.4	2 212 125[a]	35.3	1 946 000[a]	38.4	2 014 250	40.3	1 510 850[b]	28.0	824 200[b]	2.2
Yukon	176 962	2.9	357 576	5.1	301 713	4.8	178 683	3.5	195 202	3.9	128 081	2.4	135 854	0.4
Northwest Territories	360 361	6.0	552 385	7.9	739 928	11.8	456 987	9.0	355 346	7.1	2 213 337	41.0	7 178 000	19.6
Total	5 998 172	100.0	7 015 718	100.0	6 267 755	100.0	5 063 568	100.0	4 997 490	100.0	5 398 340	100.0	36 686 339	100.0

[a] Excludes placer leases. [b] Not strictly comparable to 1990 and earlier years because the 1991 and 1992 totals are the area of claims recorded in 1991 and 1992, not the area of claims staked during 1991 and 1992. [c] Not yet final.
[1] Excludes coal.
Note: Numbers may not add to totals due to rounding.

TABLE 3. GENERAL EXPLORATION PLUS MINE-SITE EXPLORATION[1] EXPENDITURES, 1990 and 1991, AND DRILLING ACTIVITIES BY PROVINCE AND TERRITORY, 1991

Province/Territory	1991 Field Expenditures	1991 Overhead[2] Expenditures	1991 Total Expenditures	1990 Total Expenditures	1991 as % of 1990 Total Expenditures	1991 Surface Drilling Diamond Drilling	1991 Surface Drilling Other Drilling	1991 Surface Drilling Total
	($ millions)				(%)	(metres)		
Newfoundland	9.7	2.4	12.1	23.3	51.8	39 067	240	39 307
Nova Scotia	3.0	1.5	4.5	11.0	41.1	17 778	1 404	19 182
New Brunswick	13.4	2.4	15.8	16.5	95.8	62 724	–	62 724
Quebec	127.4	10.7	138.1	196.4	70.3	555 175	–	555 175
Ontario	86.5	23.2	109.7	152.6	71.9	352 129	14 917	367 046
Manitoba	26.2	3.5	29.7	41.2	72.1	148 323	–	148 323
Saskatchewan	26.1	5.4	31.5	42.2	74.6	103 506	10 040	113 546
Alberta	5.1	1.6	6.6	10.7	62.1	1 990	124 673	126 663
British Columbia	102.9	32.8	135.7	226.5	59.9	450 103	62 514	512 617
Northwest Territories	27.2	4.4	31.6	36.0	87.9	104 602	–	104 602
Yukon Territory	11.9	4.6	16.5	18.4	89.7	26 596	19 062	45 658
Total	439.2	92.5	531.8	774.7	68.6	1 861 993	232 850	2 094 843

Source: Federal-Provincial Survey of Mining and Exploration Companies.
– Nil.
[1] Exploration activity includes only the search for new mines; it does not include exploration for extensions to deposits already being mined or committed to production. [2] Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.
Note: Numbers may not add to totals due to rounding.

TABLE 4. GENERAL EXPLORATION PLUS MINE-SITE EXPLORATION[1] EXPENDITURES, INCLUDING OVERHEAD,[2] BY COMMODITY SOUGHT, 1991

Commodity Groups	Expenditures	Percentage of Canadian Total	1991 as % of 1990 Expenditures
	($ millions)	(%)	(%)
Base metals (Cu, Ni, Pb, Zn)	212.4	39.9	89.9
Precious metals (Ag, Au, Pt group)	272.3	51.2	59.6
Iron ore	0.4	0.1	116.1
Uranium	16.2	3.1	67.5
Other metals	3.1	0.6	34.5
Nonmetals	15.0	2.8	63.3
Coal	9.2	1.7	77.2
Unspecified commodities	2.9	0.5	23.5
Total	531.8	100.0	

Source: Energy, Mines and Resources Canada, from the Federal-Provincial Survey of Mining and Exploration Companies.
[1] Exploration activity includes only the search for new mines; it does not include exploration for extensions to deposits already being mined or committed to production. [2] Overhead expenditures include land costs, field administration costs and exploration-related head office expenses (from data in Table 9b).
Note: Numbers may not add to totals due to rounding.

TABLE 5. PERCENTAGE OF GENERAL EXPLORATION PLUS MINE-SITE EXPLORATION[1] EXPENDITURES DIRECTED AT THE SEARCH FOR BASE METALS AND PRECIOUS METALS, 1975-91

Year	Base Metals[2]	Precious Metals[3]
	(percent)[4]	
1975	63	7
1977	42	7
1979	35	12
1981	34	25
1983	42	29
1985	20	65
1986	14	76
1987	11	83
1988	13	82
1989	23	67
1990	31	60
1991	40	52

Sources: 1975-83 compiled by Energy, Mines and Resources Canada (EMR) from individual company responses to Statistics Canada exploration questionnaires; 1985-91 compiled by EMR from the Survey of Federal-Provincial Mining and Exploration Companies.
[1] Exploration activity includes only the search for new mines; it does not include exploration for extensions to deposits already being mined or committed to production. [2] Nickel, copper, zinc and lead. [3] Gold, silver and platinum group metals. In recent years, gold exploration has accounted for 95% of exploration expenditures on precious metals. [4] Includes a pro-rated portion of expenditures for unspecified commodities.

TABLE 6. GENERAL EXPLORATION PLUS MINE-SITE EXPLORATION,[1] INCLUDING OVERHEAD,[2] BY TYPE OF COMPANY, 1989-91

Type of Company	1989 Exploration Expenditures		1990 Exploration Expenditures		1991 Exploration Expenditures	
	($ millions)	(% of Canadian total)	($ millions)	(% of Canadian total)	($ millions)	(% of Canadian total)
1. Producing companies (those with a producing mine in Canada and their affiliates)	462.4	55.9	459.7	59.3	367.2	69.1
2. Oil companies (excluding group 1 above)	23.9	2.9	8.7	1.1	9.9	1.9
3. Foreign companies (excluding groups 1 and 2 above)	46.9	5.7	43.3	5.6	31.1	5.9
4. Junior companies and prospectors	272.6	32.9	241.0	31.1	116.1	21.8
5. Other companies	22.3	2.7	22.0	2.8	7.4	1.4
Total	827.9	100	774.7	100	531.8	100

Sources: Energy, Mines and Resources Canada (EMR) and Statistics Canada, from Federal-Provincial Survey of Mining and Exploration Companies.
1 Exploration activity includes only the search for new mines; it does not include exploration for extensions to deposits already being mined or committed to production. 2 Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.
Notes: Numbers may not add to totals due to rounding. Statistics Canada totals for mine-site exploration have been revised to take into account additional or revised data obtained by EMR.

TABLE 7. GENERAL EXPLORATION PLUS MINE-SITE EXPLORATION[1] ACTIVITIES BY PROVINCE AND TERRITORY, BY TYPE OF WORK, 1991

Province/Territory	Drilling (Surface and Underground)				Surveys - Other Exploration Work						Total Field Expenditures	Total, Including Overhead[2]
	Diamond		Other				Geophysical					
	Metres	Cost	Metres	Cost	Geochemical	Geology	Ground	Airborne	Rock Work	Other Field Costs		
	(000)	($000)	(000)	($000)	($000)							
Newfoundland	39	2 907	–	75	673	3 797	1 183	41	185	804	9 663	12 065
Nova Scotia	18	853	1	15	298	745	235	2	218	640	3 006	4 532
New Brunswick	70	6 699	–	–	722	2 426	1 003	234	769	1 504	13 358	15 805
Quebec	806	44 481	–	–	3 715	17 197	6 066	1 141	14 218	40 554	127 372	138 108
Ontario	448	36 658	15	801	2 420	19 246	6 128	848	14 155	6 214	86 471	109 683
Manitoba	168	15 973	–	–	587	3 433	3 437	82	1 244	1 485	26 241	29 692
Saskatchewan	127	10 527	10	3 463	1 685	2 406	2 464	303	1 414	3 857	26 119	31 488
Alberta	2	218	125	2 789	294	153	349	–	18	1 239	5 061	6 621
British Columbia	495	38 126	63	3 992	8 105	23 519	8 196	1 169	9 591	10 181	102 878	135 670
Northwest Territories	143	14 858	–	–	465	6 394	2 307	521	76	2 567	27 189	31 624
Yukon Territory	27	3 487	20	1 999	872	2 002	1 066	65	725	1 661	11 877	16 477
Total Canada	2 341	174 789	234	13 133	19 835	81 319	32 434	4 407	42 612	70 706	439 235	531 764

Source: Energy, Mines and Resources Canada, from the Federal-Provincial Survey of Mining and Exploration Companies.
– Nil.
1 Exploration activity includes only the search for new mines; it does not include exploration for extensions to deposits already being mined or committed to production. 2 Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.
Note: Numbers may not add to totals due to rounding.

TABLE 8. GENERAL EXPLORATION PLUS MINE-SITE EXPLORATION[1] ACTIVITIES BY TYPE OF COMPANY, 1991

Type of Company	Drilling (Surface and Underground)				Surveys - Other Exploration Work						Total Field Expenditures	Total, Including Overhead[2]
	Diamond		Other				Geophysical					
	Metres	Cost	Metres	Cost	Geochemical	Geology	Ground	Airborne	Rock Work	Other Field Costs		
	(000)	($000)	(000)	($000)	($000)							
1. Companies with a producing mine in Canada	1 374	90 739	161	8 243	8 611	38 384	17 453	1 474	24 928	39 067	228 898	268 406
2. Affiliates of group 1	403	37 661	42	2 527	3 299	15 305	6 563	831	5 476	5 181	76 842	98 781
3. Oil companies	49	4 130	–	7	413	841	379	85	58	1 384	7 296	9 883
4. Foreign companies (excluding group 3)	103	7 647	12	359	1 051	6 495	1 466	377	164	5 825	25 384	31 147
5. Junior companies and prospectors	400	33 901	18	1 997	5 875	16 006	6 186	1 246	11 607	18 889	95 706	116 139
6. Other companies	13	712	–	–	587	4 288	387	395	379	361	7 108	7 408

Source: Energy, Mines and Resources Canada, from the Federal-Provincial Survey of Mining and Exploration Companies.
– Nil.
1 Exploration activity includes only the search for new mines; it does not include exploration for extensions to deposits already being mined or committed to production. 2 Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.
Note: Numbers may not add to totals due to rounding.

TABLE 9a. GENERAL EXPLORATION PLUS MINE-SITE EXPLORATION[1] EXPENDITURES, NOT INCLUDING OVERHEAD,[2] BY PROVINCE AND TERRITORY, BY COMMODITY SOUGHT, 1991

Province/Territory	Metals					Nonmetals	Coal	Commodity Not Specified	Total Field Expenditures
	Base	Precious	Iron	Uranium	Other				
					($000)				
Newfoundland	7 023	1 876	47	42	9	321	–	345	9 663
Nova Scotia	1 603	1 191	–	1	86	125	–	–	3 006
New Brunswick	10 518	2 642	–	–	15	146	36	–	13 358
Quebec	59 519	65 770	171	102	1 028	783	–	–	127 372
Ontario	41 600	43 417	–	–	2	1 381	–	70	86 471
Manitoba	23 027	2 941	–	–	233	40	–	–	26 241
Saskatchewan	4 521	4 208	–	10 498	6	6 568	317	–	26 119
Alberta	51	3	–	134	–	1 827	3 046	–	5 061
British Columbia	29 217	68 470	3	–	1 251	410	2 624	904	102 878
Northwest Territories	4 619	19 400	–	2 830	–	339	–	–	27 189
Yukon Territory	5 784	6 015	–	–	45	1	–	32	11 877
Total Canada	187 482	215 934	221	13 607	2 675	11 942	6 024	1 351	439 235

Source: Energy, Mines and Resources Canada, from the Federal-Provincial Survey of Mining and Exploration Companies.
– Nil.
1 Exploration activity includes only the search for new mines; it does not include exploration for extensions to deposits already being mined or committed to production. 2 Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.
Note: Numbers may not add to totals due to rounding.

TABLE 9b. GENERAL EXPLORATION PLUS MINE-SITE EXPLORATION[1] EXPENDITURES, INCLUDING OVERHEAD,[2] BY PROVINCE AND TERRITORY, BY COMMODITY SOUGHT, 1991

Province/Territory	Metals					Nonmetals	Coal	Commodity Not Specified	Total, Including Overhead
	Base	Precious	Iron	Uranium	Other				
					($000)				
Newfoundland	8 260	2 754	78	42	60	497	–	375	12 065
Nova Scotia	2 263	2 018	6	1	96	148	–	–	4 532
New Brunswick	12 503	3 015	–	–	26	225	37	–	15 805
Quebec	63 909	71 980	236	102	1 052	829	–	–	138 108
Ontario	45 761	61 974	13	1	24	1 838	–	72	109 683
Manitoba	25 334	3 896	–	–	255	208	–	–	29 692
Saskatchewan	5 185	5 850	–	11 906	6	7 519	1 020	–	31 488
Alberta	51	3	–	201	–	1 980	4 387	–	6 621
British Columbia	35 876	91 216	65	–	1 567	719	3 782	2 445	135 670
Northwest Territories	5 363	21 169	14	3 995	–	1 084	–	–	31 624
Yukon Territory	7 920	8 472	–	–	52	1	–	32	16 477
Total Canada	212 424	272 346	411	16 248	3 138	15 047	9 226	2 923	531 764

Source: Energy, Mines and Resources Canada, from the Federal-Provincial Survey of Mining and Exploration Companies.
– Nil.
1 Exploration activity includes only the search for new mines; it does not include exploration for extensions to deposits already being mined or committed to production. 2 Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.
Note: Numbers may not add to totals due to rounding.

TABLE 10a. GENERAL EXPLORATION PLUS MINE-SITE EXPLORATION[1] EXPENDITURES, NOT INCLUDING OVERHEAD,[2] BY TYPE OF COMPANY AND BY COMMODITY SOUGHT, 1991

Type of Company	Metals					Nonmetals	Coal	Commodity Not Specified	Total Field Expenditures
	Base	Precious	Iron	Uranium	Other				
					($000)				
1. Companies with a producing mine in Canada	117 070	91 409	47	6 061	635	7 296	5 673	706	228 898
2. Affiliates of group 1	38 076	37 726	–	23	84	65	346	523	76 842
3. Oil companies	929	3 018	–	3 152	8	186	3	–	7 296
4. Foreign companies (excluding group 3)	6 034	10 497	–	3 878	36	2 911	–	28	23 384
5. Junior companies and prospectors	22 012	69 650	173	493	1 913	1 370	2	94	95 706
6. Other companies	3 362	3 635	–	–	–	112	–	–	7 108

Source: Energy, Mines and Resources Canada, from the Federal-Provincial Survey of Mining and Exploration Companies.
– Nil.
1 Exploration activity includes only the search for new mines; it does not include exploration for extensions to deposits already being mined or committed to production.
2 Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.
Note: Numbers may not add to totals due to rounding.

TABLE 10b. GENERAL EXPLORATION PLUS MINE-SITE EXPLORATION[1] EXPENDITURES, INCLUDING OVERHEAD,[2] BY TYPE OF COMPANY AND BY COMMODITY SOUGHT, 1991

Type of Company	Metals					Nonmetals	Coal	Commodity Not Specified	Total, Including Overhead
	Base	Precious	Iron	Uranium	Other				
					($000)				
1. Companies with a producing mine in Canada	128 843	114 615	158	7 025	692	8 455	7 780	838	268 406
2. Affiliates of group 1	43 159	53 527	–	25	94	66	450	1 459	98 781
3. Oil companies	1 465	3 524	–	3 518	8	427	940	–	9 883
4. Foreign companies (excluding group 3)	7 729	13 834	–	5 153	40	3 928	–	464	31 147
5. Junior companies and prospectors	27 821	83 111	254	528	2 304	1 936	23	162	116 139
6. Other companies	3 407	3 735	–	–	–	234	32	1	7 408

Source: Energy, Mines and Resources Canada, from the Federal-Provincial Survey of Mining and Exploration Companies.
– Nil.
1 Exploration activity includes only the search for new mines; it does not include exploration for extensions to deposits already being mined or committed to production.
2 Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.
Note: Numbers may not add to totals due to rounding.

TABLE 11. GENERAL EXPLORATION PLUS MINE-SITE EXPLORATION,[1] SURFACE AND UNDERGROUND DRILLING, BY PROVINCE AND TERRITORY, BY COMMODITY SOUGHT, 1991

Province/Territory	Metals					Nonmetals	Coal	Total
	Base	Precious	Iron	Uranium	Other			
	(000 metres)							
Newfoundland	31	7	–	–	–	1	–	39
Nova Scotia	13	3	–	–	1	2	–	19
New Brunswick	52	15	–	–	–	2	–	70
Quebec	265	524	1	–	7	9	–	806
Ontario	207	254	–	–	–	2	–	463
Manitoba	155	11	–	–	2	–	–	168
Saskatchewan	25	20	–	74	–	9	8	137
Alberta	–	–	–	–	–	12	114	127
British Columbia	193	305	–	–	7	3	49	558
Northwest Territories	12	118	–	13	–	–	–	143
Yukon Territory	20	27	–	–	–	–	–	46
Total Canada	973	1 283	1	87	18	41	171	2 575

Source: Energy, Mines and Resources Canada, from the Federal-Provincial Survey of Mining and Exploration Companies.
– Nil.
[1] Exploration activity includes only the search for new mines; it does not include exploration for extensions to deposits already being mined or committed to production.
Note: Numbers may not add to totals due to rounding.

TABLE 12. GENERAL EXPLORATION PLUS MINE-SITE EXPLORATION,[1] SURFACE AND UNDERGROUND DRILLING, BY TYPE OF COMPANY AND BY COMMODITY SOUGHT, 1991

Type of Company	Metals					Nonmetals	Coal	Total
	Base	Precious	Iron	Uranium	Other			
	(000 metres)							
1. Companies with a producing mine in Canada	586	723	–	41	5	22	157	1 535
2. Affiliates of group 1	216	214	–	–	1	–	14	445
3. Oil companies	5	21	–	23	–	1	–	49
4. Foreign companies (excluding group 3)	33	48	–	21	–	12	–	114
5. Junior companies and prospectors	127	270	1	2	12	6	–	418
6. Other companies	6	7	–	–	–	–	–	13

Source: Energy, Mines and Resources Canada, from the Federal-Provincial Survey of Mining and Exploration Companies.
– Nil.
[1] Exploration activity includes only the search for new mines; it does not include exploration for extensions to deposits already being mined or committed to production.
Note: Numbers may not add to totals due to rounding.

TABLE 13a. GENERAL EXPLORATION PLUS MINE-SITE EXPLORATION[1] EXPENDITURES, NOT INCLUDING OVERHEAD,[2] BY PROVINCE AND TERRITORY, BY TYPE OF COMPANY, 1991

Province/Territory	(1) Companies With a Producing Mine in Canada	(2) Affiliates of (1)	(3) Oil Companies	(4) Foreign Companies Excluding (3)	(5) Junior Companies and Prospectors	(6) Other Companies	Total Field Expenditures
				($000)			
Newfoundland	3 707	4 467	10	185	1 290	4	9 663
Nova Scotia	1 342	337	–	–	1 317	11	3 006
New Brunswick	6 097	6 207	–	350	694	9	13 358
Quebec	72 462	12 959	836	3 126	31 513	6 477	127 372
Ontario	53 614	18 112	404	4 693	9 430	217	86 471
Manitoba	14 788	10 639	–	40	774	–	26 241
Saskatchewan	18 123	1 900	3 191	1 464	1 427	14	26 119
Alberta	2 863	395	–	1 798	5	–	5 061
British Columbia	38 636	10 921	734	6 538	45 748	300	102 878
Northwest Territories	12 701	7 673	1 341	4 214	1 183	77	27 189
Yukon Territory	4 564	3 231	780	976	2 326	–	11 877
Total Canada	228 898	76 842	7 296	23 384	95 706	7 108	439 235

Source: Energy, Mines and Resources Canada, from the Federal-Provincial Survey of Mining and Exploration Companies.
– Nil.
[1] Exploration activity includes only the search for new mines; it does not include exploration for extensions to deposits already being mined or committed to production. [2] Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.
Note: Numbers may not add to totals due to rounding.

TABLE 13b. GENERAL EXPLORATION PLUS MINE-SITE EXPLORATION[1] EXPENDITURES, INCLUDING OVERHEAD,[2] BY PROVINCE AND TERRITORY, BY TYPE OF COMPANY, 1991

Province/Territory	(1) Companies With a Producing Mine in Canada	(2) Affiliates of (1)	(3) Oil Companies	(4) Foreign Companies Excluding (3)	(5) Junior Companies and Prospectors	(6) Other Companies	Total, Including Overhead
				($000)			
Newfoundland	4 625	5 264	15	240	1 915	4	12 065
Nova Scotia	1 651	416	–	243	2 209	13	4 532
New Brunswick	6 831	7 483	–	560	923	9	15 805
Quebec	77 995	14 764	887	3 838	34 112	6 512	138 108
Ontario	60 606	29 728	475	7 042	11 596	236	109 683
Manitoba	16 916	11 620	–	87	946	123	29 692
Saskatchewan	22 415	2 093	3 559	1 720	1 686	16	31 488
Alberta	4 141	500	41	1 914	26	–	6 621
British Columbia	52 573	14 137	2 122	7 799	58 650	389	135 670
Northwest Territories	14 130	8 267	1 534	6 178	1 410	106	31 624
Yukon Territory	6 522	4 510	1 250	1 528	2 667	–	16 477
Total Canada	268 406	98 781	9 883	31 147	116 139	7 408	531 764

Source: Energy, Mines and Resources Canada, from the Federal-Provincial Survey of Mining and Exploration Companies.
– Nil.
1 Exploration activity includes only the search for new mines; it does not include exploration for extensions to deposits already being mined or committed to production. 2 Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.
Note: Numbers may not add to totals due to rounding.

TABLE 14. GENERAL EXPLORATION PLUS MINE-SITE EXPLORATION[1] EXPENDITURES, INCLUDING OVERHEAD,[2] BY PROVINCE AND TERRITORY, 1989-91

Province/Territory	1989 ($ millions)	1989 (%)	1990 ($ millions)	1990 (%)	1991 ($ millions)	1991 (%)
Newfoundland	36.2	4.4	23.2	3.0	12.1	2.2
Nova Scotia	21.4	2.6	11.0	1.4	4.5	0.9
New Brunswick	13.6	1.6	16.5	2.1	15.8	3.0
Quebec	185.0	22.3	196.4	25.4	138.1	26.0
Ontario	217.8	26.3	152.6	19.7	109.7	20.6
Manitoba	37.0	4.5	41.2	5.3	29.7	5.6
Saskatchewan	63.3	7.6	42.2	5.4	31.5	5.9
Alberta	6.3	0.8	10.7	1.4	6.6	1.2
British Columbia	186.6	22.5	226.5	29.2	135.7	25.5
Northwest Territories	45.7	5.5	36.0	4.6	31.6	5.9
Yukon Territory	15.0	1.8	18.4	2.4	16.5	3.1
Total	828.0	100	774.7	100	531.8	100
General exploration	712.6	86.1	662.3	85.5	464.5	87.3
Mine-site exploration	115.4	14.0	112.4	14.5	67.3	12.7

Sources: Energy, Mines and Resources Canada and Statistics Canada, from the Federal-Provincial Survey of Mining and Exploration Companies.

1 Exploration activity includes only the search for new mines; it does not include exploration for extensions to deposits already being mined or committed to production. 2 Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.

Note: Numbers may not add to totals due to rounding.

Canadian Mine Openings, Re-Openings, Expansions, Suspensions and Closures

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Mine openings and closures in Canada continued to reflect difficult times in the Canadian mining sector during 1992 (Table 1); 28 mines closed or suspended operations and 8 opened or re-opened.

In the first half of 1992, 17 mines (7 gold, 6 base-metal, 2 coal, 1 uranium and 1 asbestos) closed or suspended operations. No new mines came on stream, although 1 gold mine and 1 asbestos operation re-opened. In the second half of the year, an additional 11 mines (4 gold, 2 silver-gold base-metal, 2 base-metal, and 3 coal) closed or suspended operations. In the second six-month period, 6 new mines (1 silver-gold-copper, 3 base-metal, 1 coal and 1 limestone) opened, bringing some needed relief to the mining industry.

Among the new mines that opened in 1992 were the Murray Brook copper mine in New Brunswick, the Glen Morrison limestone operation in Nova Scotia, the Lindsley (Thayer Lindsley) copper-nickel mine in Ontario, the Norita East zinc-copper mine in Quebec, and the Shand coal mine in Saskatchewan. The Equity Silver underground silver-gold-copper operation in British Columbia began production in the fall. In addition, the Hope Brook gold mine and the Baie Verte tailings wet-processing operation, both in Newfoundland, re-opened.

On a regional basis, the northwestern (Baie Verte area) and southwestern regions of the island of Newfoundland have benefitted the most with two mine openings and no closures in 1992. By contrast, northern Quebec and southern and northwestern British Columbia were the hardest hit, each with eight mine closures and only one opening. Ontario and Nova Scotia followed next, with six and four closures respectively, and only one opening in each of the two provinces. Northern Manitoba and central Yukon each emerged from 1992 with the loss of one mine.

In southwestern Nova Scotia, East Kemptville, the only producing tin mine in North America, closed on January 3, 1992. Although the Glen Morrison mine, a significant high-quality sulphur-absorbent limestone operation near Sydney, opened in December, it is not likely that it will soon offset the impact of the closure of East Kemptville. In addition, the Westray coal mine near Plymouth was shut down in May, the small Evans coal mine near Inverness in Cape Breton was closed in August, and the Lingan colliery, also in Cape Breton, closed in November. The Abitibi-Temiscamingue region of Quebec continues to suffer from mine closures. In the first half of 1992, the region lost five mines, including the Mobrun copper-zinc mine and the Lac Shortt gold mine. In the second half of 1992, the Camflo gold mine closed after 27 years of commercial production, as did the Copper Rand and Portage gold-copper mines in the Chibougamau area.

Northern Ontario continues to suffer severely from mine closures. The Cheminis (Virginiatown) and Magino (Wawa) gold mines, the Denison (Elliot Lake) uranium mine, and the Langmuir No. 1 (Timmins) and Shebandowan (Thunder Bay) nickel mines were all shut down in the first half of the year. The Redstone nickel mine at Timmins closed in August. The most notable closure in Ontario in 1992 was that of the Denison mine, North America's largest underground uranium mine, which was permanently closed in March 1992 after 35 years of operation.

Northern Manitoba saw the loss of the Spruce Point copper-zinc mine to permanent closure in March. Northern and northwestern British Columbia were hit by the closure of the Lawyers underground and Premier open-pit gold mines, and the Cassiar (McDame) asbestos mine. Central British Columbia was affected by the closure of the Bell copper and Equity Silver open-pit silver-gold-copper mines, and southern and southeastern British Columbia saw the closure of the Samatosum silver-gold base-metal mine, and the suspension of operations at the Balmer and Greenhills coal mines. With eight mine closures and only one small-scale opening, British Columbia experienced the hardest conditions in its recent mining history. Underground mining operations at the Faro mine in central Yukon ceased when underground ore reserves were depleted in November. A small amount of ore, however, is left in the open-pit, which is expected to be mined out in early 1993.

While most mine suspensions resulted from low metal prices, most permanent closures were due to the depletion of ore reserves.

Most of the important mine expansion projects that started in the 1989-90 period that were to be completed by the end of 1992 were not completed. These include mine production and mill capacity expansion projects at the Joe Mann and Bousquet No. 2 gold mines in Quebec (including expansion of the Est-Malartic mill that processes ore from Bousquet No. 2) and at the Kerr (formerly Kerr Addison) gold mine in Ontario. Expansion at the Birchtree nickel-copper mine at Thompson, Manitoba, is continuing. Plans to double coal production to 500 000 Mt/y at the Quinsam coal mine at Campbell River, British Columbia, were successfully completed in 1992. The mine also increased its workforce from 75 in June to 104 at year-end 1992.

In 1992, mine closures (including suspensions) in Canada again exceeded mine openings (including re-openings), continuing a trend that started in 1990. While new and re-opened Canadian mines added nearly 18 500 t of daily production capacity and some 560 jobs in 1992, mine suspensions and closures reduced Canadian ore production capacity by some 106 470 t/d and eliminated over 6340 jobs, for net overall losses of 88 000 t of daily ore capacity and nearly 5800 jobs for the year.

The outlook for 1993 appears to be brighter, although it is still too early to be conclusive. Based on company reports and news releases available as of the beginning of 1993, mining companies plan to open or re-open more than a dozen mines. Fourteen mines are, however, scheduled to close before the end of 1993. Most of the openings will represent the reactivation of former producers. These include the Casa Berardi Est and the Sleeping Giant gold mines and the Estrades zinc-gold mine in Quebec, and the Erickson gold mine and the Balmer and Greenhills coal mines in British Columbia. The Astoria gold deposit in Quebec and the Komis gold deposit in northern Saskatchewan are among the new mines scheduled to come on stream in 1993.

Unless more ore can be found, the following mines will close by year-end 1993: the Stratmat copper-lead-zinc-silver mine in New Brunswick; the Ansil copper-zinc-silver-gold mine and the Telbel, Pierre Beauchemin, Lucien C. Béliveau and Norlartic gold mines in Quebec; the Dona Lake gold mine and Winston Lake zinc-copper mine in Ontario; the Stall Lake and Chisel Lake zinc-copper mines and the Namew Lake nickel-copper mine in Manitoba; the Nickel Plate gold mine in British Columbia; and the Faro open-pit and the Vangorda zinc-lead mines in the Yukon.

Most of the planned major mine/mill expansion projects are expected to continue in 1993. The production increase at Lac Minerals Ltd.'s Bousquet No. 2 gold mine and capacity expansion at its Est Malartic gold mill near Malartic, Quebec, which were delayed in 1992, have been rescheduled for completion in June 1993. Capacity expansions at Deak Resources Corporation's Kerr gold mill near Virginiatown, Ontario, will also continue in 1993 to accommodate ore from its Astoria mine (a new gold mine under development for production in 1993), as well as to accommodate increasing demand for custom milling. Although there is a planned general reduction of nickel output by both Inco Limited and Falconbridge Limited for 1993, the planned expansion at Inco's Birchtree nickel-copper mine at Thompson, Manitoba, which will double production to 34 million pounds of nickel annually by 1997, continues. The Quinsam mine (near Campbell River on Vancouver Island, British Columbia), which doubled its coal production in 1992 to 500 000 t, plans a further increase to 750 000 t in 1993.

Note: Information in this review was current as of February 1, 1993.

TABLE 1. CANADIAN MINE OPENINGS, RE-OPENINGS, EXPANSIONS, SUSPENSIONS, AND CLOSURES IN 1992

Project	Location	Province	Ore Capacity	Employment[1]	Date of Opening, Re-Opening, Expansion, Closure or Suspension	Mine Type	Main Commodities	Companies	Remarks
			(tonnes/day)						
NEW OPERATIONS									
Precious Metals									
Equity Silver[2] underground	Houston	B.C.	1 000	55	October	U/G	Silver, gold, copper	Placer Dome Inc.	Mine life is estimated to be about 18 months. The open-pit operation closed in September 1992 due to depletion of ore reserves (see closures).
Base Metals									
Lindsley	Sudbury	Ont.	500	65	August	U/G	Copper, nickel	Falconbridge Limited	Ore to be milled at company's Strathcona mill.
Norita East	Matagami	Que.	800	30	August	U/G	Zinc, copper	Noranda Minerals Inc.	Mine life is estimated to be about three years. Ore milled at the Mattagami mill.
Murray Brook (copper)	Bathurst	N.B.	2 000	40	October	O/P	Copper	NovaGold Resources Inc.	Ore milled at the nearby East-West Caribou mill of Breakwater Resources Ltd. and Arimetco International Inc.
Other Minerals									
Shand	Estevan	Sask.	6 500	25	September 21	Surface	Coal	Luscar Ltd.	The new mine will supply the Shand power station with lignite coal for the next 33 years.
Glen Morrison	Sydney	N.S.	1 000	30	December	Quarry	Limestone	AquaGold Resources Inc.	The project will supply quality sulphur-absorbent limestone to cut SO_2 emissions from the Nova Scotia Power Corporation's Point Aconi plant. Reserves are estimated to be 25 Mt medium to high-grade limestone. Mine life is estimated to be at least 25 years.
RE-OPENINGS									
Precious Metals									
Hope Brook	Couteau Bay	Nfld.	3 150	240	June 28	U/G	Gold	Royal Oak Mines Inc.	The mine was purchased from BP Canada Inc. on April 30, 1992. Ore reserves were recalculated and are now reported to be 7.4 million st grading 0.116 oz/st[3] gold. There is a further mineral resource of 3 million st grading 0.094 oz/st gold. The mine has been turned into a fly-in operation with supplies transported in by boat. Plans were to produce 50 000 oz of gold in 1992, at a cash cost of US$300/oz. Annual production will be about 120 000 oz of gold.

TABLE 1 (cont'd)

Project	Location	Province	Ore Capacity	Employment[1]	Date of Opening, Re-Opening, Expansion, Closure or Suspension	Mine Type	Main Commodities	Companies	Remarks
			(tonnes/day)						
Other Minerals									
Baie Verte tailings wet-processing operation	Baie Verte	Nfld.	3 500	76	April 9	Surface	Asbestos	Princeton Mining Corporation	The operation was most recently suspended in December 1991 due to low fibre recovery caused by frozen tailings. Teranov Mining Corporation, a wholly owned subsidiary of Princeton, is the operator.
EXPANSIONS									
Precious Metals									
Joe Mann	Chibougamau	Que.	1 630	240	1989-92	U/G	Gold	Campbell Resources Inc.	Mine expansion program, which began in 1989, continued in 1992. Gold production in 1991 increased to 87 500 oz compared to 72 700 oz in 1990. However, gold production for 1992 has now been revised downward to about 75 000 oz and may temporarily decline in the years 1993-95 pending completion of a new shaft.
Bousquet No. 2	Malartic	Que.	1 630	235	1991-93	U/G	Gold	Lac Minerals Ltd.	Commercial production began in October 1990. Gold production inreased from 67 163 oz in 1990 to the 169 500-oz level in 1991, and had planned to further increase to 200 000 oz in 1992. Ore is milled at Est-Malartic mill which, in September 1991, began a capacity expansion program (scheduled for completion in June 1993) to accommodate increased ore production from Bousquet No. 2 mine.
Kerr (formerly Kerr Addison)	Virginiatown	Ont.	2 000	200	1991-93	U/G	Gold	Deak Resources Corporation	Increased one of the three (initially) 1360-t/d gold circuits from 1800 t/d in 1990 to 2000 t/d in 1992. Company plans to further increase this capacity to 2700 t/d in 1993. As well, the company plans to convert another 1360-t/d circuit to treat base-metal ore or additional gold ore.
Base Metals									
Birchtree	Thompson	Man.	3 000e	85	1991-97	U/G	Nickel, copper	Inco Limited	Work to double production to 34 million lb of nickel annually by 1997 continues.

Other Minerals									
Quinsam	Campbell River	B.C.	700	104	1992-93	O/P & U/G	Coal	Hillsborough Resources Limited	Planned production increase was doubled to 500 000 t/y in 1992. New plan is to further increase production to 750 000 t/y in 1993.
SUSPENSIONS									
Precious Metals									
Cheminis	Virginiatown	Ont.	350	20	March	U/G	Gold	Northfield Minerals Inc.	Mining operation suspended because of low gold price.
Casa Berardi Est	La Sarre	Que.	600	182	April	U/G	Gold	TVX Gold Inc. and Golden Knight Resources Inc.	Mining operation suspended due to ground problem. There were no layoffs.
Magino	Wawa	Ont.	400	118	June 30	U/G	Gold	Muscocho Explorations Limited and McNellan Resources Inc.	Operation suspended due to declining gold price and a lack of working capital.
Copper Rand	Chibougamau	Que.	3 100[a]	360[a]	November	U/G	Gold, copper	Westminer Canada Limited	Mine closed due to high costs and weak metal prices.
Portage	Chibougamau	Que.			November	U/G	Gold, copper	Westminer Canada Limited	Mine closed due to high costs and weak metal prices.
Base Metals									
Langmuir No. 1	Timmins	Ont.	450	45	February	U/G	Nickel	Timmins Nickel Inc.	Mine placed on care and maintenance due to poor recoveries and low nickel price.
Shebandowan	Thunder Bay	Ont.	2 540	360	May 15	U/G	Nickel, copper	Inco Limited	Operation suspended due to weak prices for nickel and other metals.
Redstone	Timmins	Ont.	320	45	August	U/G	Nickel	Timmins Nickel Inc.	Mining suspended due to low nickel price.
Other Minerals									
Balmer	Sparwood	B.C.	30 000	1 300	May 1	O/P	Coal	Teck Corporation	Mining operation suspended due to contract dispute between union and previous owner, Westar Mining Ltd., as well as to financial difficulties. Mine purchased by Teck Corporation in December 1992. Company plans to re-open the mine in 1993.
Westray	Plymouth	N.S.	3 000	225	May 9	U/G	Coal	Curragh Inc.	Mining suspended following an underground explosion.
Greenhills	Sparwood	B.C.	3 550	650	November	O/P	Coal	Fording Coal Ltd.	Mine closed due to bankruptcy by its previous owner, Westar Ltd. Mine purchased by Fording Ltd. in December. Company plans to re-open the mine in 1993.
Lingan	New Waterford	N.S.	3 000	320	November	U/G	Coal	Cape Breton Development Corporation	Mining suspended due to severe flooding. The mine was initially earmarked for closure in March 1993 due to economic reasons.

TABLE 1 (cont'd)

Project	Location	Province	Ore Capacity (tonnes/day)	Employment[1]	Date of Opening, Re-Opening, Expansion, Closure or Suspension	Mine Type	Main Commodities	Companies	Remarks
CLOSURES									
Precious Metals									
Malartic Hygrade	Val-d'Or	Que.	450	80	January	U/G	Gold	Republic Goldfields Inc. and American Barrick Resources Corporation	Mine closed due to depletion of ore reserves.
Lac Shortt	Desmaraisville	Que.	1 150	156	March 18	U/G	Gold	Minnova Inc. and Kerr Addison Mines Inc.	Mine closed due to depletion of ore reserves. The surface complex will be kept open until mid-1993 to treat water from the tailings pond. This low-grade mine had produced continuously since 1983.
Kierens	Val-d'Or	Que.	180	10	May	U/G	Gold	Aur Resources Inc.	Mine closed due to depletion of ore reserves. Production began in April 1989.
Premier Gold open-pit	Stewart	B.C.	2 000	100	August	O/P & U/G	Gold	Westmin Resources Limited, Pioneer Metals Corporation and Canacord Resources Inc.	The open-pit mine closed due to depletion of pit ore reserves. Underground operation continues with 50 employees.
Lawyers	Smithers	B.C.	500	140	December	U/G	Gold, silver	Cheni Gold Mines Inc.	Mine closed due to depletion of mineable ore reserves. The mine began production in 1988. The company is reviewing the possibility of mining and milling the nearby small Mets gold deposit owned by Golden Rule Resources Ltd. and Manson Creek Resources Ltd.
Samatosum	Adams Lake	B.C.	450	51	September	O/P & U/G	Silver, copper, lead, zinc, gold	Minnova Inc. and Rea Gold Corp.	Mine closed due to ore depletion. The mine started production in 1989.
Camflo	Val-d'Or	Que.	1 200	125	October	U/G	Gold	American Barrick Resources Corporation	Mine closed due to depletion of ore reserves. Mill may be kept open to process custom ores. The mine began commercial production in 1965.
Equity Silver open-pit	Houston	B.C.	9 000	156	September	O/P	Silver, gold, copper	Placer Dome Inc.	Mine closed due to depletion of pit ore reserves but underground mining began in October 1992. Open-pit production began in 1980 (see openings).
Base Metals									
East Kemptville	Yarmouth	N.S.	9 000	220	January 3	O/P	Tin	Rio Algom Limited	Mine closed due to low tin price and short remaining mine life. Production began in 1985.

Mobrun	Rouyn-Noranda	Que.	1 200	115	January 10	U/G	Copper, zinc	Audrey Resources Inc.	Mine closed due to depletion of current ore reserves. Company is seeking funds to develop the 1100 lens. Production from open-pit began in July 1989 and from underground in October 1987.
Faro underground	Faro	Yukon	2 000	60	November	U/G	Zinc, lead, silver	Curragh Inc.	Mining ceased due to depletion of underground ore reserves. Company plans to complete the open-pit mining operation in the first quarter of 1993. The Faro underground operation began production in 1990. Company is seeking financing to continue with development of the nearby Grum mine as well as the Stronsay in northern B.C. Both are zinc-lead deposits.
Bell	Granisle	B.C.	16 000	260	June 12	O/P	Copper	Noranda Minerals Inc.	Mine closed due to depletion of ore reserves. Production began in 1972, was suspended in 1982 and the mine re-opened in 1985.
Spruce Point	Flin Flon-Snow Lake	Man.	680	42	March	U/G	Copper, zinc	Hudson Bay Mining and Smelting Co., Limited	Mine closed due to depletion of ore reserves.
Other Minerals									
Cassiar (McDame)	Cassiar	B.C.	3 600	450	February 5	U/G	Asbestos	Arthur Anderson & Co. (receiver)	Mine closed under orders from B.C. Supreme Court as a result of company's financial problems. Cassiar Mining Corporation (a wholly owned subsidiary of Princeton Mining Corp.), which operated the mine, went into receivership on February 6, 1992. Mine had operated since 1954, initially as an open-pit. Underground mining commenced in 1990.
Denison	Elliot Lake	Ont.	13 600	900	March 11	U/G	Uranium	Denison Mines Limited	Operation ceased due to termination of a long-term contract by Ontario Hydro. Because of low grade, low uranium prices and high production costs, the mine is no longer competitive. The mine, which began production in 1957, was the largest underground uranium mine in North America.
Evans	Inverness	N.S.	150[e]	35	August 8	U/G	Coal	Evans Coal Mines Ltd.	Mine closed due to fire followed by flooding, as well as for economic reasons.

Source: Energy, Mines and Resources Canada.
O/P Open-pit; U/G Underground.
[e] Estimated.
[a] Aggregate number for Copper Rand and Portage mines.
[1] Employment refers to workers on the company's payroll and to contract workers at an operation, or at an operation prior to its closure. [2] Reflects a change in status of operation. [3] Troy ounces.

Aluminum

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The international aluminum industry faced another difficult year in 1992. Western World consumption of primary aluminum increased about 1% over 1991. The increase in consumption was not, however, enough to keep pace with production and a steady flow of exports from the Commonwealth of Independent States (C.I.S.). The continued market imbalance resulted in further increases in inventories and weak prices.

On the London Metal Exchange (LME), prices recovered somewhat from their record lows in 1991 but remained weak through 1992. Aluminum inventories on the LME continued to rise despite several major production cuts by Western producers. Inventories in LME warehouses reached record high levels of over 1.5 Mt by year-end.

CANADIAN DEVELOPMENTS

Canadian production of primary aluminum in 1992 increased 7% to 1.950 Mt compared to 1.822 Mt in 1991. Two new smelters started production and idled capacity at three smelters was brought back on stream. Canadian exports of primary smelter products during the first nine months of 1992 were 1.17 Mt, compared with 1.11 Mt for the same period in 1991. Exports to the United States in the first nine months totalled 791 264 t compared to 723 900 t for the same period last year.

Alcan Aluminium Limited (Alcan) restarted idled aluminum production at three of its smelters in Quebec. In 1991, the company reduced production at Shawinigan by 21 000 t/y, at Isle-Maligne by 24 500 t/y, and at Jonquière by 22 000 t/y. Alcan considered the temporary closures necessary due to the weak international price of aluminum, combined with water shortages in the Saguenay-Lac-Saint-Jean region. Higher than average rainfall last summer has since replenished the region's reservoir capacity.

Alcan's Kemano completion project near Kitimat, British Columbia, continued to sit idle pending the outcome of further court action against the project. The $1 billion project is the second phase of Alcan's hydro-electric development of the Nechako River system and was expected to add 540 megawatts (MW) to Alcan's Kemano generating station by 1994. Construction started in 1989 following extensive environmental reviews and modifications to meet federal and provincial regulations.

The Kemano station currently supplies power to Alcan's 272 000-t/y aluminum smelter at Kitimat. Alcan's expenditures and spending commitments on the expansion have, to date, exceeded $675 million. In May 1992, a Federal Court of Appeal panel overturned a lower Court's decision calling for a public environmental review of the project. The Court of Appeal upheld the original 1987 agreement between Alcan and the federal and British Columbia governments, giving the company the necessary permits to start construction.

The Supreme Court of Canada ruled early in 1993 that it will not hear further arguments on the applicability of the federal Environmental Assessment and Review Process (EARP) Guidelines Order to the Kemano project. The Supreme Court decision cleared a major uncertainty that was preventing Alcan from continuing construction of the project. Alcan will not resume construction, however, until the uncertainty surrounding the outcome of the B.C. government's public review of the project has been resolved.

Aluminerie Lauralco, Inc. completed construction at its new smelter at Deschambault, Quebec, in 1992. The $1 billion plant is wholly owned by Alumax Inc. of the United States. The smelter began operations in February and is scheduled to reach its full production capacity of 215 000 t/y by the first quarter of 1993. The Lauralco smelter employs the energy-efficient Pechiney 300 KA technology and has installed the most modern environmental technology available, complete with airborne emission scrubbers and a fully recycled water system. The smelter employs 470 people and will contribute an estimated $100 million annually to the local economy.

Production began in June 1992 at the new Aluminerie Alouette Inc. project at Sept-Îles, Quebec. The $1.4 billion smelter has a production capacity of 215 000 t/y with a total workforce of 530 employees. The smelter reached full production capacity by year-end. The Alouette smelter also employs the Pechiney 300 KA technology and modern environmental control equipment. Aluminerie Alouette Inc. is a consortium of six companies comprising Germany's Vereinigte Aluminium-Werke AG (VAW), Austria Metall AG, Hoogovens Groep BV of the Netherlands, Société générale de financement du Québec (SGF), and Japan's Kobe Steel Ltd. and Marubeni Corp. Plans to build a second phase that would double the smelter's capacity by 1997 have been postponed due to weak market conditions.

Canadian Reynolds' parent company, Reynolds Metals Company, sold its North American electrical cable operations to BICC Cables Corp. for approximately US$100 million. As part of the deal, Canadian Reynolds will maintain a long-term supply agreement to provide BICC with aluminum redraw-rod from its new $49 million rod plant at Bécancour. The sale of the cable division included Canadian Reynolds' cable plant at La Malbaie, as well as the company's U.S. operations at Malvern, Arkansas; Marshall, Texas; and Longview, Washington. The La Malbaie plant has an annual capacity of about 25 500 t of aluminum alloy wire and cable. BICC intends to integrate the La Malbaie operations with the Utilities Division of Phillips Cables Ltd.

At year-end, Canadian Reynolds announced it was regrouping its fabricating activities in Canada. Beginning in January, Reynolds Aluminum Company of Canada and Reynolds Extrusion Company, both divisions of Canadian Reynolds, will merge into one Canadian organization. Reynolds Aluminum operates two fabricating plants in Quebec (Cap-de-la-Madeleine and Anjou) and two plants in Ontario (Etobicoke and Weston). Reynolds Extrusion operates two plants, one at Sainte-Thérèse, Quebec, and one at Richmond Hill, Ontario.

On December 23, 1992, Canadian Reynolds' Baie Comeau aluminum smelter celebrated the pouring of its first aluminum ingot 35 years ago. Built by Canadian British Aluminium in 1955, the plant was later expanded to 160 000 t/y in 1970. The plant was completely modernized with Sumitomo technology and expanded using Pechiney pre-bake technology between 1982 and 1985. Canadian Reynolds further expanded the plant from 1989 to 1991 bringing the plant's total capacity to 400 000 t/y. Canadian Reynolds has invested over $1.2 billion over the last 10 years, of which approximately 15% was spent on recycling facilities and environmental controls.

The Aluminerie de Bécanour Inc. (A.B.I.) smelter at Bécancour operated at full capacity in 1992. The company completed a $550 million expansion in 1991 that increased the smelter's capacity to 360 000 t/y. Two thirds of the company's production is exported to the United States. The remaining third is divided almost equally between Canada and Europe.

WORLD DEVELOPMENTS

Weak market conditions prevailed throughout most of the Western World in 1992. Despite announced smelter closures and production cutbacks of about 1 Mt in 1991 and 1992, supply remained higher than demand. Several new projects that were already under construction before the current economic down-turn started production during the year, adding about 1 Mt of new production capacity by the end of 1992. Exports to the West by C.I.S. countries continued to add to inventories on the LME. By year-end, several additional plant closures were announced in Europe and several new projects, particularly in Venezuela, were postponed.

Total world production of primary and secondary aluminum reached an estimated 24 Mt in 1991, of which 18.5 Mt was primary. Western World smelter capacity reached 15.95 Mt by the end of 1992 and Western World production declined an estimated 3% in 1992, mainly as a result of a 7% decline in European production.

United States

Despite the weak performance of the U.S. economy in 1992, total domestic aluminum shipments increased an estimated 3% over the same period in 1991. Aluminum production, however, declined 1.7% in 1992 for the first time since 1986. While most of the 23 primary aluminum smelters in the United States operated at close to their nameplate capacities, Reynolds Metals' 121 000-t/y Troutdale smelter remained closed in 1992.

Nine aluminum smelters in the U.S. Pacific Northwest were forced to buy higher-cost power after a 25% cut in hydro-electric supplies at the beginning of September. The Bonneville Power Administration exercised its right to cut power to its 15 Direct Service Industries in the last four months of 1992. Severe drought conditions have lowered water run-offs in the Columbia River tributaries that supply the area's dams. Despite the increased costs, none of the producers in the region, representing some 40% of U.S. primary output, curtailed production before the end of the year. Higher-cost power was available from other sources, including Canada. However, should the water shortage conditions continue in 1993, several producers in the Pacific Northwest will be forced to cut production.

Ravenswood Aluminum Corp. announced in June that it had reached a new three-year contract with its striking employees. The signing of the new contract ended an often bitter work dispute that lasted 19 months at the company's 200 000-t/y aluminum smelter in West Virginia.

Mexico

Alcoa closed the last potline at its 68 000-t/y Veracruz smelter in March. The smelter had been operating at close to 24 000 t/y since October 1991. Later in the year, Alcoa announced the sale of its 44.3% equity share in Grupo Aluminio to Grupo Carso for $50 million. The purchase by Grupo Carso included the Veracruz smelter and three associated mills.

Jamaica

The Jamaican Bauxite Institute reported that earnings from bauxite and alumina exports fell 10% to US$300 million in the first half of 1992 from the same period in 1991. Lower world prices were cited as the main reason for the decline. Despite the fall in revenue, total bauxite production for the first six months of 1992 had risen 1% to 5.59 Mt. Alumina production fell slightly to 1.46 Mt, down from 1.49 Mt. The decline in alumina output was attributed to technical problems at two alumina plants that are undergoing improvements.

A proposal for a joint Jamaican-Ukrainian venture to re-open the Lydford mine was delayed by year-end. The Ukraine approved the project in late October, but a change in government in the Ukraine delayed the project further. The mine has been closed for eight years. Production at Lydford is expected to reach 2.5 Mt/y within five years of the start-up date. Most of the mine's output was expected to go to the Ukraine's Nikolaev alumina plant.

Several other projects, however, were more successful in 1992. Alpart, a joint venture with Norsk Hydro, expanded output from 1.2 Mt/y to 1.45 Mt/y of alumina and is expected to expand to 2 Mt/y by the year 2000. Jamalco, a joint venture with Aluminum Company of America (Alcoa), will expand alumina production to 1 Mt/y by 1994. Discussions are continuing for a further 1-Mt expansion at a cost of up to US$750 million. Technical studies for a new $1.5 billion alumina plant are expected to begin in 1993. The plant will initially produce 1 Mt/y.

Talks to form a joint Jamaica-Trinidad aluminum smelter at Point Lisas in Trinidad continued in 1992. Plans for the project have been downgraded from the original 200 000-t/y smelter to a $200 million, 55 000-80 000-t/y mini-smelter, which could later expand to a full-scale smelter.

South America

Several Brazilian aluminum producers faced difficulties in 1992 because of increased power costs, weak international prices, and a decline in demand of about 11% in the domestic market. Exports of primary and semi-fabricated products increased 14% in 1992 to a record 944 000 t, mainly as a result of the weak domestic demand.

Alcan Alumínio do Brasil S.A. reduced production capacity by 27 000 t/y at its 56 000-t/y Aratu smelter in northeastern Bahia State due to high electricity costs. In addition, the smelter will stop producing ingot for export. The closure follows the company's closure of 9000 t/y of capacity at its Ouro Preto smelter in 1991. Alcan Alumínio's total production capacity in Brazil now stands at 81 000 t/y.

Elsewhere in Brazil, Consórcio Alumar SA completed an expansion at its Alumar smelter at São Luis. The addition of a third potline increased capacity from 160 000 t/y to 350 000 t/y. Alumar is a joint-venture consortium comprising Alcoa Alumínio SA (60%) and Billiton Metais SA (40%).

Ground-breaking activity was reportedly taking place in November for the new 215 000-t/y Aluyana aluminum smelter in Venezuela. In July, the French bank Indosuez signed an agreement to raise US$1.35 billion to finance construction of the Venezuelan-Italian joint-venture project. Construction of the project could start sometime in the second half of 1993. The plant will be built in the industrial city of Guyana, 700 km southeast of Caracas. The Italian government holds a 40% interest in the project, the Venezuelan state firm Corporación Venezolana de Guyana (CVG) holds another 15%, and a consortium of Venezuelan investors holds the remaining 45%.

Elsewhere in Venezuela, Aluminio del Caroni (Alcasa) postponed plans to add a fifth potline to expand its primary capacity from 210 000 t/y to 400 000 t/y. The fifth potline expansion, also known as the Quintametal project, would have involved Alcasa's parent company (CVG) and Austria Metall using Reynolds' technology.

Camea SA, a subsidiary of Alcan, and Kisca Industrial y Comercial SA (Kisca) signed a letter of intent in September to consider a possible merger of the two companies' activities in Argentina. Camea produces a range of products including sheet, foil and foil products, extrusions and rod, foundry alloys, and rigid containers. Kisca produces sheet, plate, extrusions, and foil. Kisca's parent company, Aluar Aluminio Argentino SAIC (Aluar), operates Argentina's only aluminum smelter. The 175 000-t/y Puerto Madryn smelter reduced capacity by 15 000 t/y in 1991.

Three joint-venture smelter projects are currently under review in Chile. Australia's Comalco Smelting, a subsidiary of Comalco Limited, and Japan's Marubeni Corp. are studying a proposal to build a 220 000-t/y smelter in southern Chile. The US$1.5 billion smelter project will include a 380-MW hydro-electric plant. Chile's Aysen SA and U.S.-based Noranda Aluminum Inc. completed initial studies for the US$1.5 billion Alumysa project and are reportedly considering partners and financing for the construction of a 240 000-t/y aluminum smelter. Plans for the project include a 380-MW hydro-electric plant. In the third project, Comalco and Geostudios have also been studying a possible smelter project for the Punta Arenas area. The cost of the 240 000-t/y smelter is reportedly about US$2 billion.

Europe

German aluminum producer VAW temporarily reduced aluminum production by 26% (105 000 t/y) at the company's Rheinwerk and Innwerk smelters. The production cuts were in response to weak prices and are expected to remain in effect until the end of 1993. Production at the company's Elbwerk smelter was not affected.

Pechiney's new 215 000-t/y Dunkirk aluminum smelter reached its full production capacity in May. The new plant will produce about half the company's total production in France. Toward year-end, Pechiney announced that it will reduce its workforce by 337 jobs and reduce annual output by 110 000 t at its European operations. The smelters affected by the production cuts include Pechiney's Vlissingen smelter in the Netherlands, and the Auzat, Lannemezan, and Saint Jean smelters in the south of France. Pechiney's 31 000-t/y aluminum smelter at Venthon will be permanently closed in stages up to April 1994.

In the Netherlands, Hoogovens Aluminium BV announced that it had decided to postpone expansion plans for its 95 000-t/y Delfzijl smelter. The plan had originally called for the plant to expand to 120 000 t/y by the year 2000; however, the company was unable to negotiate favourable power supply terms.

Italy's state-owned Alumix SpA announced that it had closed its 32 000-t/y Fusina 2 smelter. The high cost of electricity, coupled with low aluminum prices, has forced the company to evaluate all smelting operations in Italy. Alumix announced that further closures may be inevitable at its 35 000-t/y Fusina 1 and 130 000-t/y Porto Vesme smelters if no agreement can be reached to lower power rates.

Amag Metall Ges.mgH, a subsidiary of Austria Metall AG, closed its 83 000-t/y Ranshofen smelter in December. The smelter had been operating at reduced capacity since the company announced its closure in June 1991.

Romania's state-owned Slatina smelter has cut production and reduced exports to the West. Sections of the 263 000-t/y Slatina smelter have reportedly been closed.

The 92 000-t/y Mostar aluminum smelter in Bosnia-Herzegovina was closed because of heavy damage resulting from the civil war in the former Yugoslavia. Elsewhere in the former Yugoslavia, the 75 000-t/y Sibenik smelter in Croatia, also damaged by the civil unrest, remained closed in 1992. The Titograd smelter in Montenegro has reduced production by half to 55 000 t/y. United Nations trade sanctions imposed against Serbia and Montenegro have interrupted the supply of raw materials which the smelter imported from the West.

Billiton BV announced in October that it is planning to sell its 35% share in the Aughinish Alumina Limited alumina refinery west of Limerick, Ireland. Canada's Alcan owns the remaining 65% equity share in the 900 000-t/y refinery.

Etibank has outlined plans to modernize and expand its Seydisehir smelter in south-central Turkey. The project includes plans for an increase in capacity from the current 60 000 t/y to 100 000 t/y by 1996.

Commonwealth of Independent States

Russian aluminum exports for 1993 are forecast to remain at around 1992 levels, and production is not likely to fall according to Concern Aluminii, the C.I.S. aluminum consortium. Exports to the West in 1992 were estimated at 800 000 t.

The northern Russian autonomous Komi Republic reportedly announced that a joint stock company would be set up to develop a large bauxite deposit in that region. According to reports, once developed, the Sredye-Timansky deposit could eventually produce some 6 Mt/y of bauxite and 1 Mt/y of alumina.

Kaiser Aluminum Corporation of the United States continued to make progress towards the construction of a new 130 000-t/y smelter at Irkutsk in western Siberia. A budgetary feasibility study was reportedly completed in 1992. The second phase of the project involves the modernization of the existing 275 000-t/y smelter. In Kaiser's other Russian project at the 800 000-t/y Krasnoyarsk smelter, work is reportedly on target toward the 1994 completion of a modernization project.

Tadjikistan's Regar aluminum smelter was reportedly resuming normal production at year-end. Production fell slightly in 1992 to about 360 000 t/y from 370 000 t/y in 1991 due to shortages of alumina. Russian alumina supplies were disrupted because of civil unrest within the Republic. The Regar smelter has an annual production capacity of 517 000 t. The bulk of production is exported to the West through the C.I.S., and accounts for roughly 60% of Tadjikistan's foreign trade income.

Toronto-based Algoods, Inc., a Division of Alcan Enterprises, is providing its Roll-Bond technology for producing refrigerator components to a new plant at Sverdlovsk in western Siberia.

Middle East

Bahrain increased production capacity at its aluminum smelter from 255 000 t/y to 460 000 t/y. The $1.5 billion expansion program at Aluminium Bahrain BSC (ALBA) was completed before year-end and the new smelting line is operating at full capacity. ALBA is owned by the Bahrain government (77%), the Saudi Public Investment Funds Group (20%), and the German group, Breton Investments (3%). In addition to the new potlines at the smelter, ALBA also conducted an extensive modernization program on the older technology cells.

Bahrain Aluminium Extrusion Company (BALEXCO) set up a joint venture with Italy's Finleader to utilize increased output from the expanded ALBA smelter. The new Gulf Aluminium Industries Company will have a new extrusion plant and two production lines to recycle its own waste into aluminum billets. BALEXCO (80% owned by the Bahrain government) maintains a 51% equity interest in the new company and Finleader holds the remaining 49%. The new plant will export most of its output to European markets.

The Iranian Aluminium Co. (Iralco) announced that it had completed work on a new 21 000-t/y potline, increasing the Arak smelter's capacity to 96 000 t/y. A fifth potline will be commissioned early in 1993, which will increase capacity to 120 000 t/y. Elsewhere in Iran, the Iranian government and the Dubai International Development and Cooperation Co. signed an agreement late in the year for the construction of the new 220 000-t/y Al-Mahdi smelter at Bandar Abbas in southern Iran.

Asia

Finland's Kuusakoski Oy and a group of Finnish and Asian investors agreed to start construction of a new secondary aluminum processing plant and smelter in Malaysia. A joint firm, Johor Aluminium Processing Sdn Bhd, will operate the plant. The plant is due to start operations in early 1993 and will produce 7500 t/y of aluminum ingots for the domestic and export markets.

India's Larsen & Toubro announced that it had received government approval to build an export-oriented alumina plant in the eastern state of Orissa. The project's first phase, to be completed by early 1997, will produce 500 000 t of alumina for export. The capacity could later be expanded to 1.5 Mt/y. The plant will process bauxite from a new mine to be developed in Orissa.

Elsewhere in India, Nalco was awaiting final authorization for plans to expand its Angul smelter in Orissa. The expansion plan will expand the 200 000-t/y smelter to 345 000 t/y. Indian Aluminium Co. Ltd. (Indal) closed its 73 000-t/y Belgaum smelter indefinitely following a 38% power rate increase in July. Montréal-based Alcan owns 35.6% of Indian Aluminium.

No major increase in aluminum imports is forecast for China over the next several years as China expands its primary aluminum capacity. Primary aluminum production in China is expected to increase by about 60% over the next three years.

China produced 1 Mt of aluminum in 1992, compared to between 700 000 t/y and 800 000 t/y in the previous three years. China has identified the aluminum industry as a priority for development to satisfy domestic demand.

Japan's Mitsubishi Materials Corp. is investing US$400 million to expand its aluminum can output to five billion pieces per year by 1995. The company currently produces three billion pieces per year and will increase the productivity of its existing four aluminum can plants in Japan. Japan's aluminum can demand is expected to increase, partly due to environmental concerns.

Sumitomo Light Metal Industries Ltd. and Reynolds Metals Company signed a cooperation agreement to develop aluminum materials for cars. Under the three-year agreement, the two companies will exchange technology for making aluminum sheets for automobiles. Reynolds Metals will participate in another joint research project with Mitsubishi Materials Corporation, Mitsubishi Corporation, and Mitsubishi Aluminium Co. Ltd. aimed at jointly developing aluminum-extruded products for automobiles.

Africa

Egypt's Nag Hammadi smelter is undergoing a modernization and expansion that is expected to be completed by the mid-1990s. The 400 Söderberg pots are being converted to pre-bake technology and the smelter will expand from its current 180 000 t/y to 240 000 t/y.

Iran and Guinea announced the formation of a joint company to mine Guinean bauxite. Guinea will hold 49% of the company and the remaining 51% will be shared by three Iranian firms. Elsewhere in Guinea, Belgium's Tractebel Industrie SA announced that it had signed an engineering services agreement in Guinea for a project to upgrade and extend a Compagnie des Bauxites de Guinée (CBG) bauxite ore treatment plant. The upgrade is aimed at increasing Guinean bauxite production to 12 Mt/y.

South Africa's Alusaf (Pty.) Ltd. announced plans for a new aluminum smelter at Richards Bay, South Africa, at a capital cost of about $3 billion. The new smelter will employ the latest Pechiney technology and add 466 000 t/y to Alusaf's current capacity. When fully commissioned in 1996, total capacity at Richards Bay will increase to 636 000 t/y. Montréal-based SNC-Lavalin signed a contract to form a joint venture with Johannesburg-based Engineering Management Services to build the new smelter.

Work continued in 1992 on the Aluminium Smelting Company of Nigeria (ALSCON) joint-venture Ikoi Abasi aluminum smelter in Nigeria. Work on the new US$1.6 billion 180 000-t/y aluminum smelter is nearly half complete. The smelter is due to start production by 1995. The Nigerian government owns 70% of ALSCON, with the rest shared between three foreign companies, including a 10% share held by Reynolds Metals.

Senior officials at Kaiser Aluminum were reportedly in Mozambique to collect information concerning a possible aluminum smelter project to be built before the turn of the century. The project could involve the construction of a 250 000-t/y aluminum smelter to be supplied by electricity from the Cabora Bassa dam. Kaiser officials were also reportedly in Cameroon to investigate a possible 250 000-t/y smelter project in that country. No final decisions on either project have been announced.

Australia

Five Japanese firms, including Kobe Steel, Ltd. and Sumitomo Light Metal Industries Ltd., announced plans to finance a US$675 million project to expand and renovate the Boyne Smelters Ltd. aluminum smelter in Queensland. Boyne Smelters is jointly owned by Australia's Comalco Limited and the five Japanese firms. The company plans to increase aluminum smelting capacity at the plant to 460 000 t/y from the current 230 000 t/y.

The Tomago Aluminium Co. Pty Ltd. expansion was nearing completion by year-end. The A$700 million expansion added a third potline and increased the smelter's capacity from 240 000 t/y to 380 000 t/y. The smelter is owned by a joint-venture consortium comprising Pechiney (35%), Gove Aluminium Ltd. (35%), Australian Mutual Provident (15%), VAW (12%), and Hunter Douglas Holdings Limited (3%).

Alcoa of Australia Limited announced its plans to commission the A$300 million expansion at its Wagerup alumina refinery by the end of 1993. The Wagerup refinery expansion began in 1990 and will increase capacity from the current 850 000 t/y to 1.5 Mt/y.

New Zealand

Comalco's Tiwai Point smelter in southern New Zealand lost about 20 000 t of production following a forced shut-down of one of the company's three potlines. The reduction was forced after drought conditions reduced the state-owned Electricorp's ability to supply power to the smelter.

Recycling

Secondary aluminum production is increasing worldwide. Western World production of secondary aluminum in 1991 was estimated at 5.6 Mt compared to 5.3 Mt in 1990. The increase in secondary production can be attributed to continuing improvements in scrap collection systems and increased recycling. The automotive industry is the largest consumer of secondary aluminum, consuming some 80% of secondary production either through direct sales or to casters supplying the automotive industry. As requirements for lighter vehicles increase, it is likely that the demand for secondary aluminum will increase significantly.

Recycling aluminum requires less than 5% of the energy used to make the original metal. As a result, energy represents only 2% of a secondary aluminum smelter's operating cost, compared to about 26% for a primary aluminum smelter.

In 1991, the largest secondary producers were the United States at 2.1 Mt, Japan at 1.5 Mt, and Germany at 0.5 Mt. Canada produced 67 660 t of secondary aluminum in 1991. Scrap recovery is well established in the United States. In 1991, 41% of total U.S. aluminum consumption was accounted for by secondary aluminum. Canada consumed 134 500 t of secondary aluminum in 1991 compared to 137 000 t in 1990 (excluding the direct use of scrap).

The most important sources of aluminum scrap in the United States are from the packaging (principally used beverage containers) and transportation sectors. In 1991, some 56.8 billion cans were recycled in the United States, representing a recycling rate of 62.4%. In Europe, 32 000 t, or 21%, of used beverage cans were recycled in 1991; Canada recycled 80% of the aluminum cans it produced.

Secondary aluminum production in the C.I.S. in 1992 was reportedly about 364 000 t, compared with a production capacity of 770 000 t. Russian production dropped to about 270 000 t from 527 000 t in 1991, while production in the Ukraine decreased to 80 000 t from 158 000 t in 1991. The fall in production is reportedly due to a shortage of scrap. There are a total of 13 secondary aluminum producers in the C.I.S.

Programs are currently in place in the United States and Canada to promote recycling of other types of household aluminum products in addition to beverage cans. Advertising campaigns to promote the recycling of aluminum foil and other aluminum products were started by Reynolds Metals, Alcoa, and Alcan. Alcan's Arvida Research and Development Centre is working on a pilot program in the Lac-Saint-Jean region of Quebec to develop new technologies for recycling a variety of household aluminum products. In Scarborough, Ontario, Canadian Reynolds started a pilot program to increase recycling of aluminum foil products. Special recycling bins were placed at recycling depots in the city to collect foil. Barriers to wider recycling of aluminum foil products include the lack of public awareness, municipal curbside recycling programs that do not accept such products, and aluminum producers that do not handle foil or other household sources of aluminum.

The LME officially launched three-month trading of its new aluminum alloy (secondary) contract on October 6, 1992, despite strong opposition by many secondary ingot producers, particularly in Japan. Cash metal trading is set to begin on January 4, 1993. Special arrangements for storage were made since secondary aluminum oxidizes over long periods unless it is held at specific temperatures and humidity conditions. Ingots will be warranted within eight weeks of production. The LME has approved locations in the United Kingdom, the United States, Germany, Belgium, the Netherlands, France, and Italy. The LME's deliverable brands account for some 2 Mt of secondary annual production capacity.

Consumption and Uses

Total world consumption of primary aluminum is estimated at 17.7 Mt in 1992, compared to 17.3 Mt in 1991. Canada consumed an estimated 420 000 t of primary aluminum in 1992, compared to 466 000 t in 1991. Total Western World consumption of primary aluminum increased about 1% to approximately 15.3 Mt. Total Canadian consumption in 1991, including secondary waste and scrap, was 600 700 t.

Aluminum is the most abundant metal in the earth's crust. Unlike most of the other major metals, aluminum is never found in its native state; it occurs mainly as an oxide. When combined with water and other impurities, it produces the main ore of aluminum known as bauxite. Pure aluminum is a bluish silver-white, malleable, ductile metal with one third the density of steel. Aluminum's dull lustre results from a thin coating of oxygen that forms when it is exposed to air. It is this characteristic that accounts for aluminum's resistance to corrosion. Aluminum is an excellent conductor of electricity. Gram for gram, it has twice the electrical conductance of copper. It is also a good conductor of heat and a good reflector of light and radiant heat.

Combining aluminum with other metals to produce alloys enhances its characteristics and increases its versatility. The most common metals used in combination with aluminum are copper, magnesium, manganese, silicon, and zinc. Aluminum's tensile strength, hardness, corrosion resistance, and heat-treatment properties improve when alloyed with one or more of these metals. Some copper-aluminum alloys, for example, can exceed the tensile strength of mild steel by as much as 50%.

In both its pure and alloyed forms, aluminum is used to make a variety of products for the consumer and capital goods markets. The largest markets for aluminum are transportation (25%), building and construction (21%), packaging (21%), electrical (10%), consumer durables (7%), and machinery and equipment (9%). Geographically, North America is the largest consuming region, accounting for 36% of total Western World production, followed by Europe at 30% and Asia at 25%.

The transportation sector is the largest single consumer of primary and secondary aluminum. The enforcement of stricter fuel efficiency and emissions standards is encouraging many auto manufacturers to reduce their vehicles' weight. Increased consumer demand for cars with added luxury items is also driving manufacturers to find ways to reduce automobile curb-weight. New applications for aluminum sheet and extrusion go beyond the traditional casting applications used in auto parts. Currently, most aluminum applications centre on cylinder heads, intake manifolds, engine blocks, pistons, heat exchangers, air conditioners, transmission housings, wheels, and exterior trim and bumper systems.

A report released in November by the U.S.-based Aluminum Association indicates that the average North American automobile currently contains about 87 kg of aluminum. By comparison, Japanese automobiles expect to contain about 100 kg of aluminum by 1995. The study found that, in 1991, the Ford Motor Company averaged more aluminum usage per car than other North American automakers. Ford models averaged 99 kg, General Motors Corporation (GM) models averaged 89 kg, and Chrysler Corp. models averaged 71 kg per vehicle.

Several joint-venture projects are studying new applications for aluminum in the automotive industry. Kaiser Aluminum Corp., Furukawa Aluminum Co. Ltd., and Kawasaki Steel Corporation announced the signing of a letter of intent to work jointly on a product development project for aluminum automotive body sheet. Each company will provide technology and technical resources, and it is expected that the research and development phase of the project will take two to three years. Reynolds Metals signed an agreement with Mitsubishi Corporation, Mitsubishi Materials Corporation, and Mitsubishi Aluminum Co. Ltd. to pursue joint research and development work in the production of aluminum extrusion applications for the worldwide automotive industry. The five-year agreement calls for representatives of Reynolds and Mitsubishi to review possible areas of cooperation in this field to identify specific applications.

Japan's Nippon Light Metal Company, Ltd., working with Canada's Alcan, developed a new aluminum space frame for cars with 1.8- to 2.0-litre engines to promote cars made with aluminum. The new frame weighs 72 kg and is stronger than others currently available. Space frames can improve productivity by employing fewer parts. Nippon Light Metal (45% owned by Alcan) has been working on aluminum space-frame applications for the past three years.

In addition to the automotive industry, aluminum is used in several applications in other areas of the transportation sector. Aluminum, because of its light weight and strength, is used in all types of aircraft, trucks, trains, subway cars, and ships. However, it faces increasing competition in the aircraft industry from composites, polymers, ceramics, and titanium. Weight-saving carbon-fibre composites now account for between 10% and 15% of the structural weight of most new airliners. Several aluminum producers are meeting the challenge by introducing aluminum-based composites.

Aluminum is also used in a variety of applications in the building and construction sector. Uses include siding, roofing, eaves-troughs, windows, doors, frames, screens, awnings, and canopies. In recent years, aluminum has faced intense competition from vinyl in the residential siding market and from wood in framing applications.

The packaging sector is one of the fastest growing markets for the aluminum industry after the transportation sector. In the packaging sector, which includes foil, flexible packaging and food containers, the beverage can market is forecast to grow by 5% to 15% of total aluminum consumption by the year 2000. In the United States, aluminum beverage cans comprise 95% of the total beverage can market. Despite its higher costs compared to other materials, aluminum has gained wide consumer acceptance based on its light weight, convenience, and recycling potential.

In May, the U.S. brewer Anheuser-Busch announced that it had designed a new beverage can that will reduce its aluminum requirements by 9000 t/y. The new can has a lid that is 0.3 cm smaller in diameter that the lid currently used by the industry. Anheuser-Busch fills and markets about 17 billion cans annually in the United States.

Some of the most promising new applications for aluminum are based on a family of new metal matrices. Alcan has invested more than $100 million in its "Duralcan" metal-matrix composite. Duralcan comprises aluminum reinforced with silicone carbide ceramic particles. While out-performing traditional aluminum alloys, it is fabricated using the same techniques. In addition, Duralcan has greater specific strength, is lighter than steel, and is less expensive than titanium. Initial markets for this material are expected in sporting goods, cast products, and small engine components. Potential applications are also expected in the automotive and aerospace industries. Alcan is currently working with Ford, Chrysler, Allied Signal Inc., and Toyota to develop brake rotors, and with Ford, GM, and Dana Corporation to develop drive shafts.

Another promising new use for aluminum is in the new aluminum air-cell battery developed by Alcan. The main advantages of the battery are long shelf life, low weight before activation, and constant power output. One of the many potential uses for the battery is in electric vehicles. When used in combination with a conventional lead-acid battery, the range of an electric vehicle increases from approximately 75 km to over 300 km.

HEALTH, SAFETY AND THE ENVIRONMENT

Alcan continued to make steady progress toward achieving its environmental objectives. In the past five years, the group expenditures on environment-related projects totalled $564 million. This does not include the US$722 million cost of the new primary smelter built at Laterrière in 1990 to replace older capacity. In 1992, expenses incurred to safeguard the environment and improve working conditions totalled US$80 million. This amount included the costs of waste treatment and air emissions reduction, as well as US$39 million for the costs associated with the future removal of permanently closed potlines and the restoration of waste disposal sites in Quebec.

Canadian Reynolds Metals Company Limited completed the installation in September of a network of stations to test ambient air and effluent quality around its 400 000-t/y Baie Comeau aluminum smelter. The completion of the project, at a cost of $350 000, forms part of the company's environmental investment to comply with standards set by the Quebec Ministry of the Environment. Air samples will be taken at four principal locations to verify fluoride, dust, polycyclic aromatic hydrocarbon (PAH), and sulphur dioxide (SO_2) emissions around the plant. Two more stations will monitor liquid effluent from the plant. Canadian Reynolds has invested more than $100 million in environmental controls at its Baie Comeau smelter.

PRICES AND STOCKS

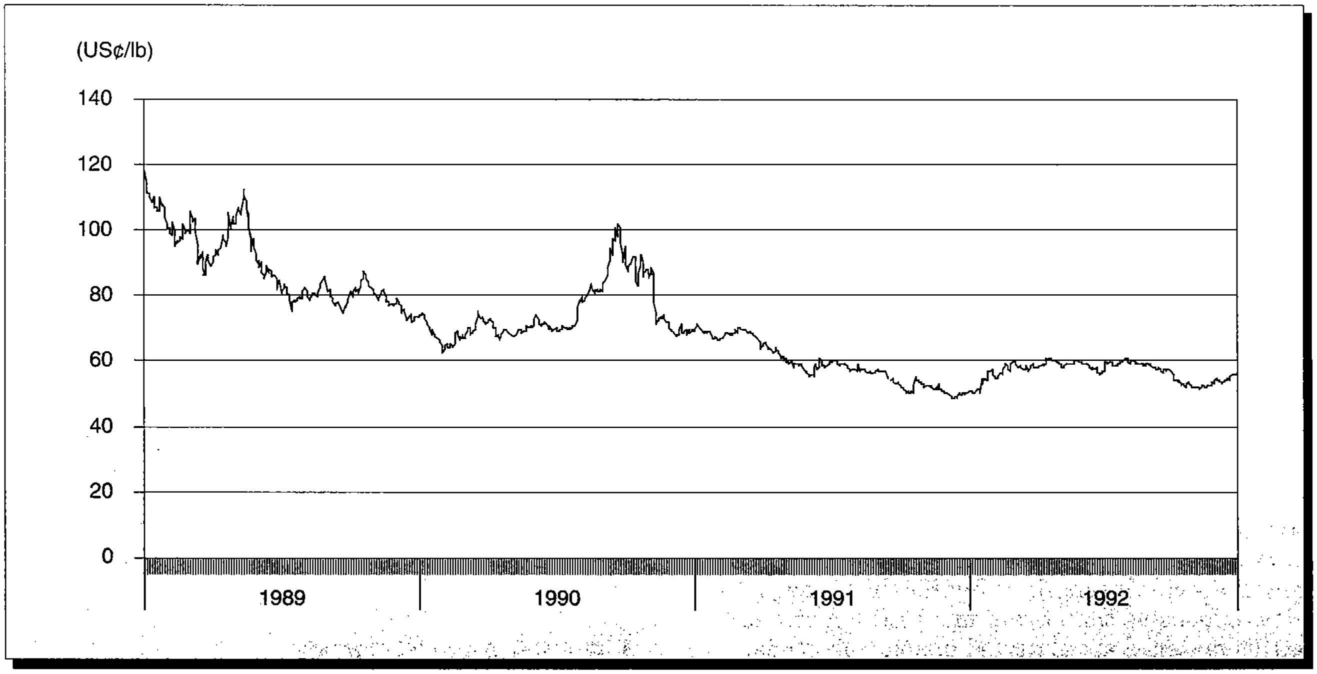
Prices on the London Metal Exchange (LME) averaged US57¢/lb in 1992 compared to an average price of 59¢/lb in 1991.

The International Primary Aluminum Institute (IPAI) reported that total Western World aluminum producer inventories (all forms) totalled 3.235 Mt in November 1992, compared to 3.339 Mt in November 1991. The IPAI also reported that unwrought primary aluminum inventories had decreased to 1.621 Mt in November 1992 compared to 1.710 Mt in November 1991.

The slight reduction in producer stocks was more than offset by the large increase in LME stocks, which reached record levels by year-end. Aluminum stocks increased to well over 1.5 Mt from about 900 000 t at the beginning of the 1991.

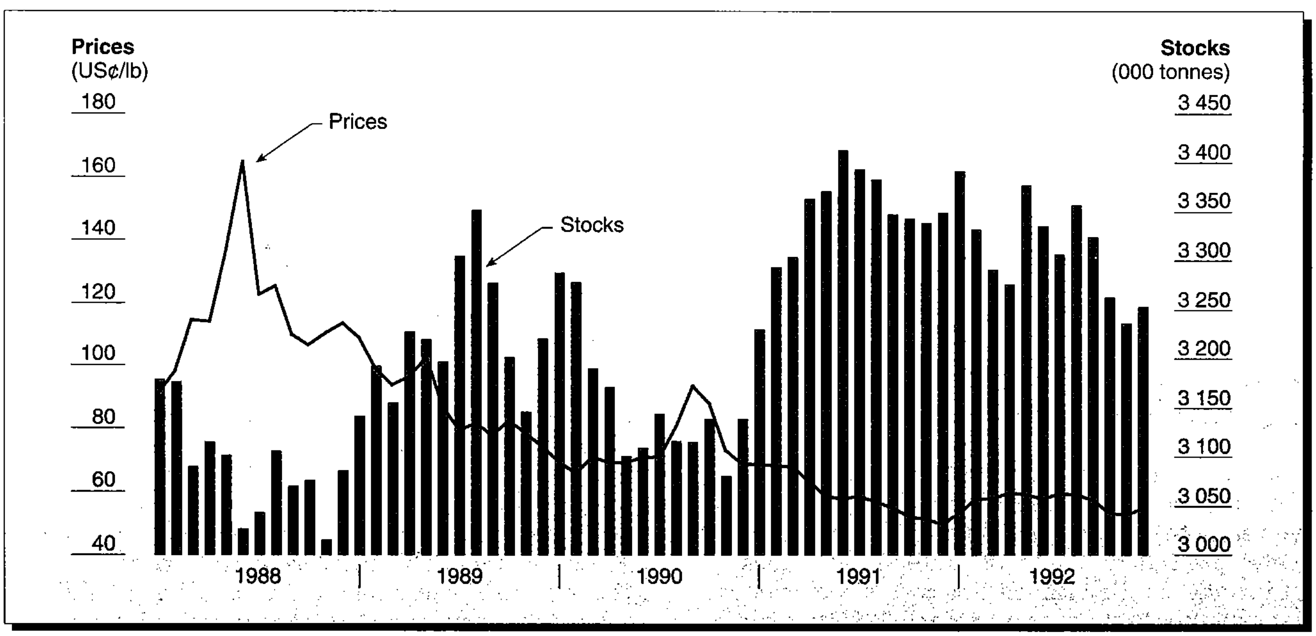
Spot alumina prices were reported at between US$175 and $180/t by the end of 1992, up from $150/t in the third quarter of 1991. Prices for spot alumina ranged between US$155 and $200/t in 1991 and are forecast to range between $160 and $190/t in 1993. The increase in spot prices toward the end of 1992 was mainly the result of a tightening of the market due to strong demand by the C.I.S. and China, coupled with the full-scale start-up of new smelter capacity at Lauralco and Alouette in Canada and at Alba in Bahrain.

Figure 1
London Metal Exchange Aluminum Prices, 1989-92



Source: Energy, Mines and Resources Canada.

Figure 2
Aluminum Prices[1] and Stocks,[2] 1988-92



1 Average monthly London Metal Exchange (LME) prices.
2 International Primary Aluminium Institute (IPAI) stocks (all forms).
Source: Energy, Mines and Resources Canada.

OUTLOOK

Canadian aluminum production capacity increased substantially in the latter half of the 1980s and early 1990s. Canadian production is forecast to increase to 2.3 Mt in 1993. Further growth in Canadian aluminum production capacity is forecast to increase by incremental amounts to the year 2000. The two new smelters commissioned this year, with a total installed capacity of 215 000 t/y, each represent the final phase of a major program of Canadian aluminum smelter capacity expansions that was started in the latter half of the 1980s. The proposed expansion of the Alouette smelter is the only announced expansion project forecast before the end of the year 2000. However, a decision on whether or not to double capacity to 430 000 t/y has been postponed as a result of the weak market conditions. Plans by Alcan to build a new smelter at Alma, Quebec, to replace older Söderberg smelters are also on hold until economic conditions improve.

Western World primary aluminum production is expected to increase from the current 14.8 Mt to about 15 Mt by 1993. To date, cuts in production have been matched by new capacity coming on stream. Additional cuts will be required if the market is to return to balance and inventories are to be reduced. Contracts linking power and alumina costs to the international price of aluminum have reduced operating costs for many smelters and, therefore, the incentive to cut production.

The Western World average cost of production is now estimated at about US54¢/lb. Should prices trade below the US50¢/lb level, however, many of the older high-cost smelters will find it difficult to continue production.

Western World aluminum consumption is expected to increase about 2% in 1993 to 15.7 Mt. The weak economic conditions that persisted throughout 1992 in Europe and Japan are expected to improve toward the latter half of 1993. Aluminum consumption in the United States is expected to increase by about 4% in 1993. Strong growth in demand for primary aluminum of between 3% and 4% is forecast for the remainder of the 1990s. The transportation and packaging (in particular, beverage can) markets are expected to lead the increase in demand for aluminum to the year 2000.

Prices are expected to remain in the US50-55¢/lb range for most of 1993. As the North American economy recovers from the recession and inventories are reduced, prices are expected to increase to about US60¢/lb by year-end. Exports to the West by the C.I.S. are expected to remain at 1992 levels of about 800 000 t. As the demand for aluminum increases, prices are forecast to average between US70¢ and 80¢/lb in constant 1992 dollars.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
7601.10	Unwrought aluminum, not alloyed				
7601.10.10	Billets, blocks, ingots, notched bars, pigs, slabs and wire bars	Free	Free	Free	Free
7601.10.91	Granules, cut from ingots, for use in the manufacture of cleaning compounds	1.98¢/kg	Free	Free	Free
7601.10.99	Other	10.3%	6.5%	Free	Free
7601.20	Unwrought aluminum alloys				
7601.20.10	Billets, blocks, ingots, notched bars, pigs, slabs and wire bars	Free	Free	Free	Free
7601.20.91	Granules, cut from ingots, for use in the manufacture of cleaning compounds	1.98¢/kg	Free	Free	Free
7601.20.99	Other	10.3%	6.5%	Free	Free
7602.00	Aluminum waste and scrap	Free	Free	Free	Free
76.03	Aluminum powders and flakes	9.2%-10.3%	Free-6.5%	Free	Free
76.04	Aluminum bars, rods and profiles	2.1%-10.3%	Free-6.5%	Free	Free-1%
76.05	Aluminum wire	2.1%-10.3%	Free-6.5%	Free	Free
76.06	Aluminum plates, sheets and strip, of a thickness exceeding 0.2 mm	Free-10.3%	Free-6.5%	Free-5.1%	Free-3.9%
76.07	Aluminum foil not exceeding 0.2 mm	Free-12.2%	Free-8%	Free-6.1%	1.8%-3.4%
76.08	Aluminum tubes and pipes	8.1%	Free	Free	1.1%
7609.00	Aluminum tube or pipe fittings	10.3%	6.5%	Free	Free
76.10	Aluminum structures (excluding prefabricated buildings of heading No. 94.06) and parts of structures, aluminum plates, rods, profiles, tubes and the like, prepared for use in structures	10.3%	6.5%	5.1%	3.4%
7611.00	Aluminum reservoirs, tanks, vats and similar containers, for any material	Free-10.3%	Free-6.5%	Free-5.1%	1.5%
76.12	Aluminum casks, drums, cans, boxes and similar containers, for any material	10.3%	6.5%	5.1%	1.4%-3.4%
7613.00	Aluminum containers for compressed or liquefied gas	10.3%	6.5%	5.1%	3%
76.14	Stranded wire, cables, plaited bands and the like, of aluminum, not electrically insulated	10.2%	6.5%	5.1%	2.9%-3.4%
76.15	Table, kitchen or other household articles and parts thereof, of aluminum	10.2%-11.4%	Free-6.5%	5.1%-5.7%	2.3%-3.4%
76.16	Other articles of aluminum	Free-10.3%	Free-6.5%	Free-6.1%	Free-3.7%

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992.

TABLE 1. CANADA, ALUMINUM PRODUCTION AND TRADE, 1991 AND 1992

Item No.		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)
PRODUCTION		1 821 642	. .	1 971 843	. .
IMPORTS				(Jan.-Sept.)	
2606.00.00	Aluminum ores and concentrates				
	Brazil	1 479 636	49 461	1 295 534	39 660
	Bermuda	–	–	260 754	8 666
	Australia	297 705	10 718	213 563	6 852
	Guinea	397 591	17 260	129 970	6 330
	United States	33 135	6 837	48 813	5 858
	Switzerland	32 950	1 430	38 560	1 643
	Other countries	532 493	23 119	180 744	7 269
	Total	2 773 510	108 825	2 167 938	76 278
2620.40.00	Ash and residues containing mainly aluminum	1 923	1 293	2 668	1 247
2818.20.00	Aluminum oxide (excluding artificial corundum)				
	United States	964 490	260 712	533 883	126 950
	Australia	827 395	192 276	771 087	155 525
	Jamaica	533 199	127 521	420 969	87 036
	Germany	1 060	1 195	541	1 440
	France	1 667	2 203	462	744
	Japan	79 167	22 651	253	259
	Austria	345	268	263	164
	Other countries	38 944	8 468	412	288
	Total	2 446 267	615 294	1 727 870	372 406
2818.30.00	Aluminum hydroxide	9 985	6 003	6 868	4 299
7601.10	Unwrought aluminum, not alloyed				
7601.10.10	Billets, blocks, ingots, notched bars, pigs, slabs and wire bars				
	United States	18 382	37 438	16 639	28 898
	France	7 757	22 265	1 104	3 159
	Switzerland	79	197	42	87
	United Kingdom	–	–	19	80
	Other countries	535	792	31	78
	Total	26 753	60 692	17 835	32 302
7601.10.91	Granules, cut from ingots, for use in the manufacture of cleaning compounds	–	–	–	–
7601.10.99	Other	923	1 745	472	1 403
7601.20	Unwrought aluminum, alloyed				
7601.20.10	Billets, blocks, ingots, notched bars, pigs, slabs and wire bars				
	United States	37 252	67 822	38 584	65 686
	Brazil	509	792	1 224	2 601
	Switzerland	1 240	3 134	444	1 000
	France	3	9	400	848
	Other countries	1 164	3 393	484	989
	Total	40 168	75 150	41 136	71 124
7601.20.91	Granules, cut from ingots, for use in the manufacture of cleaning compounds	96	159	4	12

TABLE 1 (cont'd)

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)					
7601.20.99	Other	6 189	10 137	7 035	11 680
7602.00.00	Aluminum waste and scrap	46 433	52 716	39 862	47 174
76.03	Aluminum powders and flakes	1 868	6 134	1 114	3 754
76.04	Aluminum bars, rods and profiles				
7604.10	Of aluminum, not alloyed				
	United States	3 782	20 421	2 388	11 501
	Other countries	711	2 568	168	634
	Total	4 493	22 989	2 556	12 135
7604.21 to	Of aluminum alloys				
7604.29	United States	10 690	44 726	8 835	34 100
	Other countries	1 384	4 631	327	1 375
	Total	12 073	49 357	9 162	35 475
76.05	Aluminum wire	3 292	11 612	1 713	7 022
76.06	Aluminum plates, sheets and strip, of a thickness exceeding 0.2 mm	251 601	676 021	234 346	591 651
76.07	Aluminum foil not exceeding 0.2 mm	21 052	86 989	18 216	73 892
76.08	Aluminum tubes and pipes	5 173	22 417	4 313	17 870
76.09	Aluminum tube or pipe fittings	..	9 547	..	6 176
		(number 000)		**(number 000)**	
76.10	Aluminum structures (excluding prefabricated buildings of heading No. 94.06) and parts of structures, aluminum plates, rods, profiles, tubes and the like, prepared for use in structures	..	38 283	..	36 170
76.11	Aluminum reservoirs, tanks, vats and similar containers	...	161	...	38
76.12	Aluminum casks, drums, cans, boxes and similar containers	342 789	47 517	258 965	36 154
76.13	Aluminum containers for compressed or liquefied gas	646	4 433	130	5 267
		(tonnes)		**(tonnes)**	
76.14	Stranded wire, cables, plaited bands and the like, of aluminum, not electrically insulated	294	747	125	388
76.15	Table, kitchen or other household articles and parts thereof, of aluminum	..	64 613	..	44 508
76.16	Other articles of aluminum	..	91 779	..	72 704
EXPORTS					
2606.00	Aluminum ores and concentrates				
	United States	1 471	135	303	23
	Total	1 471	135	303	23

TABLE 1 (cont'd)

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
2620.40	Ash and residues containing mainly aluminum	25 820	4 639	5 323	1 118
7601.10	Unwrought aluminum, not alloyed				
	United States	485 543	768 488	408 725	626 386
	Netherlands	114 641	188 448	100 524	154 448
	Japan	67 136	98 265	27 388	36 356
	United Kingdom	7 220	11 572	16 220	26 525
	South Korea	30 415	48 912	14 856	22 282
	Hong Kong	2 893	4 691	4 082	6 523
	Other countries	61 975	109 770	16 024	25 711
	Total	769 823	1 230 146	587 819	898 231
7601.20	Unwrought aluminum alloys				
	United States	479 170	797 066	382 539	634 213
	Japan	101 603	172 638	78 375	118 289
	United Kingdom	7 659	12 618	31 049	52 418
	South Korea	23 856	42 770	19 965	33 432
	Turkey	9 247	16 770	10 070	17 016
	Taiwan	9 947	18 305	9 900	16 792
	Netherlands	20 352	32 800	9 906	15 730
	Israel	9 871	18 629	7 016	12 111
	Other countries	41 079	74 500	32 595	56 579
	Total	702 784	1 186 096	581 415	956 580
7602.00	Aluminum waste and scrap				
	United States	150 567	196 083	129 022	173 751
	Japan	16 368	23 423	15 366	22 527
	Taiwan	1 742	1 917	2 292	2 035
	United Kingdom	222	332	1 142	1 280
	Other countries	4 754	5 751	3 217	3 584
	Total	173 653	227 506	151 039	203 177
76.03	Aluminum powders and flakes	171	360	364	558
76.04	Aluminum bars, rods and profiles	2 108	7 188	3 644	12 475
76.05	Aluminum wire	21 148	48 464	14 767	30 467
76.06	Aluminum plates, sheets and strip, of a thickness exceeding 0.2 mm	179 152	416 606	162 699	381 530
76.07	Aluminum foil not exceeding 0.2 mm	10 027	47 317	6 215	33 393
76.08	Aluminum tubes and pipes	574	5 781	663	6 755
7609.00	Aluminum tube or pipe fittings	. .	2 175	. .	1 605
76.10	Aluminum structures (excluding prefabricated buildings of heading No. 94.06) and parts of structures, aluminum plates, rods, profiles, tubes and the like, prepared for use in structures	. .	45 871	. .	37 897
		(number 000)		**(number 000)**	
7611.00	Aluminum reservoirs, tanks, vats and similar containers	1	2 097	2	789
76.12	Aluminum casks, drums, cans, boxes and similar containers	196 156	30 452	159 229	27 407
7613.00	Aluminum containers for compressed or liquefied gas	. . .	3 508	6	43

TABLE 1 (cont'd)

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
76.14	Stranded wire, cables, plaited bands and the like, of aluminum, not electrically insulated	2 035	5 761	724	1 256
76.15	Table, kitchen or other household articles and parts thereof, of aluminum	..	8 831	..	6 505
76.16	Other articles of aluminum	..	65 934	..	42 819

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; .. Not available or not applicable; ... Amount too small to be expressed; p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, ALUMINUM SMELTER CAPACITY

Company	As of December 31, 1992
	(tonnes/year)
Alcan Aluminium Limited	
Quebec	
Grande Baie	180 000
Jonquière	232 000
Isle-Maligne	73 000
Shawinigan	84 000
Beauharnois	48 000
Laterrière	204 000
British Columbia	
Kitimat	272 000
Total Alcan capacity	1 093 000
Canadian Reynolds Metals Company, Limited	
Quebec	
Baie Comeau	400 000
Aluminerie de Bécancour Inc.	
Quebec	
Bécancour	360 000
Aluminerie Alouette Inc.	
Quebec	
Sept-Îles	215 000
Aluminerie Lauralco Inc.	
Quebec	
Deschambault	215 000
Total Canadian capacity	2 283 000

Source: Energy, Mines and Resources Canada.

TABLE 3. CANADA, CONSUMPTION[1] OF ALUMINUM METAL AT FIRST PROCESSING STAGE, 1989-91

	1989[a]	1990[a]	1991[a]
		(tonnes)	
CASTINGS			
Sand	2 512	2 534r	2 974
Permanent mould	67 372r	73 633r	69 178
Die and other	53 635	58 125r	58 826
Total	123 519r	134 292r	130 978
WROUGHT PRODUCTS			
Extrusions, including tubing	112 156r	101 182r	86 280
Sheet, plate, coil and foil	152 340	131 475r	141 703
Other wrought products (including rods, forgings and slugs)	71 820	72 149	76 984
Total	336 316r	304 806r	304 967
OTHER USES			
Destructive uses (deoxidizer), non-aluminum base alloys, powder and paste and other uses	48 974r	26 817r	30 282
Total consumed	508 810r	465 915r	466 227
Secondary aluminum[2]	102 098r	136 983r	134 525

	Metal Entering Plant			On Hand December 31		
	1989	1990	1991	1989	1990	1991
Primary aluminum ingot and alloys	411 884r	381 773r	384 857	18 418r	13 117r	13 670
Secondary aluminum	74 386r	82 686r	74 998	4 119	4 180r	4 676
Scrap originating outside plant	141 516r	153 729r	151 665	6 596	7 166	8 728
Total	627 786r	618 187r	611 520	29 133r	24 463r	27 075
Aluminum shipments[3]				33 277	23 696	8 344

r Revised.
[a] Increase in number of companies being surveyed. Therefore, closing inventory of previous year does not equal opening inventory of current year.
[1] Available data as reported by consumers. [2] Aluminum metal used in the production of secondary aluminum is not included in consumption totals. [3] Aluminum metal shipped without change. Does not refer to shipments of goods of own manufacture.
Note: Numbers may not add to totals due to rounding.

TABLE 4. AVERAGE ALUMINUM PRICES

Year	Month	LME Cash[1]	M.W. U.S. Markets[1]
		(US¢/lb)	
ANNUAL AVERAGES			
1982		45.0	46.8
1983		65.3	68.3
1984		56.5	61.1
1985		47.9	48.8
1986		52.2	55.9
1987		70.8	72.3
1988		117.3	110.1
1989		88.5	87.8
1990		74.4	75.0
1991		59.1	59.5
1992		56.9	57.5
MONTHLY AVERAGES			
1991	January	68.8	68.5
	February	68.3	68.1
	March	67.9	68.3
	April	63.2	63.9
	May	58.8	59.3
	June	57.9	57.7
	July	58.8	58.9
	August	57.1	57.6
	September	54.9	55.7
	October	52.2	52.5
	November	51.5	52.4
	December	49.8	50.3
1992	January	53.4	53.7
	February	57.5	58.2
	March	58.1	59.3
	April	59.8	61.0
	May	59.3	60.0
	June	57.9	58.4
	July	59.6	59.8
	August	59.2	59.6
	September	57.6	58.2
	October	53.3	53.7
	November	52.6	52.8
	December	54.8	55.5

Source: "Metals Week."
[1] Highest grade sold.

TABLE 5. WORLD MINE PRODUCTION OF BAUXITE

	1988	1989	1990	1991
	(000 tonnes)			
EUROPE				
France	977.7	719.8	489.8	183.3
Greece	2 533.0	2 602.0	2 495.9	2 133.5
Yugoslavia	3 034.0	3 252.0	2 951.0	2 542.0
Other	19.6	11.7	0.3	8.7
Total	6 563.6	6 585.5	5 937.0	4 867.5
AFRICA				
Ghana	285.0	347.7	381.3	333.8
Guinea	17 859.0	17 547.9	17 524.0	17 054.0
Mozambique	6.5	5.5	6.6	7.7
Sierra Leone	1 403.0	1 548.0	1 445.0	1 288.3
Total	19 553.5	19 448.2	19 356.9	18 683.8
ASIA				
India	4 013.0	4 334.9	5 277.0	4 835.0
Indonesia	513.1	862.3	1 205.7	1 406.1
Iran	92.5	74.1	92.5	140.0
Malaysia	361.0	355.2	398.2	376.4
Pakistan	2.5	2.0	2.6	4.2
Turkey	269.0	534.3	772.7	530.0
Total	5 251.1	6 162.6	7 748.7	7 291.7
AMERICAS				
United States	588.0	670.0	495.0	50.0
Brazil	7 727.6	7 893.8	9 876.0	10 413.9
Dominican Republic	167.8	164.5	85.2	6.5
Guyana	1 774.0	1 340.0	1 424.0	2 209.0
Jamaica	7 409.0	9 395.0	10 936.7	11 608.6
Surinam	3 434.0	3 457.0	3 267.0	3 136.0
Venezuela	550.0	702.0	771.4	1 992.3
Total	21 650.4	23 622.3	26 855.3	29 416.3
AUSTRALASIA				
Australia	36 370.0	38 583.0	41 391.0	40 503.0
EASTERN COUNTRIES				
China	3 500.0	3 800.0	3 200.0	3 000.0
Hungary	2 906.0	2 643.0	2 559.0	2 037.0
Romania	356.0	313.0	247.0	200.0
U.S.S.R.	5 900.0	5 750.0	5 350.0	n.a.
C.I.S.	n.a.	n.a.	n.a.	4 800.0
Albania	38.0	35.0	26.0	8.0
Total	12 700.0	13 541.0	11 382.0	10 045.0
Total world	102 088.6	106 942.6	112 670.9	110 807.3

Source: Energy, Mines and Resources Canada.
n.a. Not applicable.

TABLE 6. WORLD PRODUCTION OF ALUMINA (HYDRATE)

	1988	1989	1990	1991
		(000 tonnes)		
EUROPE				
France	737.0	624.0	606.0	538.0
Germany	1 163.0	1 174.0	1 172.8	1 148.3
Greece	532.0	533.3	585.0	641.2
Ireland	842.8	891.0	926.5	981.0
Italy	705.0	722.2	752.0	804.5
Spain	880.5	949.1	1 001.6	1 004.0
United Kingdom	114.0	116.2	131.4	120.0
Yugoslavia	1 174.0	1 240.0	1 086.0	780.0
Total	6 148.3	6 249.8	6 261.3	6 017.0
AFRICA				
Guinea	593.0	626.8	642.1	650.9
ASIA				
India	1 188.0	1 418.5	1 334.0	1 435.0
Japan	414.6	863.4	890.0	864.3
Turkey	182.0	200.6	177.1	159.1
Total	1 784.6	2 482.5	2 401.1	2 458.4
AMERICAS				
Brazil	1 417.0	1 624.4	1 654.8	1 739.4
Canada	992.6	1 048.4	1 087.0	1 131.0
Jamaica	1 514.0	2 248.1	2 868.8	3 014.6
Surinam	1 632.0	1 567.1	1 531.0	1 510.0
United States	4 995.0	5 480.0	5 430.0	5 416.0
Venezuela	1 284.0	1 290.2	1 404.8	1 481.0
Total	11 843.6	13 258.2	13 976.4	14 292.0
AUSTRALASIA				
Australia	10 511.0	10 823.0	11 231.0	11 713.0
EASTERN COUNTRIES				
Czechoslovakia	167.0	205.0	209.0	187.0
Germany, Democratic Republic of	64.0	63.0	27.0	n.a.
Hungary	881.0	891.0	848.0	661.0
Romania	620.0	611.0	440.0	413.0
U.S.S.R.	4 400.0	4 800.0	4 000.0	n.a.
C.I.S.	n.a.	n.a.	n.a.	3 600.0
China, People's Republic of	1 300.0	1 400.0	1 200.0	1 200.0
Total	7 432.0	7 970.8	6 724.0	6 061.0
Total world	38 303.5	41 410.3	41 235.9	41 192.3

Sources: Energy, Mines and Resources Canada; World Bureau of Metal Statistics.
n.a. Not applicable.

TABLE 7. WORLD PRODUCTION OF ALUMINUM

	1989	1990	1991	1992e
	(000 tonnes)			
EUROPE				
France	334.9	325.9	286.1	420.0
Germany	742.0	720.3	690.3	600.0
Italy	219.5	231.9	217.7	160.0
Netherlands	277.2	277.1	263.9	240.0
Norway	859.0	871.1	885.9	810.0
United Kingdom	297.3	289.8	293.5	240.0
Yugoslavia	342.1	366.0	314.0	190.0
Other	850.8	850.3	840.0	790.0
Total	3 992.8	3 932.4	3 791.4	3 450.0
AFRICA				
Egypt	179.5	179.6	177.9	180.0
South Africa	168.2	159.8	169.0	170.0
Other	255.9	261.7	261.0	258.0
Total	603.6	601.1	607.9	608.0
ASIA				
Bahrain	186.9	212.5	213.7	250.0
Dubai	168.0	174.3	239.0	240.0
India	423.3	433.2	503.9	510.0
Indonesia	196.9	192.1	173.1	175.0
Other	159.2	162.1	155.6	125.0
Total	1 134.3	1 174.2	1 285.3	1 300.0
AMERICAS				
Brazil	887.9	930.6	1 139.6	1 170.0
Canada	1 554.8	1 567.4	1 821.6	1 972.0
United States	4 030.0	4 048.3	4 121.2	4 020.0
Venezuela	546.0	594.0	609.7	600.0
Other	264.3	264.4	251.7	115.0
Total	7 283.0	7 404.7	7 943.8	7 877.0
AUSTRALASIA				
Australia	1 242.0	1 232.7	1 228.6	1 240.0
New Zealand	258.8	259.7	258.5	240.0
Total	1 500.8	1 492.4	1 487.1	1 480.0
EASTERN COUNTRIES				
China, People's Republic of	758.3	854.3	905.0	1 000.0
U.S.S.R.	2 500.0	2 300.0	2 300.0	n.a.
C.I.S.	n.a.	n.a.	n.a.	2 300.0
Other	520.3	391.0	342.9	350.0
Total	3 778.6	3 545.3	3 547.9	3 650.0
Total world	18 223.1	18 150.1	18 663.4	18 365.0

Sources: Energy, Mines and Resources Canada; World Bureau of Metal Statistics.
e Estimated; n.a. Not applicable.

TABLE 8. WORLD CONSUMPTION OF ALUMINUM

	1989	1990	1991	1992e
		(000 tonnes)		
EUROPE				
Belgium	302.1	317.8	323.0	323.0
France	685.5	720.9	734.2	678.0
Germany	1 290.0	1 295.4	1 360.9	1 407.0
Italy	607.0	652.0	670.2	684.0
Spain	273.4	288.0	297.0	313.0
United Kingdom	454.7	453.7	412.4	438.0
Yugoslavia	201.5	170.0	140.0	169.0
Other	883.8	888.9	902.1	738.0
Total	4 698.0	4 786.7	4 839.8	4 750.0
AFRICA				
Total	253.1	227.6	236.7	230.0
ASIA				
India	420.0	433.3	420.0	450.0
Japan	2 211.6	2 415.2	2 431.6	2 250.0
Other	1 147.6	1 361.1	1 418.0	1 587.0
Total	3 779.2	4 209.6	4 269.6	4 287.0
AMERICAS				
Canada	450.2	387.2	415.0	420.0
United States	4 359.6	4 330.4	4 200.7	4 200.0
Brazil	350.0	341.2	354.2	350.0
Other	389.4	340.7	407.2	380.0
Total	5 549.2	5 399.5	5 377.1	5 350.0
AUSTRALASIA				
Total	355.5	317.5	317.8	300.0
EASTERN COUNTRIES				
Hungary	162.2	155.2	104.0	148.0
U.S.S.R.	1 750.0	1 700.0	1 100.0	n.a.
C.I.S.				1 100.0
China, People's Republic of	700.0	650.0	800.0	850.0
Other	991.0	668.6	450.8	762.0
Total	3 427.4	2 950.0	2 222.8	2 760.0
Total world	18 062.3	17 890.9	17 263.8	17 677.0

Sources: Energy, Mines and Resources Canada; World Bureau of Metal Statistics.
e Estimated; n.a. Not applicable.

Asbestos

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In 1992, Canadian asbestos production decreased 8.5% over 1991, due largely to the closure of Cassiar's underground McDame mine in British Columbia. The remaining Canadian mines, which are located in Quebec, operated at close to 100% of current capacity. Tailings reprocessing operations in Newfoundland operated at about 56% of capacity, mainly due to a forced closure over the winter that was related to frozen tailings. Still, the Newfoundland operation doubled its production compared to 1991. Average prices increased by about 7%-8%. Total shipments for 1992 are estimated to be 601 263 t valued at $235.8 million, compared to revised shipment figures for 1991 totalling 686 008 t valued at $271.0 million. The 12.4% decrease in shipments is explained by the closure of the British Columbia operation at Cassiar and reductions in production at the Jeffrey mine in Quebec. The demand for short fibres continued to be soft. The U.S. Bureau of Mines estimates 1992 Canadian asbestos imports into the United States at about 32 000 t compared with 34 525 t in 1991. The 7% decrease is still due to the effect of the now overturned 1989 ban rule of the U.S. Environmental Protection Agency (EPA).

Canadian exports of asbestos for 1992 will probably amount to 580 000 t. That volume represents a 15.5% decrease from the previous year. The value of these exports is expected to decrease by about 20.2% due to the fact that fibres produced at Cassiar before it closed were of high unit value in comparison with the remaining production. Exports in the January-September 1992 period totalled 434 908 t valued at $253.8 million, compared with 474 289 t valued at $289.4 million for the same period in 1991.

The closure of the Cassiar mine was responsible for a further decline in employment in the asbestos mining/milling operations.

ASBESTOS AND ITS USES

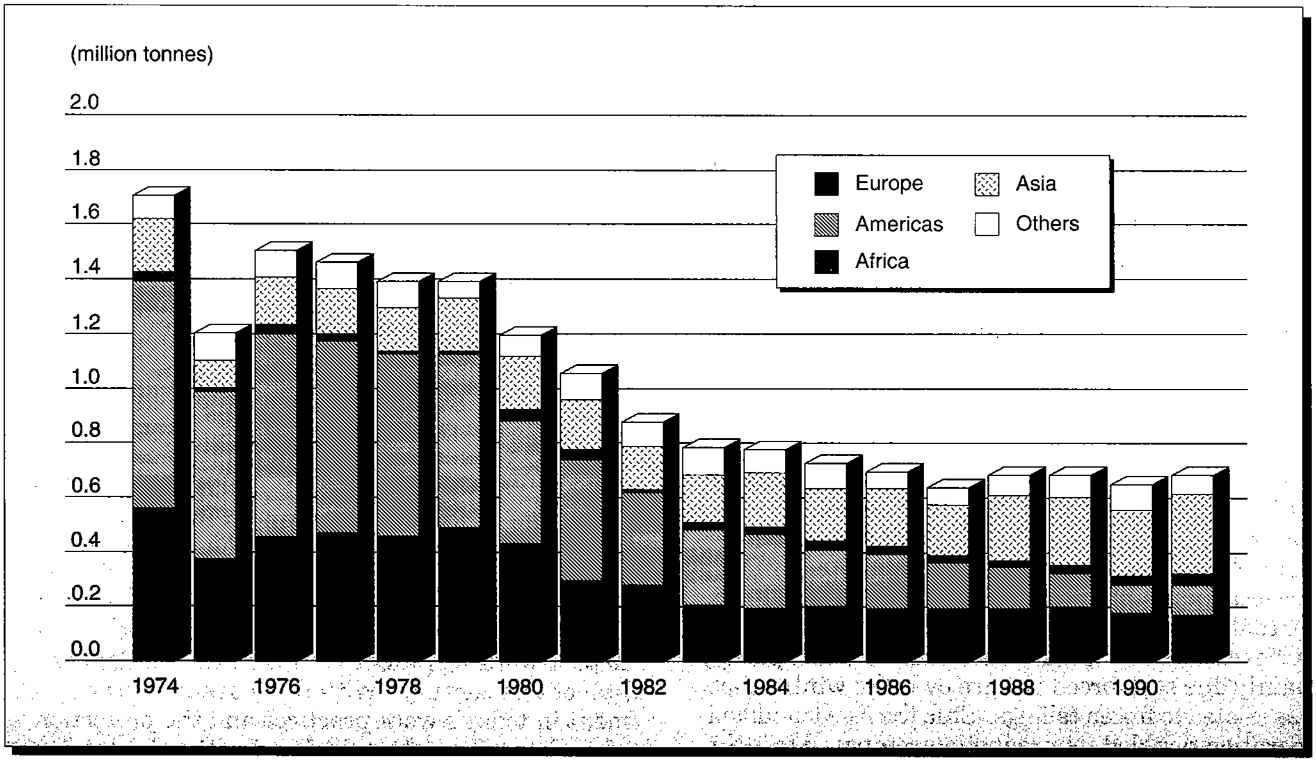
Asbestos is a generic name that covers several naturally occurring fibrous hydrated silicates. These are separated into two basic groups: serpentine and amphiboles. Chrysotile is the only member of the serpentine group, while the amphibole group consists of crocidolite, amosite, anthophyllite, actinolite and tremolite. Of all these minerals, chrysotile is the least dangerous to human health and is the only one extracted in Canada. Chrysotile, which is sensitive to acid, tends to dissolve in the lungs, unless the lungs are overburdened, rather than remain as an irritant like the other types of fibres do. Most of the problems associated with asbestos in general, and chrysotile in particular, were due to poor working practices that existed in the first half of this century. With the marked improvement in today's work practices and the protection of workers, the risks associated with asbestos have been tremendously reduced.

Because of their chemical and physical properties, asbestos fibres are an extremely useful material that has been, and still is, widely used throughout the world. In Canada, chrysotile asbestos fibres are classified into seven groups, each one with its own sub-categories with the longest fibres pertaining to group 1 and the shortest to group 7. In decreasing length, asbestos has been used in textiles, clothing, packings, woven brake linings, clutch facings, electrical insulation materials, high pressure and marine insulation, asbestos-cement pipe, asbestos-cement products (sheets, mouldings, etc.), gaskets, paper products, vinyl sheet backings and millboards. The shortest fibres (group 7) are used in moulded brake linings and clutches, and as a filler in vinyl and asphalt floor tiles, cement, plastics, roof coatings and caulking compounds. Today, however, 85% of asbestos is used in asbestos-cement products. Low density and friable products such as paper products are no longer marketed.

CANADIAN DEVELOPMENTS

In 1992, Canadian developments involved JM Asbestos Inc., LAB Chrysotile, Inc., Princeton

Figure 1
Canadian Asbestos Exports, 1974-91



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

Mining Corporation (Cassiar), Teranov Mining Corporation, and the Quebec government.

JM Asbestos reduced its production capacity by about 50 000 t to 250 000 t in order to concentrate more effort on its Phase D development which had been put on hold until the Court of Appeals' 1991 judgement on the 1989 EPA asbestos ban rule. This development, when completed, should provide the company with enough reserves to stay in operation until 2005. JM Asbestos is expecting to return to its original production capacity of 300 000 t/y by 1995.

LAB Chrysotile enjoyed a very good year, even better than in 1991, because of higher production and sales volumes. The company expects to complete the technological upgrading of the Black Lake mill by the end of 1993. This should result in an increase of 5%-10% in its annual production capacity. The Black Lake mine has 21 years of proven reserves.

Teranov Mining Corporation, the successful bidder for the Baie Verte Mines Reprocessing Inc. (BVMRI) wet-milling equipment, returned to production in April 1992 after a four-month closure due to problems with frozen tailings. During the year, production was hampered by problems related to the separation of fibres in the tailings. As in 1991, the operation was again temporarily shut down in December 1992 but should resume in March 1993. It is expected that this winter's closure will be the last one and that, in the future, the wet-milling operation will operate year-round. The Newfoundland government is currently conducting a diamond drilling program to assess the underground reserves at Baie Verte as part of a feasibility study to start underground mining in the near future. There are currently 72 people employed at Baie Verte. It is believed that the reprocessing of the tailings alone could extend asbestos operations there by up to 20 years.

Cassiar Mining Corporation, which had been under the protection of the *Companies' Creditors Arrangement Act*, was forced into bankruptcy by its creditors on February 4, 1992. That decision was prompted by the fact that Cassiar needed more cash to continue its operations at the new underground McDame mine and that it failed to reach an agreement with its major creditors on a new reorganization. Cassiar was put into receivership under the auspices of Arthur Andersen & Co. Several attempts to find a new owner failed and, when the most promising one by Black Swan Gold Mine fell through, it was decided to dispose of the assets. All assets were offered at an auction in September 1992. The permanent closure of the Cassiar operations resulted in the layoff of about 450 employees. With the closure of the mine, all hopes to see the development of a wet-milling operation to reprocess the 16 Mt of tailings at the old open-pit disappeared.

The year 1992 was a decisive year for the Quebec asbestos industry as the Quebec government decided to sell its stake in the asbestos industry after having invested about $500 million over the years. On September 2, 1992, the Quebec government gave permission to La Société Nationale de l'Amiante (SNA) to sell its assets to La Société d'exploration minière Mazarin Inc. (Mazarin) for $34.3 million. For that amount Mazarin obtained the 54.6% controlling interest in Asbestos Corporation Ltd. and 100% of Bell Asbestos Mines Ltd. and Atlas-Turner. On the financial side, Mazarin paid $2 million up front and was given 10 years to repay the remaining $32.2 million plus interest out of the expected profits. Through this transaction, Mazarin obtained a 45% equity stake in LAB Chrysotile, the partnership society that manages three operating mines (Black Lake, Bell and British Canadian mines) controlled by Jean Dupéré through Lac d'Amiante.

International and Regulatory Developments

Because the U.S. Department of Justice felt that the EPA had little or no chance to win an appeal of the judgement rendered by the Fifth Circuit Court of Appeals of New Orleans on October 18, 1991, the EPA was not granted permission to appeal the decision to the U.S. Supreme Court. The EPA is now left with three options in its crusade against asbestos: i) to issue a new ban rule, which would take them some time as most of the previous work cannot be used according to the Appeals Court's ruling; ii) to seek statutory amendment of the *Toxic Substances Control Act*; or iii) to ask Congress to pass a single statute banning asbestos. In the meantime, the EPA has said that it would re-examine the products affected by the Fifth Circuit Court of Appeals judgement and will take whatever action it deems appropriate to address risks related to the use of these products.

The EPA seems not to have accepted the Court ruling overturning its 1989 asbestos ban rule because, in a notification of control action to ban or severely restrict a chemical (asbestos) sent to the Food and Agricultural Organization/United Nation Environment Programme (FAO/UNEP) joint program, the EPA maintains that, according to its own interpretation, most asbestos products and uses are still subject to its overturned rule. To the contrary, the Court of Appeals' ruling clearly indicates that **only** products either banned, not manufactured or imported into the United States **prior** to the 1989 ban rule were still banned. Further, in a letter to the three major U.S. automobile manufacturers, the EPA clearly stated that "(it) is interested in ensuring that the phase-out of asbestos in new vehicles continues despite the Court decision that vacated and remanded most of the Asbestos Ban and Phase-Out (ABPO) rule." The EPA also claimed that substitutes for all applications existed. In their responses, the three manufacturers made clear that there is **no** substitute for all applications, to the contrary of the EPA's claim, and that roughly 20% of their production, mostly in truck manufacturing, was still using asbestos and would continue to use asbestos until such time that an appropriate substitute that ensured the same level of safety to the user was developed.

On June 8, 1992, the U.S. Occupational Safety and Health Administration (OSHA) deregulated non-asbestiform varieties of tremolite, anthophylite and actinolite that have been covered under the agency's asbestos standards. It is estimated that about 600 000 workers in the construction, paint, tile, and pottery industries would be affected. Because medical and occupational health experts consider that it is the fibrous nature of asbestos which, in excess, causes health deterioration, such deregulation should not raise health concerns. The non-asbestiform minerals will now be regulated under the OSHA standard governing particulates not otherwise regulated under which exposure shall not exceed total dust levels of 15 milligrams (mg) of dust per cubic metre of air with a respirable fraction of 5 mg/m^3.

In 1992, new EPA drinking water standards for 33 contaminants, including asbestos, became effective. The standard establishes a maximum level of 7 million fibres (f) per litre of water, greater than 10 micrometres in length.

The Building and Construction Trades Department of the American Federation of Labour and Congress of Industrial Organizations in the United States has recommended that OSHA establish a Permissible Exposure Limit (PEL) of 1.0 f/cm^3 as a Time-Weighted

Exposure (TWA) for the respirable fibres of fibreglass. The authors stated that the recommendation was consistent with the current state of their understanding of health risks, including the suggestions, but not conclusive indication, that these fibres may possess the ability to produce respiratory system cancer in exposed workers. A PEL of 0.1 f/cm^3 was recommended for respirable refractory ceramic fibres based on the fact that inhalation studies with experimental animals have demonstrated that the carcinogenic potential of these fibres is similar to that of asbestos.

In 1992, the Japan Asbestos Association worked on the compliance by its member companies with its new standard values established in 1991. The new standard values for airborne asbestos are 1 f/cm^3 for chrysotile and 0.5 f/cm^3 for amosite. These standards were established not only for concentration levels in the working environment, but also for occupational exposure levels. It is also the opinion of the Japan Asbestos Association that the controlled use of asbestos, as advocated by the International Labour Organization (ILO), is possible. Japan is being very progressive in setting standards for occupational fibre/dust which include, but are not limited to, asbestos.

Any reference to asbestos was removed from "Agenda 21" at the final preparatory meeting to the United Nations Conference on Environment and Development (UNCED) in New York in March 1992. "Agenda 21" was the UNCED's plan of action that took place in June 1992 in Rio de Janeiro, Brazil. The main goal of this conference was to issue a plan of action on issues related to the environment and economic development for the 21st century. The original reference to asbestos was made in Geneva at the third preparatory meeting for the conference, at the request of Venezuela, with the support of Colombia. The Canadian position is that controlled use remains the most sensible option for protecting workers, the public and the environment.

Germany is proceeding with its own legislation to ban the importation of asbestos-containing products and building material. It is known as "Asbestverbotsverordnung." In 1992, Germany's Labour Minister announced that Germany would be the first nation to outlaw asbestos and that the ban would take effect at the end of 1994. Such a ban would completely outlaw all uses of asbestos and eliminate the importation and production of asbestos-containing material. Germany is still committed to encouraging other European Community (EC) members to follow its lead. Germany's motivation is largely economic as it is the largest producer of synthetic fibres in Europe. In 1991, Germany imported some 3777 t of asbestos from Canada.

Italy also introduced legislation that would ban asbestos production, trade and use by 1995. The Italian law (Law 257) was approved on March 27, 1992. Under this law all asbestos-containing products will be phased out within two years. Brake pads and beverage filters are to be eliminated within the first year. So far, no permanent exceptions have been granted. Law 257 also established a new maximum tolerable chrysotile asbestos fibre concentration of 0.6 f/cm^3 compared to the old level of 1 f/cm^3, which was in line with EC Directive 83/477/CEE. The law provides extensive financial coverage for the clean-up of the Balangero asbestos mine, which was bought by an anti-asbestos conglomerate and closed down. In 1991, Italy imported some 41 254 t of asbestos from Canada.

The Dutch government is considering legislation that would ban asbestos effective July 1, 1993. This legislation would prohibit processing and working with asbestos in the Netherlands. The storage of asbestos and asbestos-containing products would also no longer be permitted. This regulatory initiative is seen as a political gesture towards maintaining union support as the Dutch unions have been very negative towards asbestos. In 1991, the Netherlands imported some 3288 t of asbestos from Canada.

Despite these bans by individual member states, the EC continues to support the controlled-use approach.

In Finland, the Council of State has decided to ban the manufacture and importation of asbestos beginning in 1993 and the use of asbestos-containing products beginning in 1994. This decision, although disappointing, was expected as imports of asbestos into Finland ceased three years ago when the manufacture of asbestos-containing products was discontinued. Current imports of asbestos-containing products include brake pads and various kinds of packing for the processing industry.

Poland is also proceeding with the introduction of regulations for the use of asbestos. By 1996, asbestos consumption would be reduced to 50% of today's level, and asbestos could be totally eliminated by the year 2000. Working conditions in Poland are in a deteriorated condition and the Montréal-based Asbestos Institute, co-sponsored by the ILO, has been holding health and safety seminars there.

In Russia, the Uralasbest asbestos mine, which is the world's largest asbestos production complex with an annual production capacity of 1.4 Mt, closed for a month and a half in July and August 1992, mainly for financial reasons. They did not have money to finance operations since asbestos prices are fixed while other prices are liberalized. In 1992, their production is expected to be about 30% lower than in the previous year. The same situation is also expected for 1993.

Scientific Developments

The year 1992 saw the death of Dr. Irving J. Selikoff of Mount Sinai Medical Centre and School of Medicine. Dr. Selikoff was the leading expert of the anti-asbestos crusade in the United States. Dr. Selikoff, prior to being involved with asbestos, developed a still widely used treatment for tuberculosis. His work focused on insulation workers in the United States and was widely used by anti-asbestos groups around the world in their attempts to ban the product. In the light of some new scientific data, Dr. Selikoff's work had become criticized, particularly in respect of its prediction on the rate of people who would be affected by lung cancer as a consequence of exposure to asbestos. Due to the inhalation of high dust levels over a prolonged period of time, these workers had high levels of asbestos-related diseases. They not only used chrysotile, but crocidolite, amosite and tremolite. Dr. Selikoff's work prompted thousands of lawsuits that are presently hampering the U.S. judicial system and that have resulted in the bankruptcy of several companies at a cost of several hundred million dollars to the asbestos industry.

A major workshop sponsored by the International Agency for Research on Cancer (IARC) on the "Biopersistence of Respirable Synthetic Fibres and Minerals" took place in Lyon, France, September 7-9, 1992. One of the major presentations of the year was that of Drs. F.D.K. Liddell, A.D. McDonald and J.C. McDonald at the 9th International Symposium on Epidemiology in Occupational Health in Cincinnati in September 1992. Their study, entitled *1891-1920 Birth Cohort of Quebec Chrysotile Miners and Millers: A Preliminary Report on Mortality to 1988*, is the largest ever conducted on chrysotile workers as observations were made on a birth cohort of nearly 11 000 workers in the Quebec chrysotile asbestos mines and mills. The authors demonstrated that there was **no epidemiological** evidence of increased lung cancer in chrysotile workers exposed for at least 20 years to fibre levels of up to about 50 f/cm^3. These exposure levels are significantly higher than today's reality of less than 1 f/cm^3 for Quebec mines and mills workers. It is also worth noting that the World Health Organization (WHO) advocates occupational exposure levels of 1 f/cm^3. The authors also state that warnings linking asbestos hazards almost exclusively to cigarette smoking (virtually all cases of asbestos-related disease occur in smokers) were ignored in some of the previous studies.

A new study on airborne asbestos in buildings was released in late 1992 and complemented the 1991 report by the U.S. Health Effects Institute-Asbestos Research (HEI-AR). In this study, co-authored by Drs. B. Price and K.S. Crump, entitled *Exposure Inferences from Airborne Asbestos Measurements in Buildings*, it is shown that "routine maintenance and repair work involving asbestos-containing materials does not significantly affect average asbestos levels in buildings" and "that managing asbestos in-place is safe and cost-effective." It is also demonstrated that "trained maintenance workers typically disturb asbestos infrequently, for short periods of time and with minimal exposures to themselves and others." It was also found that occupant exposure in buildings with asbestos-containing materials ranged in average between 0.00003 f/cm^3 and 0.00075 f/cm^3. These levels correspond to lifetime risks from 40 years' exposure of 0.5 per million to 1.2 per hundred thousand, respectively.

Asbestos Substitutes

Non-asbestos fibrous materials, many of which are used as asbestos substitutes, are coming under increasing scrutiny in the workplace. The 1991 HEI-AR report expressed concern about the substitutes for asbestos and stated that "in view of the growing numbers of different types of man-made fibres that are entering commerce to substitute for asbestos, as a result of the phase-out of asbestos itself, detailed material characterization and biological testing of such fibres should precede their widespread dissemination into the human environment." In a recent WHO (IPCS) study entitled *Report on Synthetic Organic Fibres*, it is recommended that **all** fibres that are respirable and biopersistent must be thoroughly tested for toxicity and carcinogenicity. In addition, the report states that "exposures to these fibres should be controlled to the same degree as required for asbestos until data are available supporting a lesser degree of control."

At the September 1992 Lyon workshop on "Biopersistence of Respirable Synthetic Fibres and

Minerals," several interventions were made on substitutes. On the subject of glass fibre manufacturing, J.R. Bender, Vice President at Owens Corning, stated that glass fibre compositions vary to allow forming and ultimate function and that dissolution is primarily a function of composition. A. Morgan from Harwell indicated that glass fibres with high aluminum content are more durable than those with low aluminum content, and that rock wool is relatively insoluble. The durability (or biopersistence) of fibres in the lungs is known to be a critical factor with respect to the incidence of disease. It is now accepted that some man-made mineral fibres (MMMFs) are cleared much more slowly than others. This situation compares well with asbestos fibres for which it has been established that chrysotile fibres clear within weeks or months while crocidolite, amosite and anthophyllite can take several decades.

The mandate of the International Fibre Safety Group (IFSG), which was created in 1991, is to promote safety in the use of mineral and synthetic fibres with known or suspected health risks. To that effect, the Group has signed a Memorandum of Understanding with WHO to support its project on "Harmonization of Methods and Quality Assurance in the Evaluation of Exposure to Airborne Contaminants in the Work Environment – Asbestos and Other Risk-Related Fibres." The three objectives of this project are: i) to develop standard methods for the counting of all airborne fibres; ii) to establish an International Quality Assurance Scheme to improve counting performance worldwide; and iii) to develop training material and undertake educational and training initiatives. The ILO has also approached the IFSG about co-sponsoring training programs.

OUTLOOK

The 1991 overturn of the EPA's asbestos rule has certainly had a positive result on the Canadian asbestos industry in that it has slowed down the negative trend in Canadian exports to the United States. Asbestos-cement products are still the favoured products. They are expected to enjoy the favour of the users for the year to come despite the increasing competition by substitute fibres, polyvinyl chloride, iron and steel. There are also some signs of a small recovery in the brake lining aftermarket and the next couple of years should be critical for that market. Asian countries are still the main markets for Canadian asbestos fibres, but gains are expected in South American countries. Canadian production is expected to remain stable in 1993 and 1994. Production should increase again in 1995 when JM Asbestos Inc. returns to its original 300 000-t annual capacity after the completion of its Phase D development, which will give the company access to more reserves.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2524.00.10	Crude asbestos	Free	Free	Free	Free
2524.00.90	Other asbestos	8%	5%	Free	Free
6811.10	Corrugated sheets of asbestos-cement, of cellulose fibre-cement or the like	8%	5%	Free	Free
6811.20	Sheets n.e.s., panels/tiles etc. of asbestos-cement, cellulose fibre-cement, etc.	8%	5%	Free	Free
6811.30	Tubes, pipes and tube or pipe fittings of asbestos-cement, of cellulose fibre-cement, etc.	8%	5%	Free	Free
6811.90	Articles n.e.s. of asbestos-cement, of cellulose fibre-cement, or the like	8%	5%	Free	Free
6812.10	Fabricated asbestos fibres; mixtures with a basis of asbestos or with a basis of asbestos and magnesium carbonate	8%	5%	Free	Free
6812.20	Asbestos yarn and thread	12.5%	X	Free	Free
6812.30	Asbestos cords and string, whether or not plaited	12.5%	X	Free	Free
6812.40	Asbestos woven or knitted fabric	8%	5%	Free	Free
6812.50	Asbestos clothing, clothing accessories, footwear and headgear	25%	X	Free	0.6%-2.5%
6812.60	Asbestos paper, millboard and felt	8%	5%	Free	Free
6812.70	Compressed asbestos fibre jointing, in sheets or rolls	8%	5%	Free	Free
6812.90.10	Asbestos belting	17.5%	7.5%	Free	Free
6812.90.90	Other asbestos fabricated products n.e.s.	8%	5%	Free	Free
6813.10.10	Asbestos brake linings and pads for motor vehicles of heading Nos. 87.02, 87.03, 87.04 or 87.05	11.3%	Free	5.6%	Free
6813.10.90	Other asbestos brake linings and pads	8%	5%	4.0%	Free
6813.90.10	Asbestos clutch facings for motor vehicles of heading Nos. 87.02, 87.03, 87.04 or 87.05	11.3%	7.5%	5.6%	Free
6813.90.90	Other asbestos friction material and articles n.e.s.	9.2%	2.5%	4.6%	Free

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992.
n.e.s. Not elsewhere specified.
Note: The Governor in Council may, on the recommendation of the Minister of Finance, by order, substitute a rate of customs duty for the symbol "X" in the General Preferential Tariff.

TABLE 1. CANADA, ASBESTOS PRODUCTION AND TRADE, 1991 AND 1992

Item No.		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)
PRODUCTION (SHIPMENTS)[1]					
	By type				
	Crude, groups 1, 2 and other milled	–	–	..	..
	Group 3, spinning	7 930	6 026	..	..
	Group 4, shingle	159 769	93 021	..	..
	Group 5, paper	167 807	84 274	..	..
	Group 6, stucco	231 851	66 419	..	..
	Group 7, refuse	118 651	21 290	..	..
	Total	686 008	271 030	601 263	235 760
	By province				
	Quebec	613 682	226 338	574 000	224 826
	British Columbia	63 140	41 433	12 911	6 341
	Newfoundland	9 186	3 259	14 352	4 593
	Total	686 008	271 030	601 263	235 760
EXPORTS				**(Jan.-Sept.)**	
2524.00.10	Crude asbestos				
	Japan	2 036	640	1 180	405
	United States	249	178	41	23
	Malaysia	17	6	42	15
	Total	2 302	824	1 263	443
2524.00.21	Asbestos milled fibres, group 3 grades				
	EC countries (12)[1]				
	Spain	2 463	3 200	669	867
	France	80	111	582	591
	United Kingdom	277	377	423	549
	Italy	662	810	208	267
	Germany	84	99	67	97
	Portugal	160	246	70	95
	Belgium	107	135	–	–
	EC countries, subtotal	3 833	4 978	2 019	2 466
	Mexico	1 087	1 477	926	1 190
	Japan	711	1 037	647	958
	South Korea	820	1 148	595	795
	India	884	1 239	570	748
	Colombia	130	169	450	585
	Israel	114	147	395	512
	Brazil	512	729	248	343
	People's Republic of China	408	418	240	323
	Hungary	19	24	175	232
	Turkey	1 305	1 653	167	217
	Thailand	205	227	139	179
	Other countries	2 186	2 146	674	620
	Total	12 214	15 392	7 245	9 168
2524.00.22	Asbestos milled fibres, groups 4 and 5 grades				
	EC countries (12)[1]				
	France	26 314	21 809	12 658	10 620
	Italy	28 790	23 561	10 210	8 571
	Spain	19 451	17 396	7 227	6 504
	Belgium	8 754	8 579	4 254	4 179
	United Kingdom	5 106	4 733	3 950	3 275
	Portugal	4 276	4 551	2 547	2 443
	Ireland	2 514	2 183	1 628	1 619
	Netherlands	3 110	3 309	1 306	1 386
	Germany	1 625	1 359	943	822
	Greece	278	295	300	359
	Denmark	25	17	49	34
	EC countries, subtotal	100 243	87 792	45 072	39 812

TABLE 1 (cont'd)

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
	Thailand	49 697	38 309	27 981	22 344
	Japan	34 165	29 129	16 930	13 656
	India	23 821	19 302	11 465	9 262
	Mexico	10 382	8 623	8 602	7 111
	Malaysia	14 875	11 913	8 953	7 016
	Brazil	6 316	5 958	5 912	5 233
	Nigeria	9 306	7 847	5 925	5 041
	Morocco	4 805	4 418	4 975	4 680
	Colombia	9 349	7 724	5 545	4 647
	Sri Lanka	3 879	3 687	4 000	3 889
	Indonesia	9 584	6 295	6 180	3 884
	Chile	6 413	4 988	3 809	3 120
	Egypt	5 078	4 257	2 551	2 379
	Pakistan	2 360	1 867	2 590	2 148
	United Arab Emirates	3 460	3 029	2 375	2 041
	Tunisia	2 420	2 235	1 960	2 003
	Algeria	15 210	10 535	1 698	1 374
	Angola	351	300	1 526	1 349
	Turkey	9 057	8 544	1 598	1 287
	People's Republic of China	1 033	928	1 362	1 214
	Austria	1 260	1 151	1 227	1 109
	Peru	2 067	1 658	1 346	1 079
	United States	63	26	39	7
	Other countries	15 983	15 119	9 189	8 062
	Total	341 177	285 634	182 810	153 747
2524.00.29	Asbestos shorts, groups 6, 7, 8 and 9 grades				
	EC countries (12)[1]				
	Spain	6 798	2 679	5 242	2 203
	Italy	11 802	3 943	4 335	1 495
	France	9 605	2 920	4 643	1 370
	Belgium	5 885	2 099	3 644	1 353
	Portugal	3 212	1 385	2 577	998
	United Kingdom	3 965	1 344	2 263	837
	Greece	18	3	808	414
	Germany	2 068	575	895	289
	Ireland	1 890	735	630	262
	Denmark	843	370	322	150
	Netherlands	178	46	30	7
	EC countries, subtotal	46 264	16 099	25 389	9 378
	Japan	59 934	22 235	52 873	20 220
	South Korea	46 010	16 574	44 272	16 751
	Thailand	48 497	21 050	26 467	11 547
	India	17 915	7 542	15 929	6 527
	United States	33 530	9 982	23 937	6 362
	Mexico	15 810	5 888	9 743	3 302
	Indonesia	6 167	2 255	7 035	2 542
	Malaysia	6 629	2 454	4 535	1 698
	Brazil	4 135	1 165	4 538	1 534
	Colombia	4 812	1 729	3 232	1 431
	Taiwan	4 754	1 375	3 839	1 368
	Chile	3 025	1 143	2 457	794
	Pakistan	933	366	1 578	647
	Turkey	4 764	2 137	1 675	614
	Nigeria	5 355	2 149	1 438	601
	Other countries	21 826	7 963	14 653	5 164
	Total	330 360	122 106	243 590	90 480
Grand total, crude, milled fibres and shorts		686 053	423 956	434 908	253 838
6811.10	Corrugated sheets of asbestos-cement, of cellulose fibre-cement, or the like				
	United States	..	574	..	771
	Total	..	574	..	771

TABLE 1 (cont'd)

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
6811.20	Sheets n.e.s., panels/tiles, etc., of asbestos-cement, cellulose fibre-cement, etc.				
	United States	. .	1 513	. .	606
	Germany	. .	23	–	–
	Total	. .	1 536	. .	606
6811.30	Tubes, pipes and tube or pipe fittings of asbestos-cement, of cellulose fibre-cement, etc.				
	United States	. .	2	–	–
	Total	. .	2	–	–
6811.90	Articles n.e.s. of asbestos-cement, of cellulose fibre-cement, or the like				
	United States	. .	47	. .	51
	United Kingdom	. .	15	–	–
	Total	. .	62	. .	51
6812.10	Fabricated asbestos fibres; mixtures with a basis of asbestos or with a basis of asbestos and magnesium carbonate				
	United Kingdom	. .	27	. .	93
	Chile	–	–	. .	58
	Singapore	–	–	. .	29
	United States	. .	882	–	–
	Other countries	. .	29	. .	19
	Total	. .	938	. .	199
6812.20	Asbestos yarn and thread				
	United Kingdom	30	180	70	248
	Chile	38	147	50	203
	United States	29	256	15	111
	Other countries	68	241	46	195
	Total	165	824	181	757
6812.30	Asbestos cords and string, whether or not plaited				
	United States	. .	33	–	–
	Total	. .	33	–	–
6812.40	Asbestos woven or knitted fabric				
	United States	48	451	46	517
	United Kingdom	45	290	21	150
	Other countries	2	18	4	25
	Total	95	759	71	692
6812.50	Asbestos clothing, clothing accessories, footwear and headgear				
	U.S.S.R.	–	–	. .	21
	Chile	. .	24	–	–
	Japan	. .	13	–	–
	Singapore	. .	36	–	–
	Other countries	. .	3	. .	4
	Total	. .	76	. .	25
6812.60	Asbestos paper, millboard and felt				
	Indonesia	. .	152	–	–
	South Korea	. .	63	–	–
	United States	. .	29	–	–
	Other countries	. .	41	. .	66
	Total	. .	285	. .	66

TABLE 1 (cont'd)

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
6812.70	Compressed asbestos fibre jointing, in sheets or rolls				
	United States	. .	934	. .	819
	Other countries	. .	3	–	–
	Total	. .	937	. .	819
6812.90.10	Asbestos building materials				
	Thailand	. .	140	. .	671
	South Korea	. .	1 228	. .	263
	Saudi Arabia	–	–	. .	104
	Singapore	. .	23	. .	75
	Other countries	. .	261	. .	115
	Total	. .	1 652	. .	1 228
6812.90.90	Other asbestos fabricated products n.e.s.				
	United States	. .	242	. .	25
	Cuba	. .	109	. .	2
	United Kingdom	. .	90	–	–
	Other countries	. .	53	. .	42
	Total	. .	494	. .	69
6813.10	Asbestos brake linings and pads				
	United States	. .	35 166	. .	35 568
	Other countries	. .	513	. .	253
	Total	. .	35 679	. .	35 821
6813.90	Asbestos friction material and articles n.e.s.				
	United States	. .	1 239	. .	88
	Other countries	. .	94	. .	2
	Total	. .	1 333	. .	90
Total exports, asbestos manufactured		. .	45 184	. .	41 194
IMPORTS					
2524.00.10	Crude asbestos	316	201	278	233
2524.00.90	Other asbestos	551	160	532	122
6811.10	Corrugated sheets of asbestos-cement, of cellulose fibre-cement, or the like	. .	353	. .	213
6811.20	Sheets n.e.s., panels/tiles, etc., of asbestos-cement, cellulose-fibre cement, etc.	. .	731	. .	579
6811.30	Tubes, pipes and tube or pipe fittings of asbestos-cement, cellulose fibre-cement, etc.	. .	927	. .	149
6811.90	Articles n.e.s., of asbestos-cement, cellulose fibre-cement or the like	. .	158	. .	175
6812.10	Fabricated asbestos fibres; mixtures with a basis of asbestos or with a basis of asbestos and magnesium carbonate	. .	419	. .	309
6812.20	Asbestos yarn and thread	8	41	1	2
6812.30	Asbestos cords and string, whether or not plaited	. .	78	. .	36
6812.40	Asbestos woven or knitted fabric	46	646	31	340
6812.50	Asbestos clothing, clothing accessories, footwear and headgear	. .	154	. .	496
6812.60	Asbestos paper, millboard and felt	. .	108	. .	83
6812.70	Compressed asbestos fibre jointing, in sheets or rolls	88	1 143	163	1 555
6812.90.10	Asbestos building materials	–	–	. .	6
6812.90.90	Other asbestos fabricated products n.e.s.	. .	3 209	. .	1 941
6813.10	Asbestos brake linings and pads	. .	25 974	. .	28 629

TABLE 1 (cont'd)

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)					
6813.90	Asbestos friction material and articles n.e.s.	. .	5 389	. .	3 734

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available or not applicable; n.e.s. Not elsewhere specified; p Preliminary.
1 EC includes Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain and the United Kingdom.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADIAN ASBESTOS PRODUCERS, 1992

Producers	Mine Location	Normal Mill Capacity Ore/Day	Normal Mill Capacity Fibre/Year	Remarks
		(tonnes)		
Teranov Mining Corp.	Baie Verte, Nfld.	6 000	20 000	Wet-processing of tailings started in July 1991.
LAB Chrysotile, Inc.[1]				Partnership owned 55% by LAQ and 45% by La Société d'Exploration Minière Mazarin.
- Lac d'Amiante du Québec, Ltée (LAQ)	Black Lake, Que.	9 000	160 000	Open-pit. Since September 1989, LAQ has been owned by Jean Dupéré (President of LAB) and Connell Bros. Company, Ltd. of the United States.
- Asbestos Corporation Limited British Canadian mine	Black Lake, Que.	7 000	70 000	Sold to La Société d'Exploration Minière Mazarin on September 2, 1992. Open-pit.
- Bell Asbestos Mines, Ltd.	Thetford Mines, Que.	2 700	70 000	Sold to La Société d'Exploration Minière Mazarin on September 2, 1992. Underground. Mine was re-opened January 1989.
J M Asbestos Inc. Jeffrey mine	Asbestos, Que.	15 000	250 000	Open-pit (effective capacity reduced by one half since 1982).
Cassiar Mining Corporation	Cassiar, B.C.	5 000	100 000	Forced into bankruptcy on February 4, 1992.
Total of four producers at year-end			570 000	

1 A partnership involving three operating companies.

TABLE 3. CANADA, ASBESTOS PRODUCTION AND EXPORTS, 1985-92

	Crude	Milled	Shorts	Total
		(tonnes)		
PRODUCTION[1]				
1985	–	397 729	352 461	750 190
1986	–	332 092	330 289	662 381
1987	–	365 144	299 402	664 546
1988	14	399 550	310 793	710 357
1989	–	410 588	303 448	714 036
1990	–	379 047	306 580	685 627
1991	–	335 506	350 502	686 008
1992[p]	. .	. .	. .	601 263
EXPORTS				
1985	44	395 158	326 311	721 513
1986	127	375 948	341 609	717 684
1987	1 696	353 321	293 808	648 825
1988	11 288	381 561	292 236	685 085
1989	17 198	379 601	312 915	709 714
1990	1 469	378 074	269 942	649 485
1991	2 302	353 391	330 360	686 053
1992[a]	1 263	190 055	243 590	434 908

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available; p Preliminary.
a January-September.
1 Producers' shipments.

TABLE 4. ASBESTOS, WORLD PRODUCTION BY COUNTRY, 1992

Country	Tonnes[e]
C.I.S.	2 200 000
Canada	601 000
Brazil	250 000
Zimbabwe	160 000
China	220 000
Republic of South Africa	150 000
United States	18 000
Greece	30 000
India	27 000
Swaziland	30 000
Colombia	3 500
Yugoslavia	2 000
Romania	3 600
Egypt	300
Total	3 695 400

Sources: Energy, Mines and Resources Canada; U.S. Bureau of Mines.
e Estimated.

Barite

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Barite, or barium sulphate, is a semi-soluble salt mineral of chemical composition ($BaSO_4$), and is the principal source of barium. It occurs most commonly as coarse-grained or fine-grained compact masses, which may be white, yellow, gray, brown, pink or blue. Barite is characterized by a high specific gravity of 4.5 and a low hardness of 2.5-3.5; it is for these physical properties that barite is principally used.

CANADIAN OCCURRENCES AND PRODUCERS

Barite occurs at three locations in Newfoundland: at Buchans, where it is associated with a lead-zinc ore; at Collier's Point, in the western Avalon peninsula; and at Ronan, near Port au Port Bay. Deposits in Nova Scotia are found at Walton on the south shore of Minas Basin; at Brookfield in central Nova Scotia; at Lake Ainslie and Pinebrook on Cape Breton Island; and at Bass River on the north shore of Cobequid Bay.

In central Canada, barite occurs mainly in Ontario on McKellar Island near Thunder Bay, at the Premier Langmuir mine, at Matachewan and Hemlo in northern Ontario, and in the Huntingdon-Madoc area in southeastern Ontario. Barite occurs in Quebec at St-Fabien near Rimouski, and at the Niobec mine near Chicoutimi. The principal deposits in western Canada occur in British Columbia at Brisco and Parson in the southeast, at the Mineral King lead-zinc mine and Larrabee deposits near Invermere, and at Spillimacheen.

There are currently three producers in Canada: Nystone Chemicals Ltd. in Nova Scotia, Extender Minerals Ltd. in Ontario, and Mountain Minerals Ltd. in British Columbia. Mountain Minerals Ltd., the principal operator in terms of volume, produces barite mainly for the oil-well drilling industry, with the remainder for the paint and filler industries; about 50% of filler production is exported. Extender Minerals Ltd. produces off-colour and colour-controlled grades for plastics, paint, mould lubricants and oil-well drilling. The company's largest market is brake lining manufacture. Nystone Chemicals Ltd. produces only pharmaceutical-grade barite for contrast media applications.

Mountain Minerals Ltd. opened a 40 000-50 000-t/y capacity grinding and flotation plant at Northport, Washington, in the United States; its main market is oil-well drilling. Extender Minerals Ltd. is currently developing an underground mine at Shining Tree in North William Township, Ontario.

CANADIAN PRODUCTION AND TRADE

The total value of barite shipments in 1991 was C$3 013 000, which represented a decrease of 3.7% from 1990 levels of C$3 130 000. Production, however, over the same period rose 6.2% from 43 906 t to 46 614 t. The projected estimates for 1992 are a decrease in value of 5.3% to C$2 854 000, and a decrease in production of 30.9% to 32 196 t; the decrease in production is reported by Mountain Minerals Ltd. because of reduced sales of barite. Apparent consumption (production adjusted to allow for differences between imports and exports) in Canada rose between 1990 and 1991 by 12.4% from 41 944 t to 47 134 t.

Imports of barite into Canada for the first nine months of 1992 totalled 8716 t valued at C$883 000, compared with 9355 t valued at C$883 000 for the same period in 1991. This represented a decrease of 6.8% in tonnage; however, due to the lower Canadian dollar for part of 1992, the value remained unchanged at C$883 000. The value per tonne, therefore, increased from C$94 to $101, an increase of 7.5%. Imports for the first nine months of 1992 were sourced 96% from the United States, with the remainder coming from the Netherlands, and were distributed 40.5% in central Canada and 59.5% in western Canada. Imports for the first nine months of 1991 were 90.4% from the United

States, with the remainder coming from the Netherlands, and were distributed 33% in central Canada and 67% in western Canada.

Exports of barite for the first nine months of 1992 were 98.1% to the United States, originating from Atlantic Canada (2.4%), central Canada (42.2%), and western Canada (55.4%). Exports in 1991 were also virtually all to the United States, but the distribution pattern for the first nine months of 1991 was different: 12% from Atlantic Canada, 0.5% from central Canada, and 87.5% from western Canada.

World Production

Total world production of barite for 1991 was 5.27 Mt, of which China accounted for 34%, with India, Morocco, the United States and the former U.S.S.R. accounting for 33%. Little growth occurred around the world in 1992 as China continued to dominate the international market with large capacity and good-quality low-priced barite.

Uses

Barite's high specific gravity of 4.5, low abrasiveness, chemical inertness, and opaqueness to X rays ensure its continued use for various diverse applications. Its most important use is as a weighting agent in oil-and-gas well drilling mud. Important but lesser uses include: as a filler and extender in paint, linoleum and rubber; as an ingredient in glass manufacture; as a heavy aggregate for gamma-ray shielding in concrete; in pharmaceutical formulations; in ceramics; and in the manufacture of barium chemicals.

Barite is an important ingredient in some paint formulations where it provides bulk, controls prime pigment settling, and improves viscosity, application properties and surface finish. Barite is also used as a filler in other products, including rubber, plastic, tile and linoleum, automobile undercoating compositions, and brake linings. In glass manufacture, barite improves workability, acts as a decolourizer, and increases the lustre and brilliance of glass. Barium is increasingly being used in the electronics ceramics industry; barium titanate, for example, has special electromechanical properties, and barium ferrites are used in the manufacture of high-strength permanent magnets.

Barite is the basic feed material in the manufacture of a variety of barium chemicals which include barium carbonate, barium chloride, precipitated barium sulphate, lithopone (barium sulphate-zinc sulphate), barium nitrate, and barium oxide. These chemicals are used in a wide range of applications. Barium carbonate and chloride are used in clay brick and tile manufacture to reduce efflorescence and scumming; barium oxide is used in glass, especially optical glass and television tubes, to increase density and improve brilliance. Barium carbonate is used in the manufacture of barium titanates, and as a filler in paper, linoleum and rubber.

Prices

The average value of U.S. domestic barite, as reported by the U.S. Bureau of Mines, for beneficiated material increased almost 28%, f.o.b. plant, from US$37/t in 1990 to $48/t in 1991. The average value of ground barite, sold or used by producers, was US$81/t, a 6% decrease from the $86/t reported in 1990. Well-drilling-grade barite was US$75/t, whereas chemical, filler and extender, and glass-grade barite was $148/t.

Outlook

The depressed oil prices, both nationally and internationally, which are expected to last for the short-to-medium term, will likely result in a reduction in drilling activity for new oil reserves. As a consequence, there will be marginally less demand for barite as a drilling fluid. Prospects for barium chemicals producers, however, are likely to improve as television glass manufacturers remove lead from the formulation of face-plate glass, thus necessitating the need for more barium carbonate. Sales of barite are also expected to increase for use in heavy concrete and radiation shielding protection.

Note: Information in this review was current as of February 1, 1993.

TABLE 1. CANADA, BARITE PRODUCTION AND TRADE, 1990-92, AND CONSUMPTION 1989-91

Item No.		1990		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
PRODUCTION (shipments)		43 906	3 130	46 614	3 013	32 196	2 854
IMPORTS						(Jan.-Sept.)	
2511.10	Natural barium sulphate (barytes)						
	United States	6 813	688	11 402	1 031	8 368	789
	Netherlands	932	139	1 010	149	348	94
	Germany	158	9	131	35	–	–
	Belgium	63	17	29	7	–	–
	Total	7 966	854	12 572	1 224	8 716	883
EXPORTS							
2511.10	Natural barium sulphate (barytes)						
	United States	9 928	3 162	11 992	3 302	13 828	2 521
	Chile	–	–	–	–	100	61
	South Korea	–	–	60	33	99	58
	Japan	–	–	–	–	39	15
	Taiwan	–	–	–	–	20	4
	Philippines	–	–	–	–	14	3
	Total	9 928	3 162	12 052	3 335	14 100	2 665
APPARENT CONSUMPTION		41 944		47 134		. .	

		1989	1990	1991p
REPORTED CONSUMPTION[1]				
	Well drilling	x	x	x
	Paint and varnish	1 195	1 514	1 368
	Other products[2]	15 300	15 650	18 182
	Total	16 495	17 164	19 550

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available or not applicable; p Preliminary; x Confidential.
[1] Available data reported by consumers. [2] "Other products" includes plastics, bearings and brake linings, nonferrous smelting and refining, etc. Also includes "well drilling."
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, BARITE PRODUCTION, TRADE AND APPARENT CONSUMPTION, 1984-91

Year	Production[1]	Imports	Exports	Apparent Consumption
			(tonnes)	
1984	64 197	17 688	1 248	80 637
1985	71 049	26 589	1 677	95 961
1986	40 335	10 525	5 069	45 791
1987	42 103	4 573	6 052	40 624
1988	51 450	4 528	8 022	47 956
1989	38 511	5 538	6 214	37 835
1990	43 906	7 966	9 928	41 944
1991	46 614	12 572	12 052	47 134

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Mine shipments.

Cement

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In 1992, construction activity overall remained weak, particularly in Ontario and Quebec; however, housing starts were about 7.5% higher than in 1991. Total cement shipments were 8.5 Mt valued at $739.2 million, a 9.5% decrease in volume compared to 1991, based on preliminary figures. Cost-cutting measures led to temporary reductions in active kiln capacity in Canada; reported kiln capacity in 1991 was about 15.3 Mt/y.

The Canadian Industry

The Canadian cement industry is diversified and mainly integrated with the primary construction materials and products sectors. Many cement manufacturers also supply ready-mix concrete, crushed stone aggregates, and concrete products such as slabs, bricks and pre-stressed concrete units. Restructuring during recent years has tended to result in the decentralization of operations and greater foreign control, now estimated to account for about 80% of the industry's capacity. Major international companies include: Lafarge Corporation (part of the Lafarge Coppée Group headquartered in Paris, which indirectly controls Lafarge Canada Inc.); S.A. Cimenteries CBR of Belgium (CBR), which owns Inland Cement Limited; and Société des Ciments Français (SCF) of France, which owns both Lake Ontario Cement Limited (LOC) and Miron Inc. SCF now uses the name "ESSROC" to identify all of its holdings in Canada and the United States. Accordingly, LOC also uses the name of ESSROC Canada Inc. In 1992, Italcementi S.p.A. acquired a controlling interest in SCF. This action was unexpected because SCF was the world's third largest cement producer.

Clinker-producing and finish-grinding capacities of cement plants, on a company-by-company basis, are listed in Table 2. Clinker production is more indicative of manufacturing capacity because clinker can be stockpiled for later use or sale. Accordingly, plant grinding capacities may be considerably different than the capacities relating to primary-stage clinker. The average kiln capacity over the last 10 years (1981-91) increased from about 330 000 t/y to 450 000 t/y; the average kiln age is reported to be about 23 years.

Two cement plants in **Atlantic Canada** obtain raw materials on site or nearby. These account for about 4% of total Canadian clinker-producing capacity. Nova Scotia and Newfoundland are now the only producers of cement in the region since Lafarge Canada Inc. retired its Havelock, New Brunswick, plant in 1988.

In **Quebec**, four clinker-producing plants and one grinding operation accounted for about 20% of national output. St. Lawrence Cement Inc. (SCL) is the dominant manufacturer of cement and a leading producer of concrete and aggregates in eastern Canada. Its major markets, in competition with Lafarge Canada Inc. and Ciment Quebec Inc., are in Quebec, the Maritime provinces, and northeastern United States. Considering the northeastern region of North America as a whole, there are generally four to six distribution terminals for every cement clinker plant. Plans by St. Lawrence Cement to build a $200 million cement plant at Hudson, New York, remained on hold. Expansions of stone aggregate operations and raw material reserves remain major company objectives.

Clinker-producing plants in **Ontario** account for about 45% of the nation's capacity. Lafarge Canada Inc., with operations across Canada, is the largest producer in terms of both clinker and finish grinding capacity. Lafarge's raw materials handling is extensive; for example, limestone for its plant at Bath is quarried on site and silica is supplied from Potsdam sandstone near Pittsburgh, New York, about 65 km east of Bath. Iron oxide and gypsum are purchased from Hamilton and Nova Scotia, respectively. Lafarge's Woodstock plant obtains limestone on site, silica from Falconbridge Limited, iron oxide from Stelco Inc., and gypsum from southern Ontario. At Picton, ESSROC Canada Inc. operates one of the largest cement plants in North America. In addition to the company's usual markets, the plant supplies cement and clinker to an associated company, ESSROC Materials Inc., in New York State and Michigan. Reflecting the growing importance of recycling, SLC has an alliance with Philip Environmental Services, a major supplier of used and recycled waste industrial products. With extensive operations in Ontario and metropolitan Montréal, the fully integrated waste management company may be in a position to provide a range of inputs from supplemental fuels to low-cost substitutes for some cement raw materials. SLC continued its Resource Recovery/Refuse Derived Fuel (RDF) project. Following acceptable assessment of environmental factors, the company plans to replace up to 20% of its coal requirements with RDF produced from local non-hazardous municipal wastes. St. Marys Cement Company completed a $160 million plant expansion at Bowmanville in 1991. A state-of-the-art dry-process system replaced two wet-process kilns; production of limestone on site was increased accordingly.

Two companies, CBR and Lafarge Canada Inc., normally operate four clinker-producing plants in the **Prairie provinces** and three in **British Columbia**. **Western Canada** accounts for about 26% of clinker-producing capacity, roughly in proportion to its share of total Canadian consumption. CBR affiliate Inland Cement Limited ceased production of clinker at its Regina and Winnipeg plants in 1992; clinker is now shipped from the larger Edmonton operation for finish grinding at the respective plants. (Normally, a limestone quarry at Mafeking, Manitoba, near the Manitoba-Saskatchewan border, supplied limestone to Inland's Regina plant, while the company's Winnipeg plant was supplied from Steep Rock, Manitoba.) Lafarge continued to benefit from new markets in the northern-tier states following a major upgrade of the rail facilities at its plant in Exshaw, Alberta. Most raw materials for the Exshaw plant are from on-site sources. However, gypsum is provided by Westroc Industries Limited, while iron oxide is from IPSCO Ltd. in Regina, and the Oregon Steel Co. at Portland, Oregon. Lafarge's Vancouver plant at Richmond and Tilbury's plant at Delta utilize limestone from Texada Island. Lafarge's Kamloops plant is supplied from reserves nearby.

World Developments

During the 1980s, there were marked changes in ownership, production, and sourcing in the world cement industry. In many regions, the commodity has been transformed from a domestically manufactured and marketed product to one that is traded internationally.

World cement production in 1991 was 1187 Mt, according to the U.S. Bureau of Mines. China ranked number one, leading all countries with 248 Mt, followed by the former Soviet Union with 127 Mt and the United States with 66 Mt.

In 1992, the U.S. Department of Commerce suspended its countervailing duty investigation concerning grey Portland cement and cement clinker from Venezuela. An agreement was reached with the Government of Venezuela to effectively eliminate benefits that were found to constitute bounties or grants on related exports to the United States.

Most countries are capable of supplying their own raw material requirements for cement manufacture when a plant is warranted. Normally, market range is strictly limited by transportation costs; however, large additional sales may warrant secondary distribution terminals. Few countries rely entirely on imports for their cement needs; however, multinational companies with widespread production and distribution networks have now become much more important in world markets. An outstanding recent example of this is the partial consolidation of markets in the United States, Canada and Mexico, with companies competing on a regional basis. An estimated 70% of the U.S. industry is now controlled by European and Pacific Rim cement producers.

Consumption and Trade

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 most commonly used types of cement produced by most Canadian cement manufacturers are: Normal Portland (Type I), Moderate Sulphate-Resistance Portland (Type II), and High-Early-Strength Portland (Type III).

Portland cement used in Canada should conform to the specifications of CAN/CSA-A5-M88, 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 CAN/CSA-A8-M88. Blended hydraulic cements are covered by CAN/CSA-A362-M88. Types of cement manufactured in Canada, but not covered by the CSA standards, generally meet the appropriate specifications of the American Society for Testing and Materials (ASTM).

Canada exports cement and clinker mainly to bordering states, particularly to New York, Vermont, Michigan, Minnesota and Washington. The quantities and proportions vary considerably from year to year depending on demand. Canadian cement production efficiencies and a lower-valued Canadian dollar continue to make Canadian cement and clinker competitive in U.S. markets. Low-cost marine transportation has influenced world trade considerably; however, imports are not making significant inroads into the large U.S. market as evidenced by the fact that U.S. imports for consumption were reduced by half between 1988 and 1992 to about 7.5 Mt, or 9% of apparent consumption.

TECHNOLOGY

Energy conservation programs by the Canadian cement industry reduced energy consumption per unit of production about 22% since 1974. Although the number of kilns has decreased, their individual capacities have increased and the more efficient dry-process plants now account for more than 80% of total cement production. Work continues toward using cheaper fuels, improving methods for defining optimal particle sizes based on grinding, and using waste materials in kilns. The fuel mix has changed considerably away from natural gas and petroleum products toward coal/coke. In 1991, of 20 clinker-producing plants, half reported using coal and/or coke as their primary fuel. Seven plants in 1991 reported using waste as a primary, alternate, or supplemental fuel, according to the Canadian Portland Cement Association (CPCM). In 1991, the Canadian cement industry consumed, on average, 4876 megajoules per tonne of production, of which 4317 megajoules were derived from fossil fuels (Table 2).

Suitable waste materials are an attractive alternative fuel because pyro-processing accounts for more than 80% of total energy needs, or about 30% of total manufacturing costs. Although there has been a growing acceptance that both the manufacturing process and the Portland cement product itself offer practical solutions to the management of certain types of waste, regulations governing incineration in kilns and other industrial furnaces have not been finalized. In the United States and Europe in particular, the use of waste-derived fuels and spent organic solvents has expanded. Monitoring of kiln emissions has generally confirmed that this is acceptable as a result of long residence times and the very high flame temperatures (1950°-2300°C) prevailing within. The waste materials generally established as being very satisfactory include paints and coatings, surplus oils and greases, solvents, inks, and cosmetics.

The CPCA, along with numerous co-sponsors, including the Canada Centre for Mineral and Energy Technology (CANMET), held an international symposium in 1992 on "Cement Industry Solutions to Waste Management." Among a range of subjects, it was emphasized that certain waste products having a heat-energy component can substantially reduce energy costs. In the context of sustainable development, it is apparent that large-scale waste management involving incineration could lead to greater conservation of some non-renewable fossil fuels.

CANMET, with an initiative called the Industrial Targeted Program (ITP) under the new *National Energy Efficiency and Alternative Energy Act*, is developing long-term energy efficiency R&D strategies for major industrial sectors. The cement and concrete sector study will be completed in early 1993; it is expected that there will be cooperative investments in energy efficiency research leading to field trials and technical transfer.

CANMET has also established cooperative arrangements for investigating the properties of concrete made with a high proportion of fly ash. The work, based on CANMET's technology allowing up to 60% of Portland cement replacement by fly ash, is being funded by the Electric Power Research Institute of Palo Alto, California. Past cooperative work concerning CANMET's research into supplementary cementing materials led to the production of a ground granulated blast furnace slag for use as a cementitious material in concrete. Koch Minerals of Canada Limited (formerly Reiss Lime Company of Canada, Limited) now produces this type of material, often called "slag cement," at Spragge, Ontario. Granulated slag is from The Algoma Steel Corporation, Limited's plant at Sault Ste. Marie. The capacity of the Spragge plant is about 150 000 t/y, with the product being used for complete or partial replacement of Portland cement.

CANMET was a main sponsor of one symposium and two conferences on concrete in 1992. With the American Concrete Institute (ACI), Ontario Hydro, the CPCA, and others, it sponsored the International Symposium on Advances in Concrete Technology, held in Toronto. The main purpose was to present state-of-the-art papers in fields including: high-volume fly-ash concrete, high-strength concretes, silica fume, blast furnace slag, and fibre-reinforced concrete. Similarly, along with ACI and others, CANMET sponsored the Fourth International

Conference on Fly Ash, Silica Fume, Slag and Natural Pozzolans in Concrete; it also sponsored the International Conference on Advances in Concrete Technology. The conferences were held in Istanbul, Turkey, and Athens, Greece, respectively.

Major cement-related research is carried out by the Portland Cement Association (PCA) based in Illinois. This is a non-profit research group conducting technical and market research on behalf of members and affiliates, including the CPCA. Lafarge Corporation, acting independently in technical research, operates its own research and technical centre in Montréal.

Moderate Sulphate-Resistance Cement (Type II) and Low-Heat-of-Hydration Cement (Type IV), designed for concrete poured in large masses, as in dam construction, are manufactured by several companies in Canada. Masonry cement (a generic name) includes such proprietary product 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 (35-65% by weight); and a plasticizer. The generic products do not necessarily consist of Portland cement and limestone, but may include mixtures of Portland, hydrated lime, and/or other plasticizers.

OUTLOOK

Shipments of cement in 1993 are expected to increase about 5%, based on trends in consumption. This projection, however, represents less than a true recovery because quantities will be about 1 Mt less than the average annual shipment of 9.9 Mt over the three-year period from 1990 to 1992.

The recession that began in the first half of 1990 bottomed out in January 1991. The economy in 1992 expanded about 0.9% (preliminary) in terms of real Gross Domestic Product; the outlook is for an expansion of about 3% in 1993. Five-year conventional mortgage rates declined to less than 9% in mid-1992 and, along with government programs directed mainly toward first-time buyers, there was an increase in housing starts. Housing starts were 182 000 in 1990, 156 000 in 1991, and 168 000 in 1992. The recovery is expected to continue in this sector with an estimated 180 000 starts in 1993. Given the relatively high office and industrial vacancy rates in Canada and the United States, non-residential building construction is expected to remain weak in 1993.

In December 1992, in the Minister of Finance's Economic Statement, the federal government committed $500 million in "strategic capital spending" over two years. This amount, along with expected supplementary expenditures by some provincial governments, may result in total additional expenditures of $1 billion on selected infrastructure in 1993 and 1994.

Energy management will continue to concentrate on gains in efficiency based on timely switching among the available choices of common fuels. However, most longer-term cost savings are expected to result from the partial substitution of fossil fuels by waste-derived fuels. For example, in the case of Refuse Derived Fuel (RDF), about 70% (by volume) of municipal solid waste from post-recycled curbside garbage could be used by the cement industry. This would reduce by about two thirds the volume of material for disposal as landfill. Under certain circumstances using RDF, reductions in requirements for traditional fuels, such as coal, have been predicted to be as high as 20%-25%.

The use of supplementary cements incorporating pozzolans or slags, and classified accordingly as various types of blended cements, is expected to become more important in modern concrete practice.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
25.23	Portland cement, aluminous cement, slag cement, supersulphate cement and similar hydraulic cements, whether or not coloured or in the form of clinker				
2523.10	Cement clinker	Free	Free	Free	Free
	Portland cement:				
2523.21	White cement, whether or not artificially coloured	81.59¢/t	54.25¢/t	Free	Free
2523.29	Other	Free	Free	Free	Free
2523.30	Aluminous cement	Free	Free	Free	Free
2523.90	Other hydraulic cements	Free	Free	Free	Free
68.10	Articles of cement, of concrete or of artificial stone, whether or not reinforced Tiles, flagstones, bricks and similar articles:				
6810.11	Building blocks and bricks	5%	Free	Free	0.9%
6810.19	Other	8%	Free	Free	0.9%-4.2%
6810.20	Pipes	9.8%	6.5%	Free	0.9%
6810.91	Prefabricated structural components for building or civil engineering	6.8%-8%	Free-4.5%	Free	0.9%[1]
6810.99	Other	8%	Free	Free	0.9%

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992.
[1] Brick panels originating in Canada are free of duty.

TABLE 1. CANADA, CEMENT PRODUCTION AND TRADE, 1990-92

Item No.		1990		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
PRODUCTION[1] (All Forms)							
	Ontario	5 221 285	475 214	3 760 989	348 646	3 343 768	305 906
	Quebec	2 866 937	166 521	2 267 240	135 840	1 610 000	94 339
	Alberta	x	x	x	x	x	x
	British Columbia	x	x	x	x	x	x
	Manitoba	x	x	x	x	x	x
	Nova Scotia	x	x	x	x	x	x
	Saskatchewan	x	x	x	x	x	x
	Newfoundland	x	x	x	x	x	x
	Total	11 745 152	991 442	9 372 219	810 769	8 483 697	739 211
IMPORTS						(Jan.-Sept.)	
2523.10	Cement clinker						
	Colombia	20 635r	631	76 408	2 400	9 953	321
	United States	22 028	1 306	21 236	1 255	1 894	109
	Japan	25 000	1 140	–	–	–	–
	Venezuela	27 340	808	–	–	–	–
	Total	95 003	3 887	97 644	3 656	11 847	431
2523.21	Portland cement, white, whether or not artificially coloured						
	United States	7 974r	1 472	8 908	1 344	8 469	1 325
	Japan	342r	50	736	108	204	34
	Belgium	86	12	–	–	–	–
	Total	8 402r	1 535	9 644	1 453	8 673	1 360
2523.29	Portland cement, n.e.s.						
	United States	419 225r	23 976	453 745	25 128	352 532	20 877
	Japan	–	–	–	–	3 628	265
	Germany	608	48	349	40	340	40
	Other countries	134 964	6 349	2 750	195	–	–
	Total	554 797r	30 374	456 845	25 364	356 500	21 183
2523.30	Aluminous cement						
	United States	16 141r	6 619r	9 623	4 134	7 772	3 286
	South Africa	–	–	95	45	37	20
	United Kingdom	5	2	–	–	–	–
	Total	16 146r	6 621r	9 718	4 179	7 809	3 306
2523.90	Hydraulic cement, n.e.s.						
	United States	18 116r	3 086r	51 191	5 286	25 241	3 131
	United Kingdom	1 466	184	1 704	271	615	116
	Belgium	500	44	13	3	136	14
	France	218	56	109	28	25	6
	Germany	277	7	–	–	21	5
	Other countries	24 435	1 098	8	2	23	1
	Total	45 012r	4 475r	53 025	5 592	26 061	3 275
6810.11	Building blocks and bricks of cement, concrete or artificial stone						
	United States	..	3 003	..	3 930	..	3 170
	United Kingdom	..	66	–	–	–	–
	Total	..	3 070	..	3 930	..	3 170
6810.19	Tiles, flagstones and similar articles of cement/concrete or artificial stone						
	United States	..	5 997r	..	5 880	..	5 639
	Italy	..	2 875	..	2 672	..	977
	Mexico	..	37	–	–	..	125
	Portugal	..	197	..	135	..	122
	Spain	..	10	..	2	..	60
	Belgium	..	4	..	37	..	20
	United Kingdom	..	333	..	104	..	18
	Germany	..	22	–	–	..	10
	Other countries	..	177	..	91	–	–
	Total	..	9 652r	..	8 925	..	6 976

TABLE 1 (cont'd)

Item No.		1990		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)							
6810.20	Pipes of cement or concrete						
	United States	. .	87	. .	122	. .	14
	Total	. .	87	. .	122	. .	14
6810.91	Prefabricated structural components of buildings, etc., of cement/concrete, etc.						
	United States	. .	2 876	. .	3 282	. .	3 853
	United Kingdom	–	–	–	–	. .	112
	Netherlands	. .	25	. .	4	. .	4
	Italy	. .	59	–	–	–	–
	Total	. .	2 960	. .	3 287	. .	3 969
6810.99	Articles of cement, of concrete or of artificial stone, n.e.s.						
	United States	. .	4 016r	. .	5 266	. .	6 388
	Mexico	. .	186	. .	197	. .	246
	Belgium	. .	159	. .	200	. .	82
	Italy	. .	86	. .	154	. .	78
	United Kingdom	. .	245	. .	46	. .	52
	China, People's Republic of	. .	. . .	–	–	. .	8
	Hong Kong	–	–	–	–	. .	3
	Germany	. .	. . .	–	–	. .	3
	Korea, South	. .	20	. .	19	. .	1
	Other countries	. .	94	. .	30	–	–
	Total	. .	4 811r	. .	5 914	. .	6 865
EXPORTS							
2523.10	Cement clinker						
	United States	460 075	17 233	544 870	17 487	691 751	22 821
	Total	460 075	17 233	544 870	17 487	691 751	22 821
2523.21	Portland cement, white, whether or not artificially coloured						
	United States	107 445	12 323	112 458	12 815	84 709	10 697
	St. Pierre-Miquelon	26	2	–	–	38	4
	Total	107 471	12 326	112 458	12 815	84 747	10 701
2523.29	Portland cement, n.e.s.						
	United States	2 270 318	126 198	2 133 960	109 464	1 328 054	74 108
	France	954	91	990	91	1 475	123
	Greenland	1 304	169r	200	26	300	39
	Korea, South	–	–	–	–	22	15
	St. Pierre-Miquelon	236	31	88	11	46	4
	Other countries	933	112	1 601	186	–	–
	Total	2 273 745	126 601	2 136 839	109 780	1 329 897	74 291
2523.30	Aluminous cement						
	United States	–	–	30	2	10	3
	Total	–	–	30	2	10	3
2523.90	Hydraulic cement, n.e.s.						
	United States	62 720	4 487	10 059	1 723	15 075	1 680
	Romania	–	–	–	–	31	13
	Korea, South	–	–	49	26	1	. . .
	Other countries	262	68	598	123	–	–
	Total	62 982	4 558	10 706	1 875	15 107	1 694
6810.11	Building blocks and bricks of cement, concrete or artificial stone						
	United States	. .	4 189	. .	2 189	. .	2 555
	Japan	. .	39	. .	159	. .	74
	St. Pierre-Miquelon	. .	4	. .	2	. .	2
	France	–	–	–	–	. .	2
	Other countries	. .	14	. .	20	–	–
	Total	. .	4 248	. .	2 372	. .	2 635

TABLE 1 (cont'd)

Item No.		1990		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)							
6810.19	Tiles, flagstones and similar articles of cement/concrete or artificial stone						
	United States	. .	3 226	. .	3 836	. .	2 358
	Hong Kong	–	–	–	–	. .	19
	Total	. .	3 226	. .	3 836	. .	2 377
6810.20	Pipes of cement or concrete						
	United States	. .	54	. .	110	. .	89
	Togo	–	–	–	–		
	Uganda	–	–	. .	130	–	–
	St. Pierre-Miquelon	–	–	. .	17	–	–
	Total	. .	54	. .	258	. .	89
6810.91	Prefabricated structural components of buildings, etc., of cement/concrete, etc.						
	United States	. .	34 322	. .	37 287	. .	17 867
	United Kingdom	. .	5 689	. .	8 061	. .	1 080
	Poland	–	–	–	–	. .	419
	Germany	–	–	–	–	. .	77
	Bermuda	. .	760	. .	130	. .	46
	Mauritius	–	–	–	–	. .	37
	Taiwan	–	–	–	–	. .	19
	Hong Kong	–	–	–	–	. .	15
	St. Pierre-Miquelon	–	4	–	–	. .	2
	Cuba	–	–	–	–	. .	2
	Other countries	. .	242	. .	67	–	–
	Total	. .	41 017	. .	45 547	. .	19 567
6810.99	Articles of cement, of concrete or of artificial stone, n.e.s.						
	United States	. .	9 398	. .	9 451	. .	6 159
	Taiwan	–	–	. .	19	–	–
	Germany	–	–	. .	16	–	–
	Netherlands	–	–	. .	4	–	–
	Sweden	–	–	. .	3	–	–
	Other countries	. .	3	–	–	–	–
	Total	. .	9 402	. .	9 494	. .	6 159

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified; p Preliminary; r Revised; x Confidential.
1 Producers' shipments plus quantities used by producers.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CEMENT PLANTS, APPROXIMATE ANNUAL GRINDING CAPACITY, END OF 1991

Company	Plant	Wet (W) Dry (D) Preheater (x) Precalciner (c)	Fuel (Coal, Oil, Gas, Waste)	No. of Kilns	Grinding Capacity	Clinker Capacity
					(000 t/y)	
ATLANTIC REGION						
Lafarge Canada Inc.	Brookfield, N.S.	D	C, Wa	2	600	515
North Star Cement Limited	Corner Brook, Nfld.	Dx	O, Wa	1	245	152
Subtotal, Atlantic region				3	845	667
QUEBEC						
Lafarge Canada Inc.	Montréal East		–		438	–
Lafarge Canada Inc.	St. Constant	D	C,O,G, Wa	2	1 000	991
Ciment Québec Inc.	St. Basile	W,Dc	O,G, C	3	860	1 074
St. Lawrence Cement Inc.	Beauport	W	C, Wa	2	700	611
(Independent Cement Inc.)	Joliette	D	C,O	4	1 075	1 038
Subtotal, Quebec region				11	4 043	3 714
ONTARIO						
Lafarge Canada Inc.	Woodstock	W	C,G	2	535	563
	Bath	Dx	C,G	1	1 000	1 045
Federal White Cement Ltd.	Woodstock	D	C,O,G	1	150	151
Lake Ontario Cement Limited	Picton	D,Dx	C,G	2	927	1 124
St. Lawrence Cement Inc.	Mississauga	W,Dc	C, Wa	3	1 600	1 876
St. Marys Cement Company	Bowmanville	Dc	C	1	910	1 500
	St. Marys	Dx	C,G	1	735	645
Subtotal, Ontario region				11	5 857	6 904
PRAIRIES REGION						
Lafarge Canada Inc.	Fort Whyte, Man.		–	–	474	–
	Exshaw, Alta.	D,Dc	G	2	900	1 029
Inland Cement Limited	Winnipeg, Man.	W	G	1	430	341
(S.A. Cimenteries CBR)	Regina, Sask.	D	G, O	1	400	211
	Edmonton, Alta.	Dc	G	1	1 500	726
Subtotal, Prairies region				5	3 704	2 307
BRITISH COLUMBIA						
Lafarge Canada Inc.	Kamloops	D	C,G	1	300	194
	Richmond	W	C,G	2	515	474
Tilbury Cement Limited (S.A. Cimenteries CBR)	Delta	Dx	C,G	1	968	1 085
Subtotal, B.C. region				4	1 783	1 753
Total Canada (9 companies)				34	16 262	15 345

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

TABLE 3. CANADA, CEMENT PLANTS, KILNS AND CAPACITY UTILIZATION, 1979-92

	Clinker-Producing Plants	Kilns	Approximate Cement Grinding Capacity[1]	Portland and Masonry Cement Production[2]	Clinker Exports	Approximate Total Production[3]	Capacity Utilization
			(t/y)	(t)	(t)	(t)	(%)
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	10 192 442	676 596	10 869 038	61
1986	23	49	17 900 000	10 611 223	324 000	10 935 223	61
1987	20	40	16 600 000	12 603 164	767 338	13 370 502	81
1988	20	40	15 506 000	12 349 873	331 796	12 681 669	82
1989	20	38	15 546 000	12 590 637	178 491	12 769 128	82
1990	20	38	16 439 000	11 745 152	460 075	12 205 227	74
1991	20	34	16 262 000	9 372 219	544 870	9 917 089	61
1992p	20	34	16 262 000	8 483 697	988 348	9 472 045	58

Sources: Statistics Canada; U.S. Bureau of Mines; Portland Cement Association (PCA).
p Preliminary.
1 Includes plants that grind only. 2 Producers' shipments and amounts used by producers. 3 Cement shipments plus clinker exports.

TABLE 4. CANADA, HOUSE CONSTRUCTION, BY PROVINCE, 1991 AND 1992

	Starts			Completions			Under Construction		
	1991	1992	% Diff.	1991	1992	% Diff.	1991	1992	% Diff.
Newfoundland	2 836	2 271		3 219	2 558		2 867	2 464	
Prince Edward Island	553	644		722	596		281	326	
Nova Scotia	5 173	4 679		4 905	5 485		3 567	2 751	
New Brunswick	2 872	3 310		2 858	3 051		1 366	1 599	
Subtotal, Atlantic provinces	11 434	10 904	–5	11 704	11 690	0	8 081	7 140	–12
Quebec	44 654	38 222	–15	42 720	42 323	–1	15 662	11 033	–30
Ontario	52 794	55 772	+6	59 622	63 134	+6	40 599	31 653	–22
Manitoba	1 950	2 310		2 190	2 190		1 029	1 136	
Saskatchewan	998	1 869		1 241	1 554		509	871	
Alberta	12 492	18 573		12 959	16 307		5 497	7 536	
Subtotal, Prairie provinces	15 440	22 752	+47	16 390	20 051	+22	7 035	9 543	+36
British Columbia	31 875	40 621	+27	29 578	36 060	+22	23 658	28 149	+19
Total Canada	156 197	168 271	+8	160 014	173 258	+8	95 055	87 518	–8

Source: Canada Mortgage and Housing Corporation.

TABLE 5. CANADA, VALUE OF CONSTRUCTION BY PROVINCE,[1] 1990-92

	1990			1991			1992		
	Building Construction[2]	Engineering Construction[2]	Total	Building Construction[2]	Engineering Construction[2]	Total	Building Construction[2]	Engineering Construction[2]	Total
					($ millions)				
Newfoundland	1 040	679	1 718	1 011	898	1 909	1 060	1 168	2 228
Nova Scotia	1 816	846	2 662	1 541	1 033	2 574	1 560	850	2 409
New Brunswick	1 314	719	2 033	1 147	1 061	2 208	1 166	1 039	2 205
Prince Edward Island	242	89	332	246	104	350	251	122	373
Quebec	16 394	6 552	22 946	14 996	6 592	21 588	14 077	7 027	21 104
Ontario	29 526	8 404	37 930	25 443	8 800	34 244	27 493	9 546	37 039
Manitoba	1 811	1 348	3 159	1 580	1 367	2 947	1 662	1 381	3 044
Saskatchewan	1 737	1 932	3 670	1 534	2 043	3 577	1 531	1 861	3 392
Alberta	6 283	7 494	13 777	5 391	7 191	12 582	5 689	6 754	12 443
British Columbia, Yukon and Northwest Territories	9 884	4 258	14 142	9 493	4 654	14 147	10 816	4 204	15 021
Total Canada	70 047	32 320	102 367	62 382	33 743	96 125	65 307	33 952	99 259

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Actual expenditures 1990, preliminary 1991, intentions 1992. [2] Includes total value of new and repair work purchased.
Note: Numbers may not add to totals due to rounding.

TABLE 6. CANADA, VALUE OF CONSTRUCTION BY TYPE,[1] 1990-92

	1990	1991	1992
		($ millions)	
BUILDING CONSTRUCTION[2]			
Residential	41 012	36 776	41 115
Industrial	4 344	3 416	2 840
Commercial	16 574	14 009	12 637
Institutional	5 536	5 630	6 189
Other building	2 581	2 550	2 527
Subtotal	70 047	62 382	65 307
ENGINEERING CONSTRUCTION[2]			
Marine	586	627	681
Highways, airport runways	6 463	6 308	6 478
Waterworks, sewage systems	2 925	2 742	2 972
Dams, irrigation	456	459	445
Electric power	6 132	7 285	7 557
Railway, telephones	3 612	3 040	3 296
Gas and oil facilities	8 325	9 914	9 219
Other engineering	3 820	3 370	3 303
Subtotal	32 320	33 743	33 952
Total construction	102 367	96 125	99 259

Source: Statistics Canada.
[1] Actual expenditures 1990; preliminary 1991; intentions 1992. [2] Includes total value of new and repair work purchased.
Note: Numbers may not add to totals due to rounding.

TABLE 7. WORLD PRODUCTION OF CEMENT, 1991 AND 1992

	1991	1992[e]
	(000 tonnes)	
People's Republic of China	247 661	268 000
Former Soviet Union	127 006	130 000
Japan	88 904	93 000
United States	66 224	71 000
India	49 895	54 000
Italy	39 916	41 000
Korea, Republic of	33 566	36 000
Germany	41 731	43 000
France	26 308	27 000
Canada	9 372	8 500
Other	456 015	466 500
Total world	1 186 598	1 238 000

Sources: Energy, Mines and Resources Canada; U.S. Bureau of Mines Mineral Commodity Summaries, January 1993.
[e] Estimated.

Clays

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The clays are a complex group that consists of several mineral commodities, each having somewhat different mineralogy, geological occurrence, technology and uses. They are all natural, earthy, fine-grained minerals of secondary origin and composed of an alumino silicate structure with additional iron, alkalis and alkaline earth elements. Clay minerals are classified into two broad groups: **specialty clays**, which include attapulgite, bentonite, Fuller's earth, hectorite, montmorillonite and sepiolite, and **kaolinitic clays**, which include ball clay, fire clay (refractory clay), stoneware clay and kaolinite. These minerals rarely occur in a pure state and the most frequently occurring gangue minerals, which may or may not be deleterious for ceramic applications, include quartz, calcite, dolomite, feldspar, gypsum and iron oxide.

Clay is an abundant raw material with a wide variety of uses and properties. The commercial value of a clay depends primarily on its physical properties; in fact, the most important are plasticity, strength, shrinkage, vitrification range and refractoriness, fired colour, porosity and absorption.

Canadian Occurrences

Common Clay and Shales

Common clay is a clay or clay-like material which is sufficiently plastic to permit ready molding and which vitrifies below 1100°C. Shale is a sedimentary rock, composed chiefly of clay minerals, which has been laminated and indurated while buried under other sediments. Suitable common clay and shales are used in the manufacture of structural clay products such as common brick, face brick, structural tile, partition tile, conduit tile, drain tile, lightweight aggregate, and Portland cement.

Common clay and shales are found in all parts of Canada: in Newfoundland, shales occur near Corner Brook; in New Brunswick, shales occur at Havelock in Kings County and from a quarry at Chipman; in Nova Scotia, shales occur at Lantz in Hants County; in Quebec, shales occur near plants located at Laprairie, Beauport and Deschaillons; and in Ontario, glacial clays occur near Woodstock and St. Mary's, and shales occur near numerous plants located throughout the southeastern portion of the province. In western Canada, glacial shales and clays occur in each of the major provinces: in Manitoba, glacial clays and shales occur near Lake Agassiz; in Saskatchewan, glacial clays occur near Regina, Estevan, Rockglen, Flintoft, and Readlyn; and in British Columbia there are several active deposits with the most important ones occurring at Sumas Mountain near Abbotsford.

A list of producers of structural clay products manufactured from common clay and shales is presented in Table 4.

Kaolin

Kaolin is a clay consisting of substantially pure kaolinite, or related clay minerals, that is naturally white or can be beneficiated to be white. Kaolin has many industrial applications and new uses are still being discovered. It is a unique industrial mineral because: it is chemically inert over a relatively wide pH range; it is white and has good covering or hiding power when used as a pigment or extender; it is soft and non-abrasive and has a low conductivity of heat and electricity; and it costs less than most materials with which it competes. Kaolin is used primarily as a filler in the pulp and paper, plastic, paint and rubber industries, and in the manufacture of conventional ceramic products. Kaolin is also used as a batch ingredient in the production of textile-type fibreglass and, to a smaller extent, in the preparation of medicinal products, food additives, bleaching agents, plaster, filter aids, cosmetics, detergents, paste, roofing granules, foundries, linoleum, and textiles.

Kaolin occurs in various provinces of eastern and central Canada including Nova Scotia, New Brunswick, Quebec and Ontario. Kaolin deposits are known in various areas of Quebec (in the counties of Papineau, Montmorency and Gatineau), but their small size and the presence of impurities have hindered their development. In Ontario, extensive deposits of a kaolinized sand mixture occur along the Missinaibi and Mattagami rivers southwest of James Bay in northern Ontario over an area of 10 000 km^2. An occurrence of Mesozoic clay also occurs at Limestone Rapids.

Kaolinitic clays occur at various locations in western Canada. In Manitoba, deposits are found on Deer Island, in the Cross Lake area to the north of Grand Rapids, in the Pine River area in the Swan River group, near Arborg, and in the Phanerozoic Sylvan strata; kaolinitic shales occur in the Kergwenan area south of Ste. Rose du Lac. The most important deposit is the quarry at Ste. Rose du Lac. The kaolinitic clay resources of southern Saskatchewan occur as Whitemud deposits at Wood Mountain, Knollys, Cypress Hills, Moose Jaw, and as far east as Weyburn. The deposits of principal interest are the Wood Mountain area in south-central Saskatchewan, and the Eastend-Shaunavon area along the Frenchman River in southwestern Saskatchewan. A low-grade kaolin and fire-clay deposit occurs at Wabamun, Alberta, but further development is unlikely since previous mining of the fire clay has contaminated the kaolin. British Columbia hosts various kaolinitic deposits. The most important deposit occurs at Lang Bay in the southwestern portion of the province. Other deposits occur along the Fraser River near Prince George and, at Sumas Mountain, kaolinized basement rocks occur below the basal fire-clay seam.

Ball Clay

Ball clay is a fine-grained mixture of 70% disordered kaolinite with illite, quartz, montmorillonite, chlorite and minor amounts of carbonaceous material. In Canada, ball clay is mineralogically similar to high-grade, plastic fire clay and is composed principally of fine-size kaolinite, quartz and mica. Ball clay is used mostly in the manufacture of pottery or whiteware, including domestic tableware, wall tiles, sanitaryware and electrical porcelain. Miscellaneous non-ceramic applications include uses as an animal feedstuff binder; a fertilizer anti-caking agent; as a filler in rubber and plastics, and adhesives; and in chemicals, petroleum refining, paint, and varnish.

Economic deposits of ball clay occur only in Saskatchewan in the Whitemud and the Ravenscrag geological formations. It is quarried at Estevan, Rockglen, Flintoft and Readlyn for the manufacture of face brick at Estevan Brick Limited. Clayburn Industries Limited, in British Columbia, imports ball clay for the manufacture of their refractory products.

Fire Clay (Refractory Clay)

Refractory clay, also known as fire clay, is a detrital clay composed mainly of kaolinite with a high content of alumina and silica. These clays may range in plasticity from essentially that of ball clay to non-plastic varieties such as flint clay. Fire clay is used in the manufacture of products requiring high resistance to heat such as fire brick, insulating brick, and refractory mortar.

A variety of good-quality fire-clay grades occurs in several provinces of Canada. Fire-clay deposits occur in the Musquodoboit Valley and at Shubenacadie in Nova Scotia. Multi-coloured fire clay also occurs in the James Bay lowlands of northern Ontario along the Missinaibi, Abitibi, Moose, and Mattagami rivers. In western Canada, various grades of good-quality fire clay occur in the Whitemud formation in southern Saskatchewan, and on Sumas Mountain in British Columbia where it is quarried and processed by Clayburn Industries Limited to produce several refractory products. A number of brown or dark-grey mud stone and claystone beds have also been reported in the Lang Bay area in British Columbia.

Stoneware Clays

Stoneware clays are intermediary between low-grade common clays and the high-grade kaolinitic clays. They are typically a mixture of kaolinitic and micaceous clay minerals. Stoneware clays are used exclusively in the manufacture of sewer pipe, flue liners, and face brick. They are also used widely 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 in British Columbia occur near Abbotsford on Sumas Mountain, at Chimney Creek Bridge near Quesnel, and at Williams Lake. Deposits in Manitoba occur near Swan River and Ste. Rose du Lac, and in Nova Scotia at Shubenacadie and Musquodoboit. Plainsman Clay Limited quarries plastic stoneware clay near Ravenscrag, Saskatchewan, for processing at Medicine Hat, Alberta.

Bentonite

Bentonite is a clay consisting of smectite minerals (montmorillonite group), and is formed from volcanic ash, tuff or glass, other igneous rocks, or from rocks of sedimentary origin. There are two categories: swelling and non-swelling bentonites. Sodium bentonite has strong swelling properties and possesses a high dry-bonding strength, while calcium bentonite, or the non-swelling type, usually exhibits greater adsorptive characteristics.

The widest application of swelling bentonite is in well-drilling muds, followed by pelletizing iron ore concentrates. The use as a binder in foundry molds is still considered a major application for which the swelling variety is preferred, although non-swelling bentonite is used for some foundry purposes. Minor applications of bentonite include pelletizing animal feedstuffs for which the non-swelling variety with its high green strength is preferred. Swelling bentonite in small proportions is used to provide a bond in brake linings and as a plasticizer in refractory, abrasive and ceramic mixes. Bentonite is an important ingredient in soils stabilized with lime.

There are numerous filler applications for bentonite, such as in oil-well cement, concrete lightweight aggregates, grouting material, soil sealant, diaphragm wall construction, fire retardants, paper-making applications, pesticide and herbicide weighting agents, soaps and detergents, and cleaning and polishing compounds. The extender applications are equally as various: as an emulsifier in rubber, linoleum and oil-cloth; in cosmetics and pharmaceuticals to impart a smooth, soapy consistency to creams; as a suspending agent in oil-based paints; and in both oil- and water-based paints to improve spreadability.

Bentonite is employed for its adsorptive properties in clarifying mineral, vegetable and animal oils and waxes; the non-swelling varieties are preferred for this application. Miscellaneous adsorptive and absorptive applications include water and sewage treatment, pet litter, stabilizing colours in inks and dyes, deodorizing and dehumidifying, soil conditioning, fertilizer retention, and printer's ink adsorption during the repulping of waste paper.

The principal Canadian bentonite deposits are confined to western Canada, particularly Manitoba, Saskatchewan and Alberta. Bentonite deposits have been located in Ontario and Quebec, but they are not considered to be of economic significance. Calcium non-swelling bentonite in Manitoba occurs mainly near the base of the Pembina member of the Vermilion River formation and in the overlying Millwood member of the Riding Mountain formation. Saskatchewan has many bentonite occurrences: in eastern Saskatchewan near Pelly, in the south-central part near St. Victor, and in the southwestern part near Eastend. Bentonite in Alberta is found at Rosalind near the Battle River Valley. Deposits of bentonite in British Columbia occur along the Fraser River in the Lytton to Gang Ranch area, near coal seams in the Quilchena and Guichon valleys of the Merrit Basin, and in shale and coal-rich sections throughout the northern half of the Princeton basin. Bentonite is also widespread in the Hat Creek beds of the Hat Creek Valley.

Canadian Clay Products Limited is the only producer of swelling bentonite in Canada, quarrying bentonite near Truax, 60 km southwest of Regina, Saskatchewan. Bentonite was mined in Manitoba until 1992 by Pembina Mountain Clays Incorporated at a quarry near Miami, southwest of Winnipeg, and processed at Morden (near Miami) and at Winnipeg; both activated and unactivated varieties were produced. MI Fluids of Rosalind, Alberta, who recently ceased operations in October 1992, mined and processed between 10 000 and 15 000 t/y of bentonite for a variety of markets.

Fuller's Earth

Fuller's earth is a term related to bentonite, but it is derived from a particular application for clay. Fuller's earth is defined as a non-plastic clay or clay-like material, usually high in magnesia, which has adequate absorbing properties. It is formed by the alteration of volcanic ash or by direct chemical precipitation of montmorillonite in shallow marine basins. Fuller's earth is used mainly for its adsorptive properties, although it is becoming employed in other applications as a carrier and as a filler-extender. There are now more than 90 different grades of Fuller's earth. The more important of these grades are used for pharmaceuticals designed to absorb toxins, bacteria and alkaloids; for treatment of dysentery; for purifying water and dry-cleaning fluids; for the manufacture of multiple-copy paper; for the manufacture of wallpaper; and as an extender or filler for plastic, paint and putty. A special use of Fuller's earth is as a carrier of platinum catalysts.

Fuller's earth, which is not widely found in Canada, is produced at Red Lake, British Columbia, by Western Industrial Clays Limited.

CANADIAN DEVELOPMENTS

Mineral Research of Canada is currently evaluating its kaolin-silica deposit in Kipling Township in the James Bay Lowlands of northern Ontario. Earlier this year, a 30 000-t bulk sample was removed; it is planned to remove 150 000 t over the next three years. The sample is being processed at the company's research facility at Foley near Parry Sound to define the parameters for future mining and the establishment of a large-scale 30 000-t/y processing facility. The final stage of the development program will be carried out by Great Lakes Kaolin, a potential partner. Mineral Research of Canada, to date, has spent in excess of C$10 million. The processing of drill core has indicated that the reserves meet acceptable standards for porcelain-grade in ceramic applications, coating-grades in paper mills, and industrial-filler grade in speciality cement. Silica sand, gravel and peat co-products are also considered saleable.

Interest in the Wood Mountain kaolin deposits of south-central Saskatchewan has again been rekindled, this time by Kaolin Industries of Saskatoon. Following the cessation of operations by Ekaton early in 1990, the pilot plant lay idle until this year. Kaolin Industries is currently processing kaolinized sand from the Wood Mountain and Readlyn areas using a patented process to produce both paper-filler and coater-grade kaolin. The project is partially funded by the Saskatchewan Mineral Development Agreement and the Western Economic Diversification fund.

Lang Bay Resources Limited, in British Columbia, is currently drilling for a bulk sample of kaolin from the deposit near Powell River. A 45-t sample has already been logged, of which about 35 t were processed to produce 6 t of product. The processed kaolin has been evaluated as a filler for newsprint and the initial indications are positive. In September 1992, the company received a permit from the provincial government to extract a 2000-t bulk sample. Processing this large amount will yield 500 t of kaolin, 200 t of which are to be shipped to Fletcher Challenge Canada's Elk Falls operation at Campbell River, British Columbia, for an extended paper mill trial. The balance will go to other prospective customers.

Canadian Production and Trade

The total value of Canadian shipments of all clays rose by only 2% from $122.2 million in 1991 to $124.6 million in 1992. The largest increases were 16.4% in Saskatchewan and 10.1% in Ontario. Increases in Newfoundland and Alberta were about 7%. Operations at IXL (Red River, Manitoba) and L.E. Shaw (Chipman, New Brunswick) were closed in 1992. The largest single decrease was 34% in British Columbia due to a cutback by Clayburn Industries.

Imports of kaolin into Canada for the first nine months of 1992 totalled 394 513 t valued at $56.8 million, compared with 383 940 t valued at $48.3 million for the first nine months of 1991. This represents an increase in volume of 2.8% over 1991. The value per tonne also increased from $126 to $144, an increase of 14.3%. In 1992, kaolin was imported almost entirely from the United States and was distributed 23.5% in Atlantic Canada, 71.4% in central Canada and 5.1% in western Canada. The pattern was similar for the first nine months of 1991. The principal consuming industry in 1991 was pulp and paper, which accounted for 87%.

Imports of bentonite into Canada for the first nine months of 1992 totalled 182 381 t valued at $10.1 million, compared with 192 454 t valued at $8.9 million for the first nine months of 1991. This represents a 5.2% decrease in volume over 1991. The value per tonne, however, increased from $46 to $56, an increase of 21.7%. The source of imports in 1992 was about 65% from the United States with the remainder coming mainly from Greece; imports from the United States were 82% for the same period in 1991. The distribution of bentonite within Canada was 89.3% in central Canada, 10.5% in western Canada, and less than 0.3% in Atlantic Canada. The distribution pattern was similar for the first nine months of 1991. The principal consuming industry in 1991 was iron ore pelletizing, followed by foundry mold binding and oil-well drilling fluids.

A similar growth for kaolin is expected for next year because of developments in the paper industry, as discussed above. It is expected, however, that bentonite will experience little growth until the oil and iron ore industries improve.

U.S. Production and Trade

Domestic production of all types of clays decreased by 5% in 1992 from 44.2 Mt in 1991 to 42.2 Mt in 1992; the estimated value of all marketable clay in 1992 was about US$1.9 billion. The 30 major producers supplied approximately 50% of the output and about 300 lesser producers accounted for the remainder; together they operated about 1000 mines. Common clay was the major clay produced, accounting for 62% of production; kaolin accounted for 22% of production and bentonite for 8%. Major domestic uses for specific clays were estimated as follows: kaolin, 48% in paper, 21% in refractories and 5% in glass; ball clay, 20% in sanitaryware, 19% in floor and wall tile, and 15% in dinnerware; fire clay, 67% in fire brick; bentonite, 20% in foundry-sand bonding, 23% in drilling mud, and 24% in iron ore pelletizing; Fuller's earth, 77% in absorbent uses, and 7% as an insecticide dispersant; and common clays, 97% in construction materials. Imports of clays to the United States were 42% from Mexico, 34% from the United Kingdom, and 14% from Canada.

New Products

A new delaminated kaolin pigment, "Nusurf," for dull, matte-finish, and low-weight coated rotogravure papers has recently been marketed. "Nusurf" pigment reduces sheet gloss and provides excellent print gloss. A new range of products, SAMS (sodium alumina metal silicates), which are kaolin-based structured pigments with applications in the paper, paint and plastics industries, has also been introduced to the market. In the paper industry, the SAMS pigments can be designed to lower abrasion in filler applications and, in coating applications, SAMS pigments can increase coating bulk while lowering weight. New uses for kaolin include the blending of kaolin with other minerals to make a special ceramic material which is used in the ceramic support for the automobile catalytic converter. Clays are also becoming increasingly important in lining toxic and domestic waste dumps.

Prices

Kaolin is marketed in three grades: coating-grade sells for US$140-220/t, filler-grade for US$120-160/t; and pottery-grade for US$75-220/t. Calcined kaolin sells for US$340-990/t depending on end use, and surface-treated grades of air-floated kaolin sell for US$250-425/t. Prices for paper filler and standard-coating grades are generally discounted about 15%-20% from list; air-floated kaolin for the paper industry is discounted as high as 50%-60% from list, and calcined kaolin prices are reduced to about US$385/t on large amounts.

Outlook

Positive indicators for the Canadian paper industry are the kaolin-intensive papers. Lightweight-coated papers, which contain substantial amounts of kaolin, are being increasingly used in the advertising industry, and the production of printing and writing papers for these purposes is expected to grow by 3%/y. "Groundwood specialties," papers similar to newsprint but of higher brightness, are using increasing amounts of kaolin. The specialty markets for high-quality coating, delaminated and calcined clays are expected to grow 3.4%/y over the next five to six years, with the highest growth rates in the absorbents and civil engineering applications. The demand for calcined kaolin as a filler in uncoated-freesheet paper is expected to continue to decrease. Calcium carbonate (ultra-fine ground or precipitated) continues to erode kaolin's usage in paper. The use of air-floated kaolin in extender and filler applications is expected to decrease by 1.5%/y. The demand for air-floated kaolin, however, in the rubber, adhesives and sealants, paint and plastics industries is expected to grow at about 2%/y over the next five to six years. Ceramic applications of low-grade kaolin, for example, in fire brick, glass fibre insulation, cement, and refractories are not expected to grow significantly in Canada as other local clays can be substituted.

The primary marketing issue confronting any potential Canadian developer of kaolin is consumer acceptance. A new producer must be prepared to offer strong technical product services, especially in the paper kaolin markets, and a new supplier entering the myriad "commodity" kaolin markets would face strong competition within the filler industry. The apparent transportation cost advantage of kaolin production in proximity to northern paper mills is not necessarily clear cut. Existing backhaul arrangements, for instance, have made long-distance trucking of kaolin more viable. There is, however, a positive side: the Canadian paper industry is undergoing a continuing change to higher-value paper products such as kaolin-intensive papers.

The outlook for drilling-mud-grade bentonite is linked to a return to higher oil prices. The demand for pelletizing bentonite, however, is expected to decline as the need for pelletizing will decrease, although world demand for iron ore is expected to increase by 30% to the year 2000. Specialty applications for bentonite seem to exhibit the strongest growth potential; sealants, absorbents, and desiccants are the fastest-growing applications. Absorbent uses also represent a share of current markets for bentonite. An increasing market for bentonite in Canada is in the purification of salad oils. The demand for salad oils increased by 74% between 1981 and 1987, and growth is expected to continue. The environmental application of bentonite is also a growing market. The main use is as a soil sealant, but other growth areas are the removal of oil and chemical pollutants from water, the removal of sulphur dioxide from coal combustion, the fixation of toxic organic compounds, and the escape prevention of buried radioactive wastes. It is claimed that the use of bentonite, in combination with polyacrylamid, is also a fast-growing application as more mills move to alkaline papermaking. The usage of bentonite in this application is expected to increase from 2800 t in 1991 to 30 300 t by 1995.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2507.00	Kaolin and other kaolinic clays, whether or not calcined	Free	Free	Free	Free
2508.10	Bentonite	Free	Free	Free	Free
2508.20	Decolourizing earths and Fuller's earth	Free	Free	Free	Free
2508.30	Fire clay	Free	Free	Free	Free
2508.40	Other clays (excluding expanded clays)	Free	Free	Free	Free
3802.90.10	Activated clay	12.5%	8.0%	Free	0.5%

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992.

TABLE 1. CANADA, CLAY PRODUCTION[1] AND TRADE, 1990-92

Item No.		1990		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
PRODUCTION (shipments)		..	136 029	..	119 838	..	117 326
IMPORTS[2]						(Jan.-Sept.)	
2507.00	Kaolin and other kaolinic clays whether or not calcinated						
	United States	507 470r	74 408r	523 857	66 075	394 478	56 743
	United Kingdom	111	66	448	58	35	21
	France	12	6	60	28	...	..
	Other countries	312	57	–	–	–	–
	Total	507 906r	74 539r	524 365	66 162	394 513	56 764
2508.10	Bentonite						
	United States	226 229r	10 923r	220 147	9 274	119 205	7 191
	Greece	26 015	1 202	48 430	2 423	63 156	2 919
	Germany	2	1	4	3	19	18
	Italy	1	..	5	5	1	1
	Other countries	147	130	23	5	–	–
	Total	252 395r	12 259r	268 609	11 712	182 381	10 130
2508.20	Decolourizing earths and Fuller's earth						
	United States	6 643	806	6 138	880	5 808	849
	Total	6 643	806	6 138	880	5 808	849
2508.30	Fire clay						
	United States	10 147r	1 909	8 639	2 042	6 339	1 203
	United Kingdom	253	90	403	117	357	111
	France	6	5	–	–	–	–
	Total	10 406r	2 005	9 041	2 159	6 696	1 315
2508.40	Other clays (excluding expanded clays of 68.06)						
	United States	194 771r	23 278r	170 397	27 017	141 685	22 112
	France	18	26	32	40	39	50
	United Kingdom	1 422	535r	90	78	15	14
	Switzerland	10	15	22	27	9	14
	Germany	12	4	18	10	27	12
	Italy	–	–	21	21	1	1
	Former U.S.S.R.	–	–	–	–	1	1
	Japan	2	1	6	3	...	..
	Other countries	18	19	1	2	–	–
	Total	196 253r	23 879r	170 588	27 201	141 775	22 206
3802.90.10	Activated clay						
	United States	6 053r	2 981	10 426	4 667	8 456	4 191
	Germany	126	82	–	–	–	–
	Total	6 179r	3 063	10 426	4 667	8 456	4 191
EXPORTS							
2507.00	Kaolin and other kaolinic clays whether or not calcinated						
	United States	38	22	252	41	46	6
	People's Republic of China	–	–	265	558	–	–
	Total	38	22	517	599	46	6
2508.10	Bentonite						
	United States	1 165	662	1 037	443	1 020	365
	Chile	–	–	–	–	326	301
	France	3	5	5	11	11	16
	Belize	–	–	–	–	5	2
	Other countries	2	2	93	41	–	–
	Total	1 170	671	1 136	497	1 362	685
2508.20	Decolourizing earths and Fuller's earth						
	United States	45	10	26	11	106	17
	Total	45	10	26	11	106	17
2508.30	Fire clay						
	United States	168	39	230	55	96	24
	United Arab Emirates	–	–	–	–	3	3
	Total	168	39	230	55	99	28

TABLE 1 (cont'd)

Item No.		1990		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)							
2508.40	Other clays (excluding expanded clays of 68.06)						
	United States	1 170	1 097	8 153	1 877	8 127	239
	South Korea	–	–	–	–	26	177
	Netherlands	–	–	–	–	91	53
	Argentina	–	–	–	–	2	46
	Japan	1	18	–	–	22	25
	France	–	–	–	–	14	21
	United Kingdom	–	–	–	–	3	3
	Other countries	38	39	1	1	–	–
	Total	1 209	1 155	8 154	1 878	8 285	567

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

– Nil; . . Not available; . . . Amount too small to be expressed; p Preliminary; r Revised.
[1] Production values for bentonite and diatomite have been included. [2] Imports from "Other countries" may include re-imports from Canada.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, BENTONITE IMPORTS AND CONSUMPTION,[1] 1980-92

	Imports		Consumption[2]
	(tonnes)	($000)	(tonnes)
1980	469 292	18 011	248 585
1981	311 464	13 292	286 359
1982	238 031	12 311	182 266
1983	187 228	9 545	197 429
1984	337 054	15 307	265 289
1985	346 018	18 109	275 725
1986	326 298	15 455	240 408
1987	318 074	14 715	235 488
1988a	294 269	15 058	264 032
1989	294 280	15 069	259 468
1990	252 395r	12 259r	202 335
1991	268 609	11 712	178 245
1992b	182 381	10 130	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
. . Not available; r Revised.
a Beginning in 1988, imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. b First nine months of 1992 only.
[1] As reported by consumers. [2] Does not include activated clays and earths or Fuller's earth.

TABLE 3. CANADA, REPORTED CONSUMPTION[1] OF CLAYS, BY INDUSTRY, 1988-91

	1988	1989[b]	1990	1991[p]
		(tonnes)		
China clay (kaolin)				
Pulp and paper products[2]	298 545	290 359	346 166	354 818
Rubber products	9 447	8 254	6 849	8 581
Ceramic products	13 101	11 744	10 100	7 700
Paint and varnish	5 639	6 681	8 184	7 211
Other products[3]	31 264[r]	41 202[r]	39 646[r]	28 942
Total	357 996[r]	358 240[r]	410 945[r]	407 252
Ball clay				
Ceramic products	23 661	21 330	18 747	14 399
Refractory brick, mixes	2 671	2 590	2 055	1 935
Other products[4]	29 736	4 439[r]	5 390[r]	4 480
Total	56 068	28 359[r]	26 192[r]	20 814
Fire clay				
Refractory brick, mixes	10 948	14 532	11 388	7 372
Foundries	6 899	5 738	5 310	5 123
Other products[5]	105 049	85 291	51 531	51 692
Total	122 896	105 561	68 229	64 187
Bentonite				
Iron ore pelletizing	163 446	171 373	.. [a]	.. [a]
Foundries	59 720	55 006	187 155[a]	158 831[a]
Well drilling	34 053	10 566	7 323	12 266
Refractory brick, mixes	1 173	1 494	1 310	1 007
Other products[6]	5 640	21 029	6 547	6 141
Total	264 032	259 468	202 335	178 245

Source: Energy, Mines and Resources Canada.
. . Not available; [p] Preliminary; [r] Revised.
[a] Due to confidentiality, data for iron ore pelletizing are included in Foundries. [b] Increase in number of companies being surveyed.
[1] Reported from EMR survey on the consumption of nonmetallic minerals by Canadian manufacturing plants. [2] Includes pulp, paper and paper products. [3] Includes chemicals, glass fibre wool, asphalt roofing products, gypsum products, floor coverings and other miscellaneous products. [4] Includes structural clay products, paper and paper products, gypsum products and other miscellaneous products. [5] Includes structural clay products, primary steel, rubber products, nonferrous smelting and refining, and other products. [6] Includes animal feeds, structural clay products, pulp, paper and paper products, paint and varnish and other miscellaneous minor uses.

TABLE 4. MAJOR CANADIAN MANUFACTURERS OF STRUCTURAL CLAY PRODUCTS FOR 1992, 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	Closed in 1992; all operations moved to the Nova Scotia location.
NOVA SCOTIA				
L.E. Shaw Limited	Lantz	Brick, block and tile	Common clay, ball clay	(E)
QUEBEC				
Canada Brick Co., division of Jannock Limited	Laprairie	Building and facing brick	Shale	(G)
Citadel Brick Ltd. division of Brampton Brick Limited	Beauport	Building brick, drain tile and flue lining	Shale	(C)
Montreal Terra Cotta Inc.	Deschaillons	Building brick, tile and flue lining	Shale, common clay	(B)
ONTARIO				
Martin Clay Products	Parkhill Wallenstein	Drain tile	Shale	(A)
Brampton Brick Limited Brampton division	Brampton	Building brick	Shale	(C)
Canada Brick Co.				(E)
Burlington division	Burlington	Building brick	Shale	New plant.
Burlington division	Burlington	Building brick	Shale	
F.B McFarren division	Streetsville	Building brick	Shale	Closed December 30, 1992.
Ottawa Division	Ottawa	Building brick	Shale	
Streetsville division	Streetsville	Building brick	Shale	Operating at half capacity.
Cooksville division	Streetsville	Building brick	Shale	
George Coultis & Son Limited	Thedford	Tile, drain tile	Shale	(B)
Halton Ceramics Limited	Burlington	Block and tile	Common clay and shale	(A) Bought by Paisley Brick and Tile, and all operations moved to Paisley.
Hamilton Brick Limited	Hamilton	Building brick	Shale	(B)
National Sewer Pipe Limited	Oakville	Flue lining and sewer pipe	Shale and fire clay	(B)
	Oakville	Face brick		New plant.
Norwich Brick and Tile Ltd.	Norwich	Drain tile	Shale	(A)
Paisley Brick and Tile Ltd.	Paisley	Structural and drain tile	Shale	(A)
Pottery Studio	Collingwood	Stoneware, artware	Stoneware clay	(A)

TABLE 4 (cont'd)

Company	Plant Location	Products	Raw Material	Size[1] and Remarks
MANITOBA				
I.XL Industries Ltd. Red River Brick and Tile division	Lockport	Brick and tile	Common clay	(E) Closed in 1992.
SASKATCHEWAN				
I.XL Industries Ltd. Western Clay Products division	Regina	Facing brick, flue lining and sewer-pipe	Stoneware clay	(A)
Thunderbrick Limited Estevan Brick division	Estevan	Building brick	Ball clay	(C)
ALBERTA				
I.XL Industries Ltd.				
Medicine Hat Brick and Tile division	Medicine Hat	Brick, block, flue liners	Common clay	(D)
Northwest Brick and Tile division	Edmonton	Building brick	Common clay	(B)
Redcliff Pressed Brick division	Redcliff	Facing and fire brick	Common clay	(B)
Plainsman Clay Ltd.	Medicine Hat	Processed clay	Common clay	(A) No finished products.
BRITISH COLUMBIA				
Clayburn Refractories Ltd.	Abbotsford	Refractory brick, mortar and monolithics	Imported ball clay	(D)
Sumas Clay Products Ltd.	Sumas	Brick, drain tile and flue lining	Common clay	(C)

1 Size keys: (A) up to 25 employees; (B) 25-49 employees; (C) 50-99 employees; (D) 100-199 employees; (E) 200-499 employees; (F) 500-999 employees; (G) over 1000 employees.

Coal

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Coal is an organically derived material. It is formed from the remains of decayed plant material compacted into a solid through millions of years of pressure and heat. Coal is the world's most abundant and widely distributed fossil fuel. More than 5 billion t are mined annually in over 40 countries.

Coal is used primarily for the generation of electricity and the production of steel. Nearly 50% of the world's electricity is generated from coal and about 75% of the world's steel is produced with coal. Coal can also be used to produce a wide range of by-products (tars and chemicals), and in industrial processes (cement and glass manufacture).

Canada's coal production and exports have increased steadily for over 20 years. By 1991, Canada ranked as the world's fourth largest coal exporter while, in terms of output, Canada is usually about the twelfth largest producer.

However, several uncharacteristic events made 1992 the most difficult year in over two decades for the Canadian coal industry. Labour problems and mine closures led to the largest single year-to-year drop in production, exports and earnings. Fortunately, by the end of 1992, many of these problems were resolved and the Canadian coal industry was on the road to re-establishing itself as a dependable exporter of coal.

World coal trade grew marginally in 1992, spurred on primarily by increased demand for thermal (also called "steam") coal. In spite of this increased demand, several thermal coal exporters offered coal at below market prices. Coking coal trade remained essentially flat, putting prices for this coal under continual pressure, which resulted in price reductions for both coking and thermal coals for 1993 contracts.

CANADIAN DEVELOPMENTS

Canadian coal production fared considerably better than expected, given the unprecedented difficulties in both eastern and western Canada. A strike, a lockout and an industry restructuring were the major events in the western coal industry in 1992. In eastern Canada, an underground explosion, a fire, and underground flooding closed three mines. In spite of these problems, Canadian coal production is expected to fall by only 9% to 64.6 Mt in 1992, down from the 1991 record of 71.1 Mt. Exports are forecast to total 27.5 Mt in 1992, down 20% from 1991.

Canadian coal consumption is forecast to be up by 1% in 1992 to approximately 51 Mt due to the increased use of thermal coal in Alberta, Saskatchewan, New Brunswick and Nova Scotia. Consumption of coal by the steel and industrial sectors remained basically unchanged from the year before.

In Nova Scotia, production actually increased by approximately 350 000 t to reach 4.5 Mt, despite three mine closures during the year. Curragh Inc.'s Westray mine in Pictou County terminated production in May 1992 following an explosion. The Evans Coal Mine Ltd. mine closed following a fire and subsequent flooding, and the Cape Breton Development Corporation's Lingan mine was sealed off due to flooding. Lingan had been scheduled to close in early 1993.

Production increased in Nova Scotia to meet growth in provincial demands and expanded export opportunities. Exports approached the 2-Mt level, primarily in European and Latin American markets. In 1993, domestic coal consumption in the province will increase with the October commissioning of the 165-megawatt (MW) Point Aconi electricity-generating plant.

In New Brunswick, coal production decreased by nearly 100 000 t in 1992, while consumption by New Brunswick Electric Power Corporation actually increased by approximately 50 000 t. This apparent oddity is explained by the fact that New Brunswick Electric Power ran down its inventory in 1992 in preparation for 1993 purchases of up to 1 Mt of coal from U.S. sources to fuel the new 400-MW Belledune station. Provincial coal production will level off in 1993 at approximately 400 000 t for the foreseeable future.

While neither Quebec, Ontario nor Manitoba produces coal, all three provinces consume coal for either electricity, steelmaking and/or general industry uses. Coal consumption was down in Quebec and Manitoba to less than 500 000 t and 300 000 t respectively. Coal consumption in Quebec is imported from the United States and is used by several different industries. In Manitoba, coal is used both to generate electricity and for industrial purposes. All of this coal comes from Saskatchewan.

Ontario remains Canada's second largest coal consumer, using coal for electricity generation, the steel industry and industrial purposes. Nevertheless, Ontario's 1992 coal consumption dropped by more than 1 Mt to 15 Mt. This was due primarily to reductions in the use of coal for electricity generation as Ontario Hydro used more nuclear energy. Coal utilization by the steel industry and the industrial sector was basically unchanged from 1991. About 80% of the coal consumed in Ontario was imported from the United States with the remainder coming from western Canada.

In Saskatchewan, 1992 coal production grew by 4% to 9.4 Mt. Coal consumption in the province grew by almost 1 Mt to 8.5 Mt, primarily because of the commercialization of the 300-MW Shand power station. Coal now generates over 80% of the province's electricity. The province continues to supply Manitoba and some Ontario coal requirements.

Alberta remained Canada's largest coal-producing and consuming province. Production is forecast to total 33.4 Mt, consisting of 23 Mt of sub-bituminous and 10.4 Mt of bituminous coal. Most of the sub-bituminous coal was consumed within the province to generate electricity, while about 10 Mt of the bituminous coal was sent overseas and to Ontario markets.

Coal production in British Columbia declined by nearly 7 Mt in 1992, reflecting the labour and financial problems of two of the province's largest coal exporters. Westar Mining Ltd.'s Balmer mine endured an eight-month lockout, while Westar's Greenhills mine was shut down for four months. Fording Coal Limited's Fording River mine underwent an eight-month strike. In December 1992, following Westar's bankruptcy, Teck Corporation purchased the Balmer mine and Fording Coal Limited bought the Greenhills mine. These changes should provide more financial and marketing stability for the B.C. coal industry as it faces the challenges of the 1990s and the next century.

British Columbia remains Canada's largest coal-exporting province, shipping coal to the Asian-Pacific, European, Latin American and U.S. markets, as well as to customers in Ontario. Shipments in 1993 totalled 17 Mt, down from 25 Mt in 1991. Production and exports should return to 1991 levels by 1995.

WORLD DEVELOPMENTS

Worldwide, coal use and trade reflected changing political and economic climates. Production and exports of coking coal from Poland and the former U.S.S.R. were down. The opposite was true in South Africa; with trade restrictions against the country being eased, South Africa is once again playing a major role in thermal coal markets. Colombia, Venezuela and Indonesia, all relatively new exporters, continued to increase their shares of thermal coal trade.

World coal trade in 1992 is estimated to be some 2%-3% higher than in 1991, approaching 410 Mt, with thermal coal accounting for more than half (220 Mt). Market pressures in 1992 forced down the average price of coking coal by US$2/t to about US$50/t for contract deliveries in 1993. Indications are that thermal coal contracts will also be down about the same amount in 1993 to a benchmark price of US$38/t.

In 1992, Japan continued to be the world's largest coal importer, purchasing in excess of 100 Mt of coking and thermal coal. South Korea was the next largest importer, buying over 30 Mt, followed by Taiwan, Italy, France, Germany and Canada.

World coal trade will continue to expand because of coal's large resource base and the continuous influx of new exporters into the market. This combination ensures that prices will be free from cartel constrictions. Nevertheless, one of the main challenges for coal users and exporters will be getting the price right; it has to be high enough for exporters to receive the returns necessary to be able to bring new coal production capacity on stream when it is required.

In Western Europe, coal production (primarily thermal coal) is slowly decreasing as pits are closed due to a reduction in some of the substantial subsidies in the United Kingdom, France and Germany. Pressures continue to mount for these high-cost producers to speed up the closure of all uneconomic production. Forecasts suggest that all such discontinued production could be replaced by existing thermal coal exporters.

Coking coal trade is forecast to stabilize or slowly decline in total throughout the remainder of this decade. However, within this overall demand scenario for coking coal, there will be changes in the ratio of demand for hard coking coal versus the so-called semi-soft coking coal. Demand for semi-soft coking coal, used for pulverized coal injection (PCI) in Japanese and other steel mills, will increase throughout the 1990s. As a result, demand for this lower-priced coal will grow at the expense of the higher-priced hard coking coal. Trade in thermal coal, which now accounts for about 55% of all coal trade, is expected to continue growing during the coming decades. With a considerable amount of the increase in thermal coal trade expected to occur in the Asia-Pacific region, Canadian coal is well situated to compete. Price, however, will remain the critical factor in determining the ultimate share that Canadian coal will win in this growing market.

Note: Information in this review was current as of February 1, 1993. The statistics used are estimates of final 1992 values.

TABLE 1. SUMMARY OF COAL SUPPLY BY TYPE AND VALUES, 1988-92

	1988		1989		1990		1991		1992p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
DOMESTIC[1]										
Bituminous										
Nova Scotia	3 540	216 000	3 512	199 000	3 415	191 000	4 134	242 000	4 486	273 000
New Brunswick	542	34 000	520	34 000	548	37 000	498	34 000	399	32 000
Alberta	9 561	299 000	9 907	309 000	9 153	296 000	10 312	355 000	10 508	339 000
British Columbia	24 911	974 000	24 840	948 000	24 581	1 002 000	24 962	986 000	16 922	675 000
Subtotal	38 554	1 523 000	38 779	1 490 000	37 697	1 526 000	39 906	1 617 000	32 315	1 319 000
Sub-Bituminous										
Alberta	19 910	160 000	20 918	156 000	21 252	165 000	22 242	178 000	23 020	200 000
Lignite										
Saskatchewan	12 148	122 000	10 816	100 000	9 407	99 000	8 981	94 000	10 027	100 000
Total domestic	70 612	1 805 000	70 513	1 746 000	68 356	1 790 000	71 129	1 889 000	65 362	1 619 000
IMPORTED[2]										
Bituminous and anthracite briquettes	17 248	974 000	14 660	808 000	14 204	616 000	12 424	532 000	12 833	577 000
Total supply	87 860	2 779 000	85 173	2 554 000	82 560	2 406 000	83 553	2 421 000	78 195	2 196 000

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary figures or estimates.
1 F.o.b. mines. 2 Value at U.S. port of exit.

TABLE 2. PRODUCERS' DISPOSITION OF CANADIAN COAL, 1991

Destination	Deliveries From Nova Scotia	New Brunswick	Saskatchewan	Alberta	British Columbia	Canada
	(kilotonnes)					
Newfoundland	–	–	–	–	–	–
Prince Edward Island	5	–	–	–	–	5
Nova Scotia	2 390	–	–	–	–	2 390
New Brunswick	11	498	–	–	–	509
Quebec	39	–	–	–	–	39
Ontario	–	–	1 022	1 642	584	3 248
Manitoba	–	–	296	–	27	323
Saskatchewan	–	–	7 654	1	50	7 705
Alberta	–	–	–	22 778	–	22 778
British Columbia	–	–	–	20	265	285
Total Canada	2 445	498	8 972	24 441	926	37 282
Shipments for export	1 693	–	10	8 112	24 037	33 852
Total	4 138	498	8 982	32 553	24 963	71 134

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

TABLE 3. SUMMARY OF COAL SUPPLY-DEMAND, 1980-92

Year	Canada Production				Imports		Total Available	Domestic Consumption	Exports
	Bituminous	Sub-Bituminous	Lignite	Total	Anthracite	Bituminous			
					(million tonnes)				
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	75.7	48.6	25.1
1985	34.2	16.8	9.7	60.7	0.3	14.6	75.6	48.7	27.4
1986	32.2	17.3	8.3	57.8	0.4	12.7	70.1	44.6	25.9
1987	32.7	18.5	10.0	61.2	0.4	14.3	75.9	50.1	26.7
1988	38.6	18.9	12.1	70.6	0.4	16.8	87.8	54.4	31.7
1989	38.8	20.9	10.8	70.5	0.4	14.3	85.2	53.9	32.7
1990	37.7	21.3	9.4	68.4	0.4	13.8	82.6	49.0	31.0
1991	39.9	22.2	9.0	71.1	0.2	12.2	83.5	50.3	34.1
1992p	32.3	23.0	10.0	65.3	0.2	12.6	78.1	51.2	27.4

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

TABLE 4. COAL USED BY THERMAL POWER STATIONS IN CANADA, BY PROVINCE, 1972-92

	Nova Scotia	New Brunswick	Ontario	Manitoba	Saskat-chewan	Alberta	Total Canada
				(000 tonnes)			
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	2 974	610	13 413	163	7 925	16 123	40 208
1985	2 235	521	10 985	253	8 290	18 112	40 396
1986	2 137	469	9 172	111	6 786	17 719	36 394
1987	2 077	526	12 016	457	7 672	19 077	41 825
1988	2 266	678	13 079	780	8 637	20 538	45 978
1989	2 141	705	12 809	327	8 534	21 410	45 926
1990	2 184	496	10 362	298	7 462	21 340	42 142
1991	2 290	426	10 850	232	7 548	22 480	43 826
1992p	2 344	471	10 234	233	8 179	23 735	45 196

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

TABLE 5. SUMMARY OF COAL DEMAND, 1986-92

	1986	1987	1988	1989	1990	1991	1992p
				(000 tonnes)			
THERMAL ELECTRIC							
Canadian	30 033	33 932	37 614	37 447	35 858	36 413	38 567
Imported	6 359	7 892	8 441	8 392	6 284	7 413	6 629
Total	36 392	41 824	46 055	45 839	42 142	43 826	45 196
METALLURGICAL							
Canadian	243	290	19	–	–	–	–
Imported	5 891	6 019	6 242	5 918	4 996	4 906	4 886
Total	6 134	6 309	6 261	5 918	4 996	4 906	4 886
GENERAL INDUSTRY							
Canadian	642	591	673	608	465	461	356
Imported	1 364	1 416	1 477	1 430	1 433	980	756
Total	2 006	2 007	2 150	2 038	1 898	1 441	1 112
EXPORTS							
Canadian	25 904	26 741	31 725	32 827	31 009	34 113	27 410
TOTAL							
Canadian	56 822	61 554	70 031	70 882	67 332	70 987	66 333
Imported	13 614	15 327	16 160	15 740	12 713	13 299	12 271
Total demand	70 436	76 881	86 191	86 622	80 045	84 286	78 604

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; p Preliminary.

TABLE 6. EXPORTS OF CANADIAN COAL BY TYPE AND DESTINATION, 1992

Country	Metallurgical	Thermal	Total
		(kilotonnes)	
Japan	13 460	2 260	15 720
South Korea	3 253	1 254	4 507
Brazil	1 089	50	1 139
Portugal	113	88	201
United Kingdom	681	90	771
Denmark	46	1 053	1 099
United States	302	46	348
Taiwan	522	–	522
France	253	49	302
Germany	170	40	210
Netherlands	330	–	330
Chile	220	–	220
Italy	229	–	229
Pakistan	44	–	44
Spain	379	–	379
Turkey	52	–	52
Egypt	46	–	46
Iran	72	–	72
Mexico	337	80	417
Sweden	65	–	65
Dominican Republic	–	24	24
Iceland	4	3	7
Belgium	131	–	131
Total	21 798	5 037	26 835

Source: Energy, Mines and Resources Canada/Statistics Canada joint survey, Coal.
– Nil.

TABLE 7. CANADA, COAL PRODUCTION, IMPORTS, EXPORTS AND CONSUMPTION, 1986-92

	Production	Imports	Exports	Domestic Consumption
		(000 tonnes)		
1986	57 811	13 125	25 943	44 558
1987	61 209	14 719	26 740	50 144
1988	70 644	17 248	31 732	54 390
1989	70 513	14 660	32 744	53 881
1990	68 356	14 204	31 009	49 040
1991	71 134	12 424	34 113	50 282
1992p	65 362	12 833	27 410	40 996

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

Cobalt

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Summary

In 1992, the cobalt content of metal concentrates produced in Canada was 2219 t, an increase of 2.2% from 1991. However, the value of the 1992 production, $136.9 million, was 76.7% more than in 1991. These higher earnings are due to a major price hike for cobalt early in 1992 in response to political wrangling and civil unrest in Zaire, which is the world's largest cobalt-producing country.

Market conditions, characterized by depressed consumption and rising producer stocks, developed during the year, decreasing prices and forcing Inco Limited and Falconbridge Limited to shut their operations down for limited periods. These shutdowns, coupled with cuts in the workforces to rationalize operations, resulted in a difficult year.

World production estimates by the Cobalt Development Institute put the 1992 production of refined cobalt at 22 781 t, a decrease of about 10% from 1991. The drop in production is attributed to the situation in Zaire.

The outlook for 1993 calls for an increase in demand as world economies improve. Market observers expect cobalt production to increase marginally, although continued deterioration of the situation in Zaire could alter this forecast. The authorized 1993 sale of up to 2100 t of cobalt from the U.S. stockpile and increased sales of Russian cobalt may, at the end, balance the equation.

Uses

One of the major uses for cobalt is in superalloys where it improves the strength, wear and corrosion-resistance characteristics of alloys at elevated temperatures. The major uses of cobalt-based superalloys are in turbine blades for aircraft jet engines and in gas turbines for pipeline compressors. Cobalt-based superalloys normally contain 45% or more cobalt, while nickel- and iron-based superalloys contain 8%-20% cobalt.

The demand for cobalt in the production of magnets has been declining in recent years. The substitution of neodymium-iron-boron magnets for cobalt-rare earth magnets has been a major factor. However, the use of cobalt-rare earth permanent magnets will continue where the specific advantages of reliability and good performance are required. In addition, Alnico magnets are staging a comeback, especially in automobile anti-lock braking systems.

Cobalt-based alloys are also used in specialized applications, such as in machining very hard materials or where high abrasion-resistant qualities are required. In such applications, the most important group of cobalt-based alloys is the stellite group, which contains cobalt, tungsten, chromium and molybdenum as principal constituents. The hard-facing or coating of tools with cobalt alloys provides greater resistance to wear, heat, impact and corrosion.

Cobalt metal powder has an important application as a binder in the production of cemented tungsten carbides for heavy-duty and high-speed cutting tools. In chemical applications, 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 for petroleum desulphurization.

Canadian Developments

Canada's mineral production of cobalt in 1992 was 2219 t, whereas the output of refined cobalt totalled 1957 t.

In Canada, Inco Limited and Falconbridge Limited produce cobalt as a by-product of their nickel-copper operations and from purchased concentrates. Inco refines its concentrates in Canada to produce cobalt metal and oxide, while Falconbridge sends nickel-cobalt matte to its refinery in Norway. Sherritt Gordon Limited produces refined cobalt at its Alberta refinery from concentrates purchased domestically and abroad.

Inco's 1992 mineral production of cobalt was 1495 t, up 5% from last year, while its production of refined cobalt was 1154 t, up 4% from 1991.

Inco's cobalt production comes from several underground mines located in the Sudbury area of Ontario and in Manitoba's Thompson Nickel Belt. The nickel-cobalt ores from these operations are processed at the Clarabelle and Copper Cliff mills near Sudbury and at the mill and concentrator complex in Thompson. The Sudbury concentrate is then sent to the nearby Copper Cliff smelter for further processing to produce a variety of nickel and copper products, including nickel matte. Some of this matte is sent by rail to Inco's refinery complex at Port Colborne, Ontario, where cobalt metal is produced as a by-product. An electrolytic cobalt refinery further upgrades the material to 99.9% pure cobalt rounds.

In Thompson, a local plant smelts and refines the concentrate to produce electrolytic nickel and by-product cobalt oxide. The cobalt oxide is sent by ship to Inco's Clydach refinery in Wales for reprocessing.

In 1992, to reduce stocks, the planned summer vacation shut-down of all Inco mining and milling operations was extended from four to five weeks. The Port Colborne nickel-cobalt refinery was also closed for the same period. The operations were shut down a second time for a three-week period over Christmas. Inco announced in October 1992 that its Ontario and Manitoba divisions would shut down for a four-week vacation period in 1993.

In 1992, Falconbridge's Canadian mineral production of cobalt was 723 t, down 3% from 1991.

Falconbridge operates five mines in the Sudbury, Ontario, area. The nickel-cobalt ore is concentrated at the Strathcona mill and further processed at the Falconbridge smelter to produce cobalt-bearing nickel matte. This matte is sent by ship to the company's refinery, located at Kristiansand, Norway, to produce cobalt metal.

In a bid to lower stocks, Falconbridge shut its Sudbury division for five weeks during the summer and for a similar period at Christmas. For 1993, the company has already announced a 10-week shut-down starting June 27, instead of the normal two weeks. On another front, the company is in the process of cutting its workforce of 2150 by about 10% to improve productivity.

Going against the trend, Falconbridge's Thayer Lindsley project north of Sudbury, Ontario, entered production in August. Mining operations centre on a mineralized body hosting reserves of 1 Mt grading 2.23% nickel, 4.21% copper and 0.124% cobalt. This mineralized zone is the core of a larger body of mineralization evaluated at 7 Mt grading 1.58% nickel and 1.51% copper, which is not economic at present.

In 1992, Sherritt Gordon Limited's production of refined cobalt was 803 t, 2% less than in 1991. The drop in production resulted from problems encountered while starting its redesigned processing system in May. The new circuit will more than double the company's production of refined cobalt.

Sherritt Gordon produces cobalt strictly from purchased feedstock, both domestic and foreign. It does not operate any Canadian base-metal mines. In 1992, its domestic feed included ore from Timmins Nickel Inc.'s mining operations and Hudson Bay Mining and Smelting's Namew Lake mine, while foreign ore originated from the Philippines, Cuba, and Western Mining Corp. of Australia.

Sherritt Gordon's nickel-cobalt refinery located at Fort Saskatchewan, northeast of Edmonton, Alberta, produces cobalt metal in the form of briquettes and is the Western World's only producer of Standard (S) grade cobalt powder. As a result of importing feed from Cuba, however, Sherritt Gordon lost the U.S. powder market because of the U.S. embargo which bans imports of materials originating in Cuba.

The feed supplied by Timmins Nickel Inc. was cut in August after the company lost the right to lease a mill used for concentrating their ore and was forced to close the Redstone and Langmuir No. 1 mines in Ontario. The free capacity was quickly filled by additional Cuban feed.

In Canada, the Windy Craggy deposit remains the largest undeveloped source of cobalt. Owned by Geddes Resources Ltd., the deposit hosts 297 Mt of reserves grading 1.38% copper and 0.06% cobalt with gold and silver credits.

At year-end, Geddes was still awaiting the B.C. government's response to its environmental impact studies before proceeding to the final feasibility study. The response was delayed when the provincial government decided in April to put the project on hold to undertake a full review on the designation of the land area. An interim report on the review, delivered in January 1993, stated that further studies were needed in order to make a decision.

Canada's most important cobalt export in 1992 was in the form of matte and "other intermediate products." This trade, directed mostly to Norway and the United States, generated revenues of $105.6 million, up 12.6% from 1991. By extension, the most important cobalt import on the basis of value was "unwrought cobalt," which includes waste and scrap. The greater portion of these products was imported from Zaire for transformation and made up 80% of total imports.

Canada's cobalt trade is significantly greater than indicated in the statistics because much of the cobalt imported in ore, concentrates and matte is counted as nickel and copper imports (therefore, it is not included in the cobalt statistics). For example, Canada imported 15 805 t of Cuban nickel-cobalt matte in the first nine months of 1992.

WORLD DEVELOPMENTS

The Cobalt Development Institute estimates the 1992 world production of refined cobalt to be about 22 781 t. This figure includes 17 781 t supplied by member countries of the Institute, and 5000 t estimated to be the combined production of Russia, China, South Africa and Brazil.

The economical and political situation in Zaire, the world's largest cobalt-producing country, continued to deteriorate in 1992. Despite political wrangling, social unrest, and a lack of investment damaging the metal industry's infrastructure, Zaire's cobalt output is expected to be about 8000 t in 1992 compared to 8790 t in 1991 and 10 033 t in 1990.

Outside aid from the United States or Europe to help resolve the situation is not expected until steps are taken to allow the transitional government, set up in December 1991, to govern Zaire. This should allow it to prepare the country for an election and to improve the economy. Experts agree that even after banks put the necessary financial packages back in place, Générale des Carrières et des Mines (Gécamines), the state-owned mining company, will need three to five years before it can produce at "normal" levels.

The Government of Zambia, the world's second largest cobalt-producing country, has started restructuring the Zambia Consolidated Copper Mines (ZCCM), the state-controlled company that mines copper and cobalt. The company is being restructured to prepare for its privatization without disturbing production. In 1992, Zambia's cobalt production was an estimated 5000 t.

Also in 1992, driven by collapsing domestic demand and the need to generate foreign exchange earnings, Russian cobalt producers centred at Noril'sk and Monchegorsk flooded the market with their product. This action disrupted the market by lowering prices and creating a certain chaos in the trade. International pressure eventually forced Russian authorities to try to reduce cobalt exports. This had little effect at first because most of the sales were contraband or unregulated. By the end of the year, however, as a result of tougher border controls or transport logistic problems as winter settled in, less smuggling of cobalt material was reported.

The U.S. House of Representatives passed a bill in May authorizing the sale of 2722 t of cobalt from the National Defense Stockpile. The sale is to occur over fiscal years 1993 to 1995.

The first lot, 365 t, will be open for bids March 10. Rondelles and granules, presumably of Belgian Congo (now Zaire) origin, make up the lot. The rondelles can be used in the chemical industry while the granules are suitable for the magnet and tool steel industries.

If the sale is successful, other lots could be sold; Congress has agreed to the disposal of up to 2100 t of cobalt in 1993 alone. However, because it is not top-quality material and therefore has limited use, market observers expect this material to sell cheaply and to have little effect on market prices.

Black Hawk Mining Inc. of Toronto is at the permitting stage for its Knox deposit located near Warren, Maine, in the United States. Reserves, estimated at close to 6.5 Mt grading 1.45% nickel, 0.67% copper and 0.12% cobalt, are, in part, amenable to open-pit mining. The company expects to produce 340 t of cobalt in concentrates annually by 1995. These concentrates would be sent to the smelter in Sudbury, Ontario, or to Finland for processing.

A group of investors known as Blackbird Metals is still considering plans to build a 5000-t/y cobalt refinery in Idaho in the United States. The plant, located close to the Blackbird cobalt deposit, which was mined briefly in the early 1980s, would treat imported materials and scrap. Because of problems over environmental issues, there are no current plans to re-open the Blackbird cobalt mine. The last reserve figures published for this deposit were 4 Mt grading 1.2% copper and 0.6% cobalt. The refined cobalt produced at the plant would be 99.9% pure and suitable for use in the superalloy industry.

BHP Minerals International Inc. took an option on Sutton Resources Ltd.'s Kabanga and Kagera concessions in northwestern Tanzania. The Tanzanian government has retained a 10% interest in each of the projects while BHP holds a 60% stake and Sutton holds 30%.

Recent drilling on the Kabanga nickel-cobalt deposit returned several wide, near-surface mineralized intersections that confirmed the project's bulk tonnage potential. The latest reserve figures for the deposit, which exclude recent results, are 20 Mt grading 1.22% nickel, 0.17% copper and 0.08% cobalt. Because of the project's remoteness from power sources and shipping points, reserves of 40 Mt at a similar grade are needed to warrant the development of the Kabanga deposit. A two- to three-year lead time is necessary, after feasibility studies, before the start of commercial production at an open-pit operation.

The Bureau de Recherches Géologiques et Minières (BRGM), a French government agency, concluded a formal agreement with the Government of Uganda to extract cobalt from stockpiled ores at the African nation's Kilembe copper mining complex. BRGM and its partner, Barclays Metals Ltd., will rely on bioleaching and solvent-extraction/electrowinning technology to produce an estimated 1000 t/y of cobalt cathode. This operation will test the amenability of the ore type to this process. If positive, results from this plant would be useful to engineer a full-scale cobalt operation at Kasese in western Uganda, which could be in operation by early 1995.

The United Nations Development Programme (UNDP) is helping Cuba develop a new technique for processing nickel and cobalt ores that is less damaging to the environment. Work is under way at the Commandante Pedro Sotto Alba plant at Moa to improve the pressure-leaching processing method, which uses sulphuric acid.

Fondmetall International of Gothenburg, Sweden, has outlined economic reserves of cobalt associated with manganese ore mined in the Spanish province of Catilla La Mancha. With cobalt grades in the 0.8%-0.9% range, resources of 6000 t of cobalt have been identified at the site. The operation under consideration would produce about 300-600 t/y of cobalt.

Japan has decided to boost its rare metals stockpile levels. Its target for cobalt is to increase the stockpile to equal 60 days of consumption by the end of fiscal year 1995. Stocks currently amount to about 45 days of consumption. If Japan's 1990 cobalt consumption level is taken as a reference, 150 t of cobalt will have to be bought by the end of 1995 to reach the fixed goal.

PRICES

In 1992, the cobalt market was very unstable in response to supply disturbances. Although the African producer price, fixed at US$25/lb in December 1991, was kept at that level until November 1992, it did not have the anticipated stabilizing effect on the market. Responding to a tightening in the supply of cobalt due to the drop in production, the open market price increased and reached a peak of US$34/lb in January 1992. Depressed demand and the flooding of the market by Russian cobalt, mostly smuggled out of the country, resulted in prices falling during the remainder of the year. Aside from a rally around February to April due to heavy Chinese speculative buying, the free market price tumbled until November when it stabilized at close to US$16/lb.

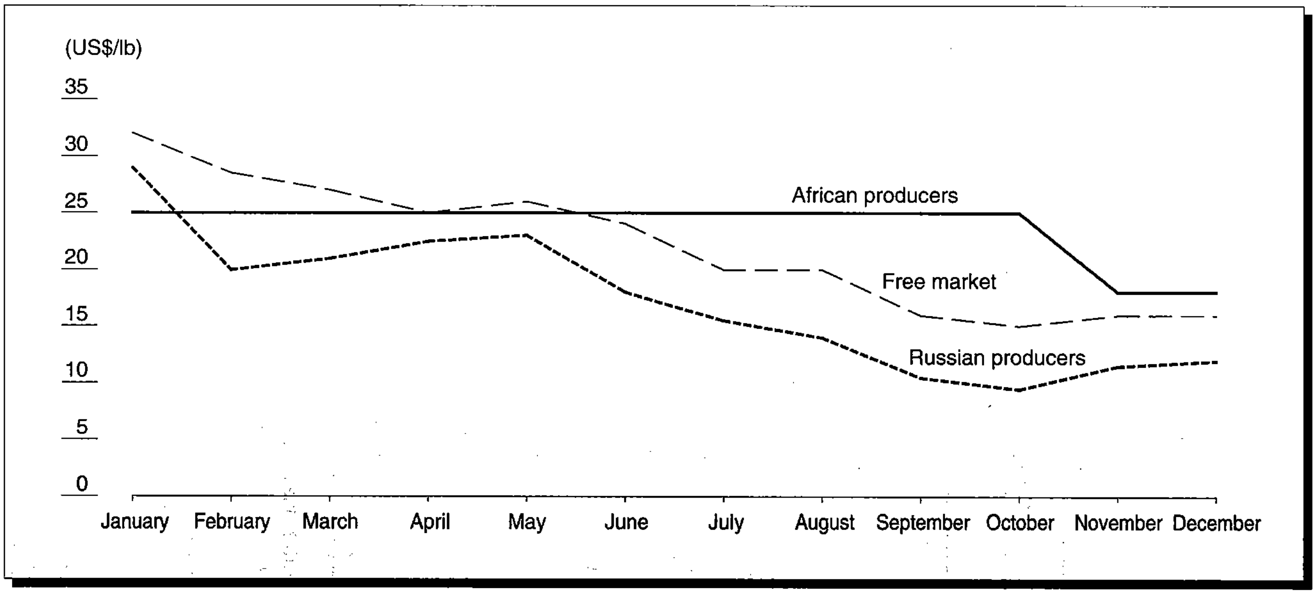
As a result of the volatility and downward trend in prices, consumers in 1992 reacted by buying their immediate needs on the spot market instead of taking longer-term contracts.

After initial doubts about the quality of Russian cobalt had dissipated, the cobalt-consuming industry felt at ease to use the material for most applications other than alloying. Taking into consideration the effect the Russian producers could have on the market, Gécamines, with ZCCM, decided to involve Russia in consultations on the fixing of the cobalt producer price. Returning from a meeting with Russian delegates in November 1992, the African producers fixed the price of cobalt at US$18/lb.

OUTLOOK

In 1993, the U.S. Defense Logistics Agency will start selling cobalt from the National Defense Stockpile Centre. The action is designed to reduce the cobalt inventory from 24 000 t to 18 000 t over a period of 10 years. The sale will provide the capital

Figure 1
Cobalt Price Variations, 1992



NOTE: Quotes are for spot cathode.
SOURCES: London Mining Journal; Metals Week.

needed to finance the economic program of the Clinton administration. For that matter, sales could even be accelerated.

Compared to 1992, the world production of refined cobalt is projected to increase by 200 t in 1993. Canada, the only country projected to produce more in 1993 than in 1992, should witness marginally lower cobalt production at Falconbridge and Inco, countered by increased output at Sherritt Gordon. Despite production cuts at Falconbridge and Inco, these companies expect to offset the lowered domestic production of nickel-cobalt matte with purchases from abroad. For its part, Sherritt Gordon expects to double its production of refined cobalt to about 1600 t following the revamping of its cobalt processing system. This will bring Canada's total production of refined cobalt to about 2750 t in 1993.

Despite the apparently placid world production projection, the market's overall situation in 1993 could be as volatile as in 1992. The continued strife in Zaire could further decrease, and even stop, production in that country. Additional production cutbacks at nickel operations around the world could decrease the supply of cobalt in the marketplace. However, continued, and even increased, Russian contraband cobalt and additional sales from the U.S. stockpile could come into play to offset these production losses.

Because of greater industrial output and speculative buying, only China is expected to consume more cobalt in 1993 than in the past year. The consumption in the superalloy sector, which uses 40% of cobalt production, will continue to decline in the short term due to the recession in military and commercial aircraft manufacturing. It should, however, pick up from 1995 onwards in the commercial segment of the industry as the major airlines replace their ageing fleets of 747s. In the chemical and cutting tools sectors, consumption will increase as the world economy improves.

In the longer term, the use of cobalt in the chemical industry should expand as new applications are found in the tire and medical industries. Continued tight supply in the market and the lack of price stability, however, hampers the growth of the cobalt industry and favours the switch to substitutes.

Prices in the short term are expected to stabilize at current levels until the economy expands. However, because of the cobalt market's small size, any contraction in supply, a sudden burst of demand or a cut in production could send prices up.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2605.00	Cobalt ores and concentrates	Free	Free	Free	Free
2822.00.10	Cobalt hydroxides	Free	Free	Free	0.5¢/kg
2822.00.90	Cobalt oxides, commercial cobalt oxides	9.8%	Free	Free	0.5¢/kg
2827.34	Cobalt chloride	12.5%	8%	Free	0.8%
2833.29.00.40	Cobalt sulphate	9.2%	6%	Free	0.2%
2836.99.00.20	Cobalt carbonates	12.5%	8%	Free	Free
2915.23	Cobalt acetates	12.5%	8%	Free	0.8%
8105.10.10	Cobalt mattes and other intermediate products; unwrought cobalt, alloyed; waste and scrap; powders, alloyed	10.2%	6.5%	Free	1.1%
8105.10.20	Unwrought cobalt, not alloyed; powders, not alloyed	Free	Free	Free	Free
8105.90.10	Cobalt bars and rods, not alloyed	6.8%	Free	Free	1.1%
8105.90.90	Cobalt and articles thereof, n.e.s.	10.2%	6.5%	Free	1.1%

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992.
n.e.s. Not elsewhere specified.

TABLE 1. CANADA, COBALT PRODUCTION AND TRADE, 1991 AND 1992, AND CONSUMPTION, 1989-91

Item No.		1991		1992p	
		(kilograms)	($000)	(kilograms)	($000)
PRODUCTION[1] (All Forms)					
	Ontario	1 761 289	61 768	1 764 314	109 541
	Manitoba	410 194	15 781	454 232	27 345
	Total	2 171 483	77 549	2 218 546	136 886
EXPORTS				(Jan.-Sept.)	
2605.00	Cobalt ores and concentrates	–	–	–	–
2822.00	Cobalt oxides and hydroxides; commercial cobalt oxides				
	United Kingdom	448 271	11 134	351 389	16 639
	Australia	–	–	5 956	295
	United States	10 422	256	1 617	124
	Total	458 693	11 391	358 962	17 060
2915.23	Cobalt acetates	–	–	–	–
8105.10	Cobalt, unwrought, matte and other intermediate products, waste, scrap and powders				
	Norway	1 596 076	41 828	897 715	37 748
	United States	1 049 712	28 145	596 278	34 858
	United Kingdom	312 230	9 182	179 816	11 050
	Japan	33 448	911	108 289	7 176
	Belgium	214 603	5 534	119 025	6 829
	Other countries	235 626	8 239	108 071	7 972
	Total	3 441 695	93 839	2 009 194	105 633
8105.90	Cobalt and articles thereof, n.e.s.				
	Germany	2 985	337	7 129	623
	United States	5 253	153	2 105	308
	United Kingdom	3 592	175	372	70
	Other countries	2 140	323	855	68
	Total	13 970	988	10 461	1 069
IMPORTS					
2605.00	Cobalt ores and concentrates				
	People's Republic of China	–	–	3 810	62
	United States	3 029	64	1 971	49
	Zaire	33 600	902	–	–
	Belgium	1 000	28	–	–
	Total	37 629	994	5 781	112
2822.00.10	Cobalt hydroxides				
	Japan	–	–	9 560	540
	United States	5 235	112	5 388	322
	Belgium	26 000	650	5 000	218
	Other countries	5 120	120	3 000	76
	Total	36 355	882	22 948	1 156
2822.00.90.10	Cobalt oxides				
	Greece	–	–	1 960	84
	United States	3 972	146	2 075	49
	Belgium	2 000	36	888	22
	Total	5 972	182	4 923	156
2822.00.90.20	Commercial cobalt oxides				
	United Kingdom	–	–	54	1
	Other countries	45	. . .	5	. . .
	Total	45	. . .	59	1
2827.34	Cobalt chlorides				
	United States	167 182	928	272 070	1 577
	Other countries	1 900	17	686	9
	Total	169 082	946	272 756	1 587
2833.29.00.40	Cobalt sulphate				
	United States	34 644	355	13 164	182
	People's Republic of China	–	–	3 000	25
	Belgium	29 460	222	568	8
	United Kingdom	–	–	18	. . .
	Total	64 104	577	16 750	216

TABLE 1 (cont'd)

Item No.		1991 (kilograms)	1991 ($000)	Jan.-Sept. 1992p (kilograms)	Jan.-Sept. 1992p ($000)
IMPORTS (cont'd)					
2836.99.00.20	Cobalt carbonates				
	United States	9 243	181	15 101	371
	Former U.S.S.R.	–	–	22 170	279
	Other countries	6 855	116	11 670	322
	Total	16 098	297	48 941	972
2915.23	Cobalt acetates				
	United States	17 133	170	11 653	203
	United Kingdom	4 021	42	104	1
	Italy	4 750	48	–	–
	Total	25 904	260	11 757	204
8105.10.10.10	Unwrought cobalt; powders; mattes and other intermediate products				
	United States	19 557	718	12 659	654
	Other countries	2 119	82	138	8
	Total	21 676	800	12 797	662
8105.10.10.20	Cobalt waste and scrap				
	Zaire	436 128	11 194	147 904	7 308
	Former U.S.S.R.	431	23	51 625	1 290
	United States	135 381	1 249	139 886	751
	Other countries	95 800	1 475	5 497	35
	Total	667 740	13 941	344 912	9 384
8105.10.20.10	Unwrought cobalt, not alloyed				
	Zaire	909 915	27 667	536 346	34 985
	Zambia	–	–	46 282	1 992
	United States	14 192	388	12 234	554
	Norway	5 618	204	2 298	132
	Belgium	419 200	11 246	–	–
	Other countries	26 765	887	180	13
	Total	1 375 690	40 392	597 340	37 676
8105.10.20.20	Cobalt powders, not alloyed				
	United Kingdom	3	...	35 025	2 595
	United States	49 492	2 408	29 791	2 485
	Other countries	5 783	266	1 183	100
	Total	55 278	2 674	65 999	5 180
8105.90.10	Cobalt bars and rods, not alloyed				
	United States	1 103	116	895	46
	Germany	77	3	444	34
	Total	1 180	119	1 339	81
8105.90.90	Cobalt and articles thereof, n.e.s.				
	United States	44 052	3 659	22 117	2 260
	United Kingdom	1 295	59	1 366	109
	Other countries	357	33	889	31
	Total	45 704	3 751	24 372	2 400

	1989 (kilograms)	1990 (kilograms)	1991p (kilograms)
CONSUMPTION[2]			
Cobalt contained in:			
Cobalt metal and metallic compounds	68 585	76 068	72 554
Cobalt pigments, feed and ground coat frit	9 107	13 068	9 039
Cobalt salts and driers and other uses[3]	69 607	105 069	84 315
Total	147 299	194 205	165 908

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified; p Preliminary.
[1] Production (cobalt content) from domestic ores. [2] Available data reported by consumers. [3] Other uses include glass and chemicals.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, COBALT PRODUCTION, TRADE AND CONSUMPTION, 1975 AND 1980-92

		Exports			Imports	
	Production[1]	Cobalt Metal	Cobalt Oxides and Hydroxides	Cobalt Ores[2]	Cobalt Oxides and Hydroxides[3]	Consumption[4]
	(tonnes)					
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	212	2	30	81
1983	1 410	885	192	45	30	101
1984	2 123	1 487	373	14	27	113
1985	2 067	1 551	268	36	192	101
1986	2 297	1 805	374	20	31	96
1987	2 490	1 875	440	45	38	120
1988	2 398	3 062	953	98	37	159
1989	2 344	3 236	371	22	33	147
1990	2 184	3 039	391	–	73	194
1991	2 171	3 456	459	–	42	166
1992p	2 219	2 020a	359a	–a	28a	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available; p Preliminary.
a First nine months only.
1 Production from domestic ores and cobalt content of intermediate products exported, including cobalt content of Inco Limited and Falconbridge Limited shipments to overseas refineries. 2 Cobalt content. 3 Gross weight.
4 Consumption of cobalt in metal, oxides and salts.

Copper

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Copper prices remained quite strong in 1992, despite some build-up of inventories. While the scale of the economic recovery in the major industrialized economies was less than anticipated, the market continued to be buoyed by the expectation that demand will strengthen significantly in the coming year. Copper prices were also supported by major buying activity on the part of the People's Republic of China and by a favourable outlook for a continued growth in demand in that country. In addition, copper prices continued to benefit from the threat of serious supply disruptions in a number of major copper-producing areas.

Western World copper consumption in 1992 was about 9.0 Mt, the same as that recorded in 1991. Prices averaged US$1.04/lb in 1992 compared to $1.06/lb the previous year.

CANADIAN DEVELOPMENTS

Copper shipments (recoverable copper) from Canadian mines in 1992 declined to about 745 000 t ($2.06 billion) from 780 000 t ($2.11 billion) in 1991. During 1992, refined copper production increased to 545 000 t from 538 000 t in 1991.

The reduction of copper shipments was due to the combined effects of a number of mine closures in 1991 and 1992 as well as lower output at several mines in 1992. Canadian copper mine production is expected to fall in the medium term as new capacity will be unable to match expected mine closures or the decline of capacity at existing operations. However, encouraging exploration results in recent years could result in a recovery of output by the end of the decade.

British Columbia

The British Columbia Mine Development Review Process for the Windy Craggy project of Geddes Resources Limited was suspended in mid-1992 pending the completion of a land and water use study for the Tatshenshini-Alsek region in northwestern British Columbia. The provincial Commission on Resources and Environment (CORE), which is conducting the study, issued an interim report in January 1993. This report presented the government with three options to consider when making a decision on the future of the area.

The first would be to designate the entire Tatshenshini-Alsek region as a protected wilderness area. Under this option, Geddes would be entitled to certain compensation. The second option would be provide for integrated land uses. This would allow resource development in certain portions of the territory that have the greatest mineral potential. The remainder of the area would be protected from development. The CORE report noted that recent geological mapping of the area by the province had revealed a significant number of copper occurrences with the potential to equal or surpass the grade and size of the Windy Craggy deposit. Finally, the third option would be to delay any decision until more information could be obtained on a number of issues. Under this option, compensation to Geddes could be considered.

The Windy Craggy deposit hosts reserves of 272 Mt grading 1.44% copper, 0.07% cobalt, 0.2 g/t gold and 3.8 g/t silver. At a planned mining rate of 30 000 t/d, the mine should have an average annual output of 140 000 t of contained copper during the first 14 years of operation.

Noranda Minerals Inc. ceased operations at its Bell copper mine and mill at Granisle, British Columbia, in June 1992 due to the depletion of ore reserves. At the time of closure, the operation employed 235 workers. The mine, which produced over 20 000 t/y of copper in concentrate, was brought on stream in 1972.

In northwestern British Columbia, Redfern Resources Ltd. continued work on its Tulsequah Chief property located 100 km south of Atlin. On the basis of promising exploration results, the company anticipates a significant increase in reserves. The previous reserve estimate was about 8 Mt grading 1.6% copper, 1.2% lead and 6.5% zinc, plus silver and gold.

At the South Kemess property, located in the Toodoggone area, El Condor Resources Ltd. (60%) and St. Philips Resources Inc. (40%) plan to undertake a detailed prefeasibility study in 1993. Mineable reserves for the property total 185 Mt grading 0.23% copper and 0.65 g/t gold. Based on a mine life of 14 years, annual copper production would total about 26 000 t/y of contained copper and 6800 kg of gold.

On the basis of additional exploration work, Taseko Mines Ltd. increased its preliminary reserve estimate for its Fish Lake gold-copper prospect located southwest of Williams Lake. Preliminary reserve estimates for the deposit now total over 1 billion t grading 0.23% copper and 0.5 g/t gold.

On October 6, 1992, British Columbia issued a Mine Development Certificate to Imperial Metals Corporation for its Mount Polley copper-gold project. While Imperial must still obtain project financing, the certificate eliminates some potential risks involved with the development.

The Mount Polley deposit, which is located 56 km northeast of Williams Lake, has probable mineable reserves of 48.8 Mt grading 0.383% copper and 0.556 g/t gold using a copper equivalent cut-off grade of 0.39%. With recoveries of 76% for copper and 80% for gold, annual production over the 10-year life of the operation is expected to be 13 500 t of contained copper in concentrate and an average of 2100 kg of gold. Capital costs for the project are estimated at $130 million.

At the Gibraltar mine near McLeese Lake, exploration work undertaken in 1992 outlined significant copper mineralization in the Gibraltar North zone. However, the company reported in early 1993 that development of the deposit would be uneconomic due to its significant depth.

PRM Resources Ltd. is continuing work on plans to build a copper smelter/refinery complex at Kitimat. The $500 million facility would likely have a capacity to treat approximately 800 000 t/y of both Canadian and offshore copper concentrates. At present, the bulk of the copper concentrates produced in British Columbia is exported to Japan.

While initial plans for the smelter project envisaged the installation of a sulphuric acid plant to process sulphur dioxide flue gases, the company has modified the plant design in order to produce elemental sulphur.

Manitoba

In Manitoba, Hudson Bay Mining & Smelting Co., Limited announced that it would delay the construction of a new copper smelter in Flin Flon due to higher-than-expected costs for its zinc smelter modernization project. With the closure of the Rod mine in 1991, the Spruce Point mine in 1992, and the expected closure of the Stall Lake, Chisel Lake and Namew Lake mines in 1993, the company reported that it was increasing its efforts to secure a major source of copper concentrate supply.

Ontario

As a result of depressed nickel markets, Inco Ltd. announced in October that it will reduce planned mine production over the next 12 months. The cuts were to be accomplished through a reduction in operating rates at its Ontario and Manitoba divisions for three weeks at the end of 1992, a four-week vacation shut-down in 1993, and the postponement of the re-opening of the Shebandowan mine in Ontario. It is expected that this cutback will reduce Inco's Canadian copper output in 1993 by about 10%, or roughly 10 000 t.

In February 1993, Inco announced that it will spend $40 million over the next two years to re-open the Garson mine at its Sudbury operation. Production will initially focus on a zone containing 4.4 Mt of ore grading 1.58% nickel and 1.09% copper.

During 1993, copper output at Falconbridge Limited's Sudbury operation will be affected by an extension of a Christmas shut-down through January as well as by an 11-week closure in the summer.

Quebec

During 1992, development continued on the Louvicourt deposit near Val-d'Or. The operation, which should reach full production in 1995, is expected to cost $350 million. During its expected 18-year operating life, Louvicourt will produce an average of about 50 000 t/y of contained copper and 20 000 t/y of zinc, as well as significant amounts of gold and silver. It is expected that the orebody will be developed in a manner that will provide a higher copper output during the first several years of operation. Diluted mining reserves of the deposit total 24 Mt grading 3.9% copper, 2.0% zinc, 31 g/t silver and 1.2 g/t gold. The Louvicourt deposit is owned by Aur Resources Inc. (30%), Société Minière Louvem (45%) and Teck Corporation (25%).

During 1992, Billiton Metals Canada Inc. purchased BP Canada Inc.'s 61% interest in Les Mines Selbaie. As a result of this transaction, Billiton has increased its ownership stake in the company from 39% to 100%. In 1991, the Selbaie mine produced about 31 000 t of copper in concentrate.

At the end of November, Westminer Canada Limited closed its two copper-gold mines in the Chibougamau area due to high operating costs. The Copper Rand and the Portage mines employed about 350 workers. Westminer purchased the two mines from Northgate Exploration Limited in 1987.

In December, Breakwater Resources Ltd. announced that it would resume mining operations at its Estrades polymetallic massive sulphide mine near Joutel. Proven and probable reserves at Estrades total 276 000 t grading 13.6% zinc, 0.88% copper, 1.34% lead, 215 g/t silver and 7.5 g/t gold.

At the Mobrun mine near Rouyn-Noranda, Audrey Resources Inc. and Minnova Inc. announced that they would proceed with a $7.3 million exploration and development program on the 1100 lens project. Reserves in the upper portion of this deposit total 15.5 Mt grading 4.64% zinc, 0.83% copper, 36 g/t silver and 1.2 g/t gold.

During 1992, there were major ownership changes for both Minnova and Audrey Resources. In the case of Audrey, Cambior inc., through several transactions, acquired a 65% ownership position in the company. This included the purchase of a 17% interest in Audrey held by Northgate Exploration Ltd. Meanwhile, the ownership change for Minnova Inc. involved the purchase, by Metall Mining Corp., of a 50.4% interest in the company from Kerr Addison Mines Ltd.

Falconbridge Ltd. expects to complete a full feasibility study on its Raglan nickel-copper property in northern Quebec by mid-1993. Raglan hosts proven and probable reserves of about 17 Mt grading 3.13% nickel and 0.88% copper.

New Brunswick

During 1992, Novagold Resources Inc. commenced development work on a copper-bearing zone at its Murray Brook deposit in northeastern New Brunswick. While the company initially planned to produce copper using a bio-heap leach technology, it subsequently signed an agreement with Arimetco International and Breakwater Resources whereby approximately 1800 t/d of ore from Murray Brook will be processed at the nearby Caribou mill using conventional milling techniques. While initial mining activity will focus on a supergene zone that contains about 500 000 t of ore grading approximately 2.5% copper, Novagold announced in October that it had discovered a rich primary copper zone underlying existing ore reserves. Further exploration at the site will be undertaken by Arimetco and Breakwater, who will together be able to earn up to 50% of any additional reserves.

Yukon

During 1992, Thermal Exploration Co. and Western Copper Holdings continued exploration on their Williams Creek deposit located approximately 230 km north of Whitehorse. On the basis of recent work at the site, diluted open-pit reserves were increased to 12.3 Mt grading 1.06% copper plus 0.5 g/t gold. Potential development of this property would utilize solvent extraction/electrowinning (SX-EW) technology. A feasibility study for the project is expected to be completed by the middle of 1993.

Northwest Territories

On the basis of a 1992 exploration program on the Izok Lake deposit of Metall Mining Corp. and Minnova Inc., proven and probable reserves were increased to 13.6 Mt grading 2.5% copper and 14.6% zinc, plus lead, silver and gold. Izok Lake is located approximately 360 km northeast of Yellowknife.

Metall Mining reported in November that prefeasibility work was well under way and that a prefeasibility study was expected to be completed by March 1993. Development costs for the Izok Lake deposit, which could be brought into production by as early as 1997, are estimated at between $300 million and $350 million.

Downstream Processing

Alcatel Canada Wire Inc. announced that it would close its wire and cable plant in Etobicoke, Ontario, by the end of 1992. The plant's principal product line was power cable. The closure will result in the loss of 127 jobs. In December 1991, Alcatel closed a cable plant in Orangeville, Ontario, that employed 84 workers.

During 1992, Wolverine Tube (Canada) Inc. sold the manufacturing equipment from its New Westminster, British Columbia, copper tube plant which had been closed since 1991. The buyer of the equipment was Dasan Industrial Company of South Korea.

WORLD DEVELOPMENTS

During 1992, Western World mine production of copper was expected to have increased to 7.6 Mt from 7.4 Mt in 1991. The production of Western World refined copper, which includes metal derived from both primary and secondary material, increased in 1992 to an estimated 8.9 Mt from 8.5 Mt one year earlier.

Chile

During 1992, copper output in Chile increased to about 1.925 Mt compared to 1.814 Mt in 1991.

Copper production at the mines of government-owned Corporacion Nacional del Cobre (Codelco) totalled 1.16 Mt, up slightly from 1.12 Mt in 1991. Output at the company's Chuquicamata mine declined to 628 000 t from about 640 000 t in the previous year. At Codelco's El Teniente mine, production was expected to total 314 000 t in 1992 compared to about 280 000 t in 1991. As a result of declining ore grades at several of its existing mines, Codelco announced plans in 1991 to develop several new orebodies. In early 1993, the company reported that it would start clearing the site of the Radomiro Tomic deposit located 6 km north of the Chuquicamata mine. Should financing for the project be approved by the Chilean government, development work could begin in 1995 with production starting in 1997. It is expected that the US$450 million mine will produce an estimated 150 000 t/y of copper cathode. Reserves at the Radmiro Tomic deposit total 691 Mt grading 0.73% copper. Codelco also announced in 1992 that it would undertake the development of the Inca orebody at its El Salvador division. Annual production is expected to be about 60 000 t of contained copper. Codelco is also proceeding with the development of the Quebrada Teniente zone at the El Teniente mine. This project, which will be completed in 1994, will increase output at El Teniente by about 50 000 t/y of contained copper.

The La Escondida complex, which is owned by The Broken Hill Proprietary Company Limited (BHP) (57.5%), RTZ Corporation PLC (30%), a Japanese consortium (10%) and International Finance Corp. (2.5%), produced approximately 325 000 t of contained copper in concentrate during 1992 compared to 300 000 t in 1991. The owners of La Escondida are proceeding with plans to build an ammonia leach facility to treat concentrates at the port of Coloso, located south of Antofagasta. The process will recover high-purity cathode by electrowinning. There are also plans to process oxide ores at the La Escondida mine using SX-EW technology.

The Los Pelambres mine, controlled by Minera Anaconda Chile Ltda (20%), Midland Bank (40%) and Lucky Goldstar International Corp. (40%), began production in 1992. It was reported that the owners of the mine were studying the feasibility of expanding the operation beyond the current capacity of about 25 000 t/y of copper in concentrate. While workers at the mine went on strike at the beginning of 1993, production was not seriously affected.

The new El Lince mine of Compania Minera Carolina de Michilla SA (60%) and Outokumpu Copper Resources B.V. (40%) reached full production in the first half of 1992. The operation's capacity is approximately 20 000 t/y of electrowon copper. In October, Outokumpu sold its interest in the El Lince mine to Chilean Northern Mines Ltd.

At the end of 1992, Empresa Minera de Mantos Blancos announced that it would double the size of its Mantos Blancos operation to approximately 130 000 t/y of contained copper. It is expected that the expansion will be completed in 1995. It was also reported that the company will undertake a feasibility study on its Manteverde copper oxide deposit in northern Chile. Reserves total 85 Mt grading 0.86% copper.

Elsewhere in Chile, Minera Disputada de Las Condes S.A., a subsidiary of Exxon Minerals Chile, Inc., completed an expansion of its Los Bronces operation that will increase the production of copper in concentrate to 125 000 t/y.

Phelps Dodge Corporation and Sumitomo Metal Mining Co. Ltd. are proceeding with the development of their La Candelaria project. The mine, which will likely come on stream at the beginning of 1995, is expected to produce about 110 000 t/y of contained copper. The total cost of the first phase of the project is estimated at US$560 million. Geological reserves at La Candelaria total 320 Mt grading 1.14% copper, plus gold.

During 1992, work continued on the 75 000-t/y Quebrada Blanca SX-EW project, with production expected to begin in the first half of 1994. Capital costs for the project are estimated at about US$300 million. The Quebrada Blanca property is owned 42.5% by Cominco, 32.5% by Teck Corporation, 10% by Empresa Nacional de Mineria (Enami), 10% by Cominco Resources International Ltd., and 5% by Sociedad Minera Pudahuel (SMP). Copper oxide reserves at Quebrada Blanca, which total 85 Mt grading 1.35% copper, are sufficient to sustain the operation for at least 14 years.

In December, Placer Dome Inc. announced that it had completed the acquisition of a 50% interest in the Zaldivar SX-EW project from Outokumpu Copper Resources B.V. for US$100 million. Placer also reported that the existing feasibility study for the mine would be updated by the middle of 1993. Should the partners decide to proceed with the project at that time, production would begin in 1995. The mine, which would have a capacity to produce about 90 000 t/y of copper cathode, could be expanded to 140 000 t/y. Reserves are estimated at about 1 billion t grading 0.57% copper at a cut-off grade of 0.2% copper. This includes a higher-grade zone with 1.16% copper at a cut-off grade of 0.7% copper. The entire project is expected to cost about US$500 million.

In July 1992, Placer announced that it was withdrawing from the Andacollo copper project in northern Chile. On the basis of a one-year drilling and evaluation program, the company concluded that the economics of the project were insufficient to warrant further investment.

Rio Algom Ltd. continued development work in 1992 on its Cerro Colorado mining project in the northern part of the country. Capital costs for the project are estimated at US$250 million. Annual production at this SX-EW operation is initially expected to total 40 000 t of copper cathode and to eventually reach 60 000 t. The Cerro Colorado deposit contains reserves of 79 Mt grading 1.39% copper. Production is expected to begin in 1994. During 1992, RTZ Limited sold its 51.5% interest in Rio Algom.

Falconbridge Limited continued work at its Collahuasi project in northern Chile. Reserve estimates for the property, which includes three separate orebodies, total over 2 billion t grading 1% copper. Within this total, the Ujina deposit contains a preliminary reserve estimate of more than 100 Mt of secondary copper mineralization grading 2% copper. The project, which is equally owned with Shell Chile SA and Minera Mantos Minorco Limitada (a joint venture between Minorco SA and Empresa Minera de Mantos Blancos), is expected to be brought into production in 1997. The mine will produce at a planned rate of at least 150 000 t/y of contained copper and reach 300 000 t/y by 1999.

During 1992, North Lily Mining Co. and International Mahogany Corp. began production on their La Tuina copper property in northern Chile. Until an SX-EW plant is built, the operation will produce a copper precipitate product. Production in 1992 was expected to total about 6000 t of contained copper.

Other Canadian companies who are active in copper-related exploration or development in Chile include Princeton Mining Corporation, Minera Rayrock Inc., Cambior inc., and Aurex Resources Corp.

In December 1992, workers at Enami's Paipote smelter staged a short strike to back wage demands. The Paipote smelter produces about 75 000 t/y of copper anodes.

Refinadora de Metales SA (Refimet) announced plans to bring a new copper smelter on stream by mid-1993. The plant, which is being built near Antofagasta, will have a capacity of about 75 000 t/y of blister copper. The company was reported to be considering a further expansion to 120 000 t/y in the near future.

The government of Chile announced that it would provide the equivalent of US$120 million for the modernization of Enami's Las Ventanas smelter. The project, which will include the replacement of the smelter's existing reverberatory furnace with a "Teniente" reactor, will permit the company to drastically reduce sulphur dioxide emissions. An expansion of the smelter to handle up to 830 000 t/y of concentrates is also under consideration. This would entail the construction of an additional Teniente converter and another acid plant.

Codelco is proceeding with a modernization project at its Chuquicamata smelter that will also increase capacity by approximately 10%. The project includes the replacement of the remaining reverbatory furnaces with a modified Teniente converter and the construction of an additional acid plant. The project is expected to be completed in 1994. The expansion will permit the Chuquicamata Division to become self-sufficient in smelting capacity.

During 1992, a feasibility study was completed for the proposed 200 000-t/y Refineria del Pacifico smelter/refinery complex. While the report concluded that the project would be viable, there had been no decision on the project by year-end. The project involves a consortium of companies which includes Empresa Nacional de Mineria (ENAMI), Lac Minerals Inc., ACEC-Union Minière, Arbi Participacoes, and Sudmetal. The cost of this project is estimated at about US$450 million.

Brazil

In Brazil, Companhia Vale do Rio Doce and Mineracao Morro Velho signed an agreement to develop the Salobo copper-gold deposit in the state of Para. The mine will have an annual output of 150 000 t of copper cathode and 8000 kg of gold.

Mexico

In January 1993, production was disrupted at the 150 000-t/y copper refinery of Cobre de Mexico as a result of a strike by workers to back wage demands. The strike ended in mid-February.

Cuba

During 1992, there were reports of extensive exploration for copper in Cuba. Matlock Mining of Australia plans to develop the Hierro-Mantua deposit, which contains reserves of 5.3 Mt grading 3.3% copper. Copper output is expected to total about 15 000 t/y.

United States

During 1992, copper mine production in the United States was expected to total 1.75 Mt compared to 1.63 Mt in 1991.

In the first quarter of 1992, Kennecott Corporation announced that it plans to replace its existing 150 000-t/y Garfield smelter with a new 273 000-t/y plant by 1995. The new smelter, which will cost an estimated US$880 million, will use Outokumpu flash smelting technology and flash converting technology developed by Kennecott in cooperation with Outokumpu Oy. It is expected that the new smelter will capture 99.9% of the sulphur contained in the concentrate feed.

In Wisconsin, development work at Kennecott's Flambeau mining project resumed in May 1992. Work was halted in 1991 when opponents of the project won a temporary injunction against further development work at the site. That injunction prohibited further construction for a period ending 30 days after the state completed a supplemental environmental impact report concerning the mine's impact on threatened species in the area. The study, which was completed in April, found that the design of the mine's waste water treatment would likely require no changes.

The Flambeau mine, which is expected to produce about 27 000 t/y of copper plus gold over a six-year period, is now expected to come on stream in 1993. Ore from the mine has an average grade of 10.5% copper.

In May, ASARCO Incorporated received environmental approval for a modernization and expansion of its El Paso, Texas, smelter. The work, which will increase capacity by about 20 000 t/y of copper, is expected to be completed in 1993. In 1992, ASARCO also completed an expansion of its Ray mine in Arizona that will increase capacity by 58% to about 180 000 t/y of contained copper. Early in 1993, the company announced that it was temporarily closing its Troy silver and copper mine in Montana. ASARCO attributed the decision to low metal prices and declining production. The capacity of the Troy mine is about 15 000 t/y of copper in concentrate.

During 1992, Cyprus Minerals Company completed an expansion and modernization program at its Miami, Arizona, smelter. The new Isasmelt furnace, which will increase throughput capacity to 600 000 t/y of concentrate, is expected to reach full capacity by mid-1993.

Magma Copper announced that it would proceed with the development of its Robinson mining project near Ely, Nevada. The mine, which could be fully on stream by the end of 1994, will produce almost 57 000 t/y of contained copper in concentrate as well as significant amounts of gold and silver. The orebody contains proven and probable ore reserves of 182 Mt grading 0.61% copper and 0.4 g/t gold. In the second half of 1992, the company received the necessary construction permits for an expansion of its San Manuel smelter from about 275 000 t/y of copper to roughly 325 000 t/y. The expansion, which will cost about US$100 million, is expected to be completed in early 1994.

Azco Mining Inc. will proceed with the development of its Sanchez copper project in southern Arizona. This SX-EW operation is expected to produce about 25 000 t/y of copper cathode. Production is expected to begin in 1994.

In Arizona, heavy rainfall during January of 1993 resulted in the loss of at least 30 000 t of copper production. SX-EW operations were particularly affected due the dilution of leach solutions by rainwater.

The U.S. government announced that, in March 1993, it would begin sales of five metals, including copper, from its National Defense stockpile of strategic and critical metals and materials. At the end of 1992, the stockpile contained approximately 26 000 t of copper.

Australia

During 1992, Western Mining Corporation completed an expansion of its Olympic Dam mine and processing facilities in South Australia. As a result of the project, refined copper output at Olympic Dam will increase from 45 000 t/y to 65 000 t/y. In November, Minorco SA agreed to purchase the 49% interest in Olympic Dam held by British Petroleum Co. Plc.

In northeastern Victoria, Deanhurst Ltd., 20% owned by Furukawa Co. Ltd., will develop the Benambra copper deposit. The deposit contains two major ore zones with reserves of 1.9 Mt grading 2% copper and 7% zinc, and 8.8 Mt grading 2% copper and 4% zinc. It is expected that production will begin in 1993. Annual output is expected to be about 19 000 t of copper in concentrate.

Western Mining Corporation announced that it will develop the Nifty deposit in the Pilbara region of Western Australia. The mine, which will use SX-EW technology, will cost an estimated A$60 million. Annual output is expected be about 16 000 t of copper cathode. It was also reported that Nord Pacific Limited and Straits Engineers Contracting will proceed with the development of the Girilambone copper project in Western Australia. This SX-EW operation, which is expected to begin production in 1993, will produce about 14 500 t/y of copper cathode.

MIM Holdings Limited announced that construction of its A$100 million Isasmelt smelter was completed in July. The smelter will have a capacity of 210 000 t/y of copper. The company plans to operate both its new smelter and old smelter for the time being in order to take advantage of the prevailing shortage of copper-smelting capacity.

Papua New Guinea

During 1992, fighting continued between secessionist rebels on the island of Bougainville and the government of Papua New Guinea. According to press reports, any re-opening of the Bougainville copper mine, which was closed in 1989, is at least two years away.

In December, force majeure was declared on shipments from the Ok Tedi gold-copper mine due to low water levels in the Fly River. In February 1993, production was suspended due to a strike. The mine is 30% owned by Broken Hill Pty Co. Ltd.

Philippines

In the Philippines, North Davao Mining Corporation closed its 10 000-t/y Amacon copper mine on the island of Mindanao. Press reports surmised that the operation was not economic.

Atlas Consolidated Mining and Development Corp. announced that production at its Carmen underground mine project was scheduled to begin in September 1992 with full production to be reached in early 1993. The deposit contains proven and probable reserves of 884 Mt grading 0.41% copper.

Marcopper Mining Corporation was reported to have commenced production at its San Antonio copper mine project on Marinduque Island. When in full production, the mine is expected to produce 32 660 t/y of contained copper along with significant quantities of gold and silver.

Indonesia

Freeport-McMoran Copper & Gold Inc. announced that it would increase production at its Grasberg copper-gold orebody in Indonesia from 57 000 t/d to 66 000 t/d by the second half of 1993 and to 90 000 t/d in 1996. At this mining rate, annual output will reach about 450 000 t of copper in concentrate. Proven and probable reserves at the Grasberg deposit total 768 Mt grading 1.45% copper, 1.66 g/t gold and 3.86 g/t silver.

Freeport also reported that surface drilling at its Big Gossan deposit in Irian Jaya had outlined an estimated reserve of over 6 Mt grading 5% copper and 2.9 g/t gold.

At the beginning of 1992, Freeport announced that it would participate with Metallgesellschaft AG in a copper smelter and refinery project to be built at Gresik in eastern Java. The smelter, which is expected to cost an estimated US$590 million, could begin production in 1996. Other partners in the 150 000-t/y facility include Nippon Mining Co. Ltd. and Petrokimia Gresik. A final decision on the project is expected by August of 1993.

Japan

Nippon Mining Co. Ltd. announced that it was considering an expansion of its Saganoseki smelter from 330 000 t/y to about 400 000 t/y. The company expects to make a final decision on the project in 1993.

People's Republic of China

In the People's Republic of China, Jiangxi Copper Corporation announced that it planned to increase copper production from 110 000 t/y to 200 000 t/y by the end of the decade. This increase will be accomplished through a number of projects, including the completion of the third phase of the Dexing mine in which daily mining capacity will be increased to about 90 000 t.

In 1992, it was estimated that copper consumption in China was at least 750 000 t while refined copper output was about 550 000 t. Despite efforts to increase domestic production, it is expected that China will require increasingly large quantities of copper from offshore in order to satisfy a forecast growth rate for domestic consumption of up to 5% for the remainder of the decade. Chinese officials have forecast that copper imports will total between 300 000 t and 400 000 t by the year 2000.

During 1992, Noranda Minerals Inc. signed a technology transfer agreement with China National Nonferrous Metals Import & Export Corp. under which Noranda will supply its continuous smelter technology for an expansion and modernization of China's Da Ye copper smelter. The capacity of the Da Ye smelter will be increased from 60 000 t/y to about 120 000 t/y of copper metal.

Thailand

In Thailand, a consortium of companies are proceeding with plans to build a 150 000-t/y copper smelter/refinery project. The cost of the project is estimated at about US$500 million. The consortium would include Padaeng Industry Co. Ltd., Mitsubishi Materials Corporation, Mitsubishi Corporation, Mitsui & Co. Ltd., MIM Holdings, Ltd., and Marc Rich & Co. AG. The project is expected to be completed in 1995.

India

In India, Sterlite Industries (India) Limited announced plans for a 60 000-t/y copper smelter and refinery at Ratnagiri in the state of Maharashtra. The target for completion of the project is the third quarter of 1994.

Saudi Arabia

The Japan International Development Organization will undertake a feasibility study for the construction of a 150 000-t/y greenfield smelter project at Yanbu in Saudi Arabia. It is expected that the study will be completed in early 1993.

Turkey

In Turkey, Metall Mining Company, Etibank, and Gama Endustrie Tesisleri Imlat VE Montaj A.S. announced that they are proceeding with the development of the Cayeli deposit in the northeastern part of the country. The mine will produce about 20 000 t/y of copper and 35 000 t/y of zinc in concentrate. The project, which is expected to be completed by the end of 1994, will cost an estimated US$150 million. The orebody contains reserves of 10.6 Mt grading 4.7% copper and 7.3% zinc.

Also in northeast Turkey, Cominco Resources International Limited announced an increase in the size of the secondary enrichment zone of its Cerattepe copper deposit. On the basis of its 1992 exploration program, reserves in this zone now stand at 1.2 Mt grading 10% copper. The deposit also contains an additional 4 Mt of material grading 2% copper.

Commonwealth of Independent States

At the beginning of 1993, Udokan Mining Company, a consortium of Russian companies, was awarded the right to develop the large Udokan copper deposit in Siberia. The deposit contains estimated reserves of about 1.2 billion t grading 2% copper. The project, for which development costs are estimated at about US$1 billion, will take seven or eight years to complete.

During 1992, exports of refined copper from countries of the former U.S.S.R. were expected to increase to almost 300 000 t from about 175 000 t in 1991. The dramatic decline in consumption in that region is thought to have played a major part in promoting copper exports. There was also a significant increase in blister copper shipments from the former U.S.S.R. It is likely that much of this material originated from the large volumes of offshore concentrates that were processed at smelters in Russia, Kazakhstan and Uzbekistan in 1992 under tolling contracts. It is likely that such tolling arrangements were responsible for an alleviation of the worldwide shortage of smelting capacity that developed in 1991.

Poland

Workers at the mining and milling operations of Poland's KGHM Polska Miedz SA went on strike in July to back wage demands. While the strike continued through most of August, the company's smelters continued to operate at reduced capacity. It was reported that the strike resulted in the loss of about 25 000 t of refined copper.

There were a number of reports during 1992 that the Polish government was entertaining investment offers from several foreign companies for a stake in its copper industry. The companies most widely mentioned were Western Mining Corporation Holdings Limited and ASARCO Inc.

Zambia

Despite concerns relating to possible shortages of hydro-electricity, it was expected that copper output in Zambia in 1992 would increase to about 435 000 t from 412 000 t in 1991.

At the beginning of 1993, there was intense speculation that Zambia Consolidated Copper Mines Ltd. was facing severe financial problems and that the government was considering the privatization of the company as a way of ensuring needed investment for continued operations.

Zaire

The copper industry in Zaire suffered further setbacks in 1992 due to political upheaval and a continuing lack of investment to maintain existing mining infrastructure and develop new capacity. Copper output in 1992 was expected to decline to about 180 000 t from 290 000 t in 1991.

International Copper Study Group

In June 1992, the inaugural meeting of the International Copper Study Group (ICSG) was held in Geneva. While progress on a number of issues was achieved at this meeting, including the group's terms of reference and rules of procedure, a special session of the ICSG was convened in Santiago, Chile, in November to consider the choice of a headquarters site and the selection of a secretary-general. At this meeting, member nations selected Lisbon as the headquarters for the organization and Valentin Daniels of Chile was selected as the group's first secretary-general. For the calendar year 1993, the group elected: Günter Behrendt (Germany) as Chairman, Gordon Peeling (Canada) as Chairman of the Standing Committee, Antonio Santana Carlos (Portugal) as Chairman of the Finance Committee, and Anthony Cammarota (United States) as Chairman of the Statistics Committee.

At the end of 1992, the ICSG had 21 members (Belgium, Luxembourg, Canada, Chile, Finland, France, Germany, Greece, Indonesia, Italy, Japan, the Netherlands, Norway, Peru, Philippines, Poland, Portugal, Spain, the United States, Zambia and the European Community). Member countries account for slightly more than 80% of world copper trade.

The first general session of the ICSG, at which strong industry participation is expected, will be held in Lisbon in June 1993.

CONSUMPTION AND USES

Canadian refined copper consumption in 1992 was estimated to have decreased to approximately 177 000 t from 185 000 t in 1991. Western World consumption of refined copper in 1992 was estimated to have increased slightly to 9.1 Mt (this includes refined copper from both primary and secondary material) from 9.0 Mt in 1991. In 1991, about 2.8 Mt of copper scrap was used directly by consumers. Altogether, 4.125 Mt of copper scrap was recovered in 1991.

Copper's high electrical and thermal conductivity, combined with its good tensile strength and mechanical properties, elevated melting point (1083°C), non-magnetic properties and resistance to corrosion, make it and its alloys very attractive for electrical transmission, water tubing, castings and heat exchangers. Copper is the most efficient conductor of electrical power, signals and heat of all the industrial metals (aluminum's electrical and thermal conductivity is only 72% and 76%, respectively, of copper's). In Canada, more than half of the refined copper consumed annually is used for electrical applications, mostly in wire.

Detailed copper consumption statistics are not officially collected in Canada. The Canadian Copper and Brass Development Association (CCBDA), an association of producers and fabricators, collects certain statistics for its members. Besides its traditional uses, copper is consumed in Canada for retrofitting fire suppression systems, natural gas tubing in residences, central vacuuming, and roofing. Changes are being contemplated that would require fire suppression systems in all new residential dwellings, and copper is the preferred material for such systems.

Table 8 presents preliminary end-use data for 1990 and 1991 for the United States collected by the Copper Development Association Inc. Building construction represented the largest market for copper with 40% of the total in 1991. Electrical and electronic products accounted for about 24% of U.S. copper usage, followed by industrial machinery and equipment (14%), transportation equipment (12%), and consumer and other products (10%).

NEW MARKETS

A number of promising new markets for copper could well provide significant growth opportunities for the industry by the end of the century. These include applications in roofing, fire suppression systems, and natural gas systems inside houses and buildings, as well as solar power generation, data communications, and the storage of spent nuclear fuel. While copper use in original-equipment automobile radiators has declined due to the market penetration of aluminum radiators, copper and brass radiators have an important share of the replacement market. According to the Copper Development Association, non-electrical copper use in automobile in the United States (largely in radiators) declined from 6.8 kg in 1986 to 5 kg in 1990. However, with the development of new solders and new processing methods for coating and core baking, as well as a new brazed structure, it is possible that copper can regain a large share of this market in view of its superior heat exchange efficiency.

According to the Copper Development Association, the average North American automotive vehicle contained about 15 kg of copper in 1986 for electrical parts and wiring. This increased to over 18 kg in 1990. This change has largely been due to the increasing complexity of automotive electrical systems. A typical vehicle, which had about 500 electrical circuits in 1981 and about 750 circuits in 1986, was expected to contain up to 1200 circuits in 1992.

While the use of copper for automotive electrical applications has experienced significant growth in recent years, the use of multiplexing technology may limit future growth for copper in this area.

Despite a number of technological advances in the communications and telecommunications sectors in recent years that promised to reduce copper consumption, including fibre optics, multiplexing and gauge reduction, recent technological breakthroughs for copper will enable this metal to maintain an important share of this expanding industry.

During 1992, a subsidiary of American Telephone and Telegraph Co. announced that its new carrierless amplitude/phase (CAP) modulation transport technology could handle up to three megabits of data per second using standard copper subscriber loops. This is almost as much as a fibre-optic transmission system.

Together with technological advances for copper in the communications and telecommunications sectors, this metal will continue to benefit from its relatively low cost and durability in comparison to competing materials or systems, including fibre-optic systems or wireless local loops.

Meanwhile, copper also continues to be the preferred metal for electrical wiring applications in building construction. As houses increase in size and incorporate more labour-saving electrical devices, the use of copper in household wiring applications could increase by up to 40%. At present, the average new home in the United States contains about 420 lb of copper, up from 230 lb in the early 1980s.

TRADE

In 1991, about 1.94 Mt of copper in concentrate was exported by Western World countries. Chile was the largest exporter (507 000 t) followed by Canada (320 000 t) and the United States (253 000 t). Blister and anode copper exports by Western nations totalled 474 000 t, while refined copper exports were about 3.52 Mt. In 1991, the countries of the former Eastern Bloc enjoyed a trade surplus of about 312 000 t of refined copper. It is estimated that this surplus increased slightly in 1992.

During 1992, there was no progress at the Uruguay Round of multilateral trade negotiations with regard to the elimination or reduction of Japan's 21 yen/kg import duty on refined copper. Within Japan, the Electric Wire and Cable Manufacturers Association also supports the elimination of this duty since it increases the cost of refined copper in that country.

Canada, the United States and Mexico signed a North American Free Trade Agreement (NAFTA) in 1992. This accord, which will pave the way for the elimination of tariffs on the movement of goods between the three countries, will effectively create a single North American market with a population of 360 million. It is expected that the governments of the three nations will ratify the agreement before the end of 1993.

For the Canadian copper industry, one of the principal issues under discussion at the NAFTA negotiations was that pertaining to "Rules of Origin" for copper products that will be traded within the proposed free trade area. One of the principal shortcomings of the existing Free Trade Agreement with the United States has been that Canadian refined copper loses its "free trade" territorial status if it contains any material that was derived from offshore scrap. Under NAFTA, this problem has been eliminated.

In early 1993, Canada initiated an investigation into the alleged dumping of certain copper pipe fittings from some exporters in the United States. The investigation was initiated as a result of a complaint by Cello Products, Inc. of Cambridge, Ontario, who is a manufacturer of plumbing fittings.

HEALTH AND THE ENVIRONMENT

Proper human and animal health depends on an adequate dietary intake of copper. Copper combines with proteins to form many enzymes critical for life. One such important enzyme is superoxide dismutase, which removes the superoxide radicals in the human body. Superoxide radicals are the "residues" of metabolic processes which otherwise could build up to toxic levels. Copper is also required to transport iron from absorption sites to the bone marrow where red blood cells are produced.

Many regulatory agencies have chosen 1 part per million (ppm) as the maximum desirable concentration of copper in drinking water. It signifies more of an aesthetic limit than a health limit; water containing more than 1 ppm can stain laundry, and persons with a keen sense of taste may perceive a metallic flavour in the water.

Copper tube used for the distribution of potable water supplies inhibits bacterial growth. In addition to the suppression of bacteria such as *Legionnella pneumonillia* in a water system, copper also discourages biofilm formation under which bacteria can survive.

Most of the environmental concerns that arise from producing copper are associated with the sulphur dioxide emissions that result from copper smelting. Under a 1985 Ontario government regulation, Inco and Falconbridge must reduce their emissions of sulphur dioxide to 265 000 t and 100 000 t, respectively, by 1994.

At the Sudbury operations of Inco Limited, work is nearing completion on projects that are required to achieve compliance with the regulation. The principal components of Inco's program include two oxygen flash furnaces, a new sulphuric acid plant, an additional oxygen plant, and a novel oxygen flash smelting converter for the production of blister copper.

While Falconbridge has already achieved compliance with the regulation, the company is conducting research on methods to further reduce its Sudbury emissions to 75 000 t/y by 1998. Most of this work will focus on greater rejection of pyrrhotite during processing.

STOCKS

Combined copper stocks on the London Metal Exchange (LME) and the Commodities Exchange, Inc. (COMEX), which totalled over 360 000 t at the beginning of 1991, decreased during the first half of 1992 to slightly more than 280 000 t in early August. From that point, stocks rose once again to almost 440 000 t at the beginning of 1993. Figure 1 shows both LME copper stocks and prices for the period 1989-91.

The American Bureau of Metal Statistics reported that total refined copper stocks held by U.S. refineries at the end of December were 29 200 t. The Bureau also reported that copper stocks at other Western World refineries totalled 386 000 t in November 1992.

While the absolute volume of total stocks at the end of 1992 was not particularly large when viewed from an historical perspective, the inventory management practices of consumers have changed radically in the past decade.

PRICES

Despite some volatility, copper prices were, on average, only slightly lower than those in 1991. The average LME Grade A settlement price in 1992 was slightly less than US$1.04/lb compared to $1.06/lb in 1991.

From a low of below US$0.95/lb LME in early January 1992, prices increased through the month due to significant buying activity by China. Prices in February, March, April and May were relatively stable at around $1.00/lb. In June, prices rose sharply due to concerns about major supply disruptions.

Figure 1
Daily London Metal Exchange Copper Prices, 1992
Highest Grade Sold

This included possible strikes at CCR in Canada, at ASARCO in the United States and at KGHM in Poland; technical problems in Chile; and the threat of a national rail strike in the United States. The average price in June was about US$1.04/lb.

In July prices continued to climb, reaching US$1.17/lb on July 22. This increase was supported by copper-buying activity by China, increased speculative activity, improved prospects for consumption in the United States, and continued concern over possible supply disruptions, particularly in Poland. The average price in July was slightly more than US$1.14/lb.

Prices remained stable through August but weakened in September due to slackening demand, principally in Europe and Japan, along with an increasingly pessimistic outlook for an overall economic recovery. This decline in prices in September corresponded to an increase in exchange stocks. The average LME price in September was slightly less than US$1.10/lb.

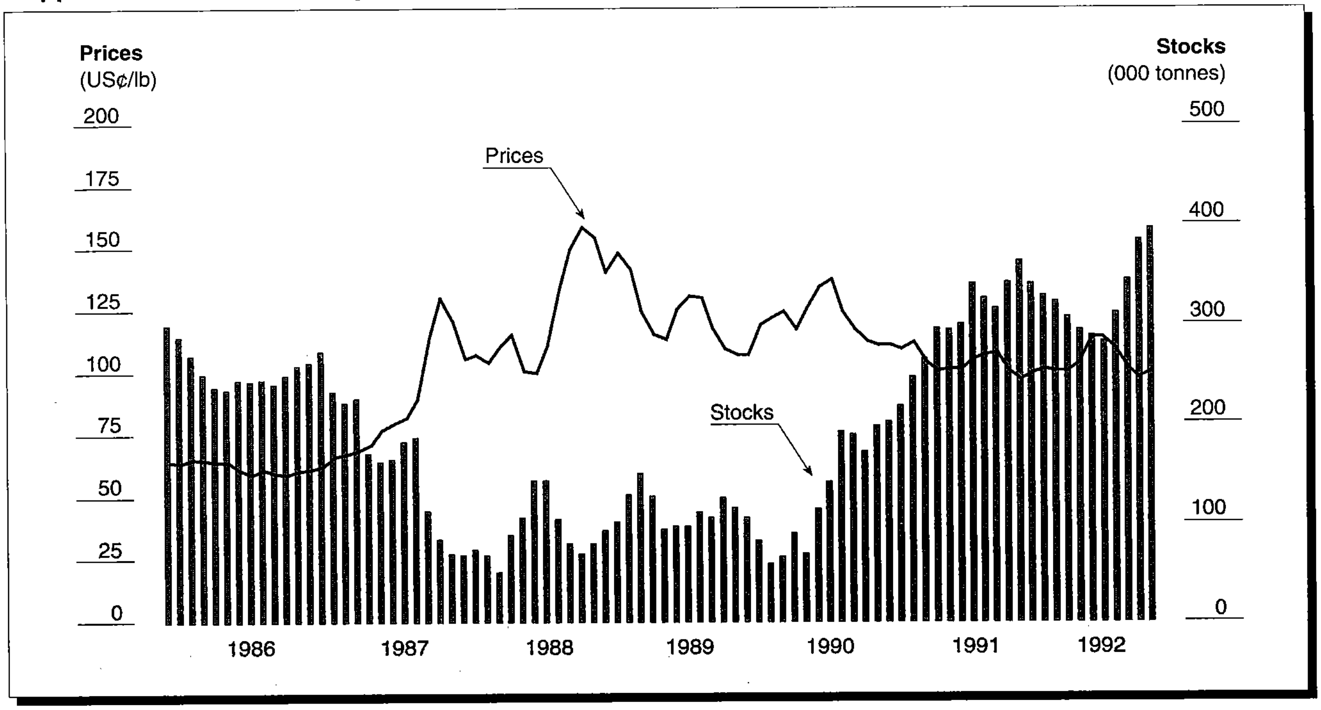
Prices continued their slide in October as market sentiment continued to worsen and exchange stocks continued to climb. Copper prices averaged US$1.02/lb in October. With further increases in stock levels and continuing gloom with regard to short-term prospects, copper prices fell through the US$1.00/lb level in early November. Prices for the month averaged US$0.98/lb.

In December, prices rebounded somewhat due to increased buying activity by China combined with concerns for copper supply due to labour problems and technical factors. The average price for December was slightly more than US$1.00/lb.

In early January 1993, strong buying activity by China pushed prices to US$1.08/lb. However, several days later, heavy selling by China pulled prices down again to below US$1.00/lb. Prices for the remainder of the month were relatively stable at about US$1.00/lb.

The LME and COMEX predominate in establishing copper prices worldwide. Both trade in spot or "cash" metal, as well as in futures contracts. Figure 2 shows daily LME cash prices from 1989 to 1991 in US$/lb. Canadian producers sell refined copper in the United States at COMEX plus a premium of between US2.5¢ and 3¢/lb, in Canada at the Canadian dollar equivalent of COMEX plus between 3¢ and 3.5¢/lb, and in Europe at LME plus £8-10/t (payment terms may differ between regions).

Figure 2
Copper Prices[1] and Exchange[2] Stocks, 1986-92



1 Average monthly LME cash prices.
2 Combined LME and COMEX stocks at beginning of the month.
SOURCE: Nonferrous Division, Mineral Policy Sector, EMR Canada, February 1993.

In December 1992, the LME announced that, effective July 1, 1993, trading in Grade A copper contracts would be conducted in U.S. dollars. In 1993, the LME plans to examine the expansion of its warehouse network for copper into the United States.

Treatment and refining charges (TC/RCs) for copper concentrates declined from almost US40¢/lb on the spot market at the beginning of 1992 to roughly 24¢/lb at the end of the year. A smaller surplus of copper concentrates in 1992 was the principal reason for this change. It was reported in the press at the end of the year that negotiations between copper producers and the Japanese smelter pool for 1993 TC/RCs were progressing very slowly. The range of charges being discussed was reported at between US21¢/lb and US27¢/lb. Several contracts were reported to have been signed at about US25¢/lb.

OUTLOOK

With indications that the recovery in North America is progressing very slowly and that other major economies are continuing to experience problems, it is likely that there will be some further easing of copper prices in the first half of 1993.

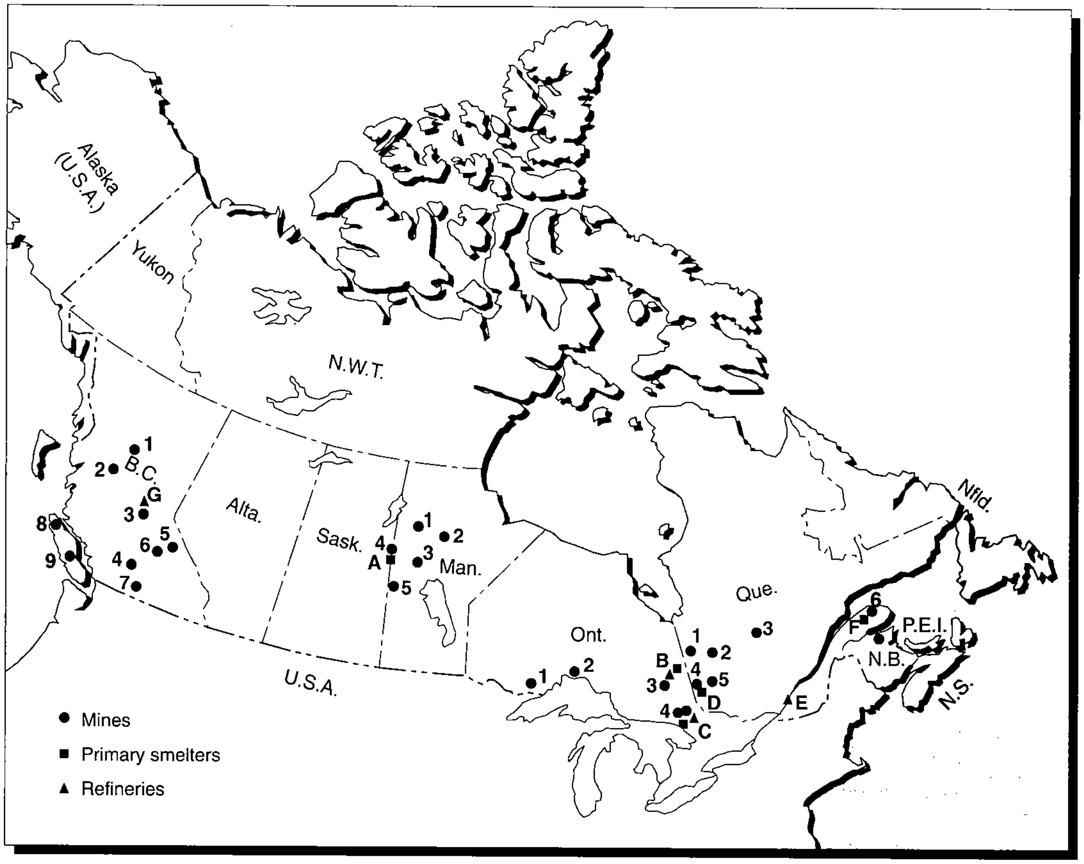
While copper consumption is expected to experience increased growth by the second half of 1993, prices in the medium term are likely to be adversely affected by even larger increases in copper mine production capacity. Moreover, significant exports of copper from the former Eastern Bloc will continue to exert pressure on prices for at least the next two years. After 1995, prices are expected to strengthen due to a forecast slowdown in the growth of world copper supply, accompanied by very strong demand growth. From a range of between US85¢ and 95¢/lb in 1993 (constant 1992 dollars), copper prices should rise on average to a range of between US$0.95 and $1.15/lb in the year 2000.

For the remainder of the 1990s, copper consumption is expected to grow at an annual average rate of between 2.0% and 2.5%. It is expected that the largest increases in copper consumption will occur in the construction and transportation industries. It is also expected that a large share of the forecast growth in demand will occur in the Asian and Latin American markets.

Canadian copper mine production is expected to decline in the medium term as additions to copper capacity will be less than the loss due to mine closures. The overall decline of Canadian mine output could be reversed by the late 1990s if a small number of deposits, particularly in British Columbia, come on stream. The British Columbia deposits that could be developed in the 1990s include Windy Craggy, Mount Polley, Mt. Milligan, Fish Lake, Kemess, and Telsequah Chief. Elsewhere in Canada, promising projects include Williams Creek in the Yukon and Izok Lake in the Northwest Territories.

Note: Information in this review was current as of February 21, 1993.

Figure 3
Copper Producers in Canada, 1992



MINES

British Columbia

1. Noranda Inc. (Bell mine)
2. Equity Silver Mines Limited
3. Gibraltar Mines Limited
4. Highland Valley Copper[1]
5. Bethlehem Resources Corporation
   Goldnev Resources Inc. (Goldstream mine)
6. Minnova Inc. (Samatosum)
7. Princeton Mining Corporation (Similco)
8. BHP-Utah Mines Ltd.
9. Westmin Resources Limited

Saskatchewan

Hudson Bay Mining and Smelting Co., Limited (Flin Flon)

Manitoba

1. Hudson Bay Mining and Smelting Co., Limited (Ruttan mine)
2. Inco Limited (Thompson mine)
3. Hudson Bay Mining and Smelting Co., Limited, Snow Lake area mines
4. Hudson Bay Mining and Smelting Co., Limited, Flin Flon area mines
5. Hudson Bay Mining and Smelting Co. Limited/Outokumpu Mines Ltd. joint venture (Namew Lake mine)

Ontario

1. Noranda Inc., Geco Division
2. Minnova Inc. (Winston Lake mine)
3. Falconbridge Limited (Timmins)
4. Falconbridge Limited (Sudbury area)
   Inco Limited (Sudbury area)

Quebec

1. Les Mines Selbaie
2. Noranda Inc., Matagami Lake Division
3. Westminer Canada Limited
   Campbell Resources Inc.
4. Minnova Inc. (Lac Dufault Division – Ansil mine)
5. Agnico-Eagle Mines Limited (La Ronde mine)
   LAC Minerals Ltd. (Bousquet mine)
6. Noranda Inc., Division Mines Gaspé

New Brunswick

Brunswick Mining and Smelting Corporation Limited
Noranda Inc. (Heath Steele mine)

SMELTERS

A. Hudson Bay Mining and Smelting Co., Limited (Flin Flon)
B. Falconbridge Limited (Timmins)
C. Inco Limited (Sudbury area)
   Falconbridge Limited (Sudbury area)
D. Noranda Inc. (Noranda)
F. Noranda Inc. (Division Mines Gaspé)

REFINERIES

B. Falconbridge Limited (Timmins)
C. Inco Limited (Sudbury area)
E. Noranda Inc. (Division CCR)
G. Gibraltar Mines Limited (SX-EW)

1 Highland Valley Copper is a partnership of Cominco Ltd., Teck Corporation and Rio Algom Limited.
NOTE: For detailed production and ore grade information, refer to the nonferrous mine production table following the last commodity chapter.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
2603.00	Copper ores and concentrates						
2603.00.00.10	Copper content	Free	Free	Free	Free	Free	Free
2825.50	Copper oxides and hydroxides	Free	Free	Free	0.7%-1.0%	3.2%	7.2%
28.33	Sulphates; alums; peroxosulphates						
	Sodium sulphates:						
2833.25	Of copper						
2833.25.10	Cupric sulphate	6.8%	Free	Free	0.2%	3.2%	5.8%
74.01	Copper mattes; cement copper (precipitated copper)						
7401.10	Copper mattes	Free	Free	Free	0.1¢/kg on copper content	Free	Free
74.03	Refined copper and copper alloys, unwrought						
	Refined copper:						
7403.11	Cathodes and sections of cathodes	Free	Free	Free	0.2%	Free	21 yen/kg
7403.12	Wire-bars	4.0%	Free	Free	0.2%	Free	21 yen/kg
7403.13	Billets	Free	Free	Free	0.2%	Free	21 yen/kg
7403.19	Other						
7403.19.10	Ingots, ingot-bars and slabs	Free	Free	Free	0.2%	Free	21 yen/kg
7403.21	Copper-zinc base alloys (brass)						
7403.21.10	Ingots, ingot-bars, slabs and billets	4.0%	Free	Free	0.2%	Free	21 yen/kg
7403.22	Copper-tin base alloys (bronze)						
7403.22.10	Ingots, ingot-bars, slabs and billets	10.3%	6.5%	Free	0.2%	Free	21 yen/kg
7404.00	Copper waste and scrap						
7404.00.10	Not alloyed	Free	Free	Free	Free	Free	Free
	Alloyed:						
7404.00.21	Copper-zinc base alloys (brass)	4.0%	Free	Free	Free	Free	Free
7405.00	Master alloys of copper	10.3%	6.5%	Free	0.5%-1.2%	Free	6.0%
74.06	Copper powders and flakes						
7406.10	Powders of non-lamellar structure						
7406.10.10	Not alloyed	4.0%	Free	2.0%	3.2%	1.4%	7.2%
7406.20	Powders of lamellar structure; flakes						
7406.20.10	Not alloyed	4.0%	Free	2.0%	1.8%	6.2%	7.2%
74.07	Copper bars, rods and profiles						
7407.10	Of refined copper						
	Unworked:						
7407.10.11	Bars and rods, of a maximum cross-sectional dimension not exceeding 12.7 mm	4.5%	3.0%	2.2%	0.6%-3.7%	6.0%	7.2%
	Of copper alloys:						
7407.21	Of copper-zinc base alloys (brass)						
	Unworked:						
7407.21.11	Bars and rods, of a maximum cross-sectional dimension not exceeding 12.7 mm	4.5%	3.0%	Free	Free	6.0%	7.2%
7407.21.12	Bars and rods, of a maximum cross-sectional dimension exceeding 12.7 mm; profiles	4.0%	Free	Free	Free	6.0%	7.2%
74.08	Copper wire						
	Of refined copper:						
7408.11	Of which the maximum cross-sectional dimension exceeds 6 mm						
	Not exceeding 12.7 mm:						
7408.11.11	Not coated or covered	4.5%	3.0%	2.2%	0.6%-2.4%	6.0%	7.2%
	Exceeding 12.7 mm:						
7408.11.21	Not coated or covered	4.0%	Free	2.0%	0.6%-2.4%	6.0%	7.2%
74.09	Copper plates, sheets and strip, of a thickness exceeding 0.15 mm						
	Of refined copper:						
7409.11	In coils						
7409.11.10	Unworked	4.0%	Free	2.0%	0.6%-4.0%[2]	6.0%	6.5%
7409.19	Other						
7409.19.10	Unworked	4.0%	Free	2.0%	0.6%-2.8%[2]	6.0%	6.5%
	Of copper-zinc base alloys (brass):						

TARIFFS (cont'd)

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
7409.21	In coils						
7409.21.10	Unworked	4.0%	Free	2.0%	1.1%[2]	6.0%	6.0%
7409.29	Other						
7409.29.10	Unworked	4.0%	Free	2.0%	1.1%[2]	6.0%	6.0%
74.10	Copper foil (whether or not printed or backed with paper, paperboard, plastics or similar backing materials) of a thickness (excluding any backing) not exceeding 0.15 mm						
	Not backed:						
7410.11	Of refined copper						
7410.11.10	Unworked	4.0%	Free	2.0%	0.6%[3]	6.5%	6.0%
74.11	Copper tubes and pipes						
7411.10	Of refined copper						
7411.10.10	Unworked	4.0%	Free	2.0%	0.9%	6.0%	6.5%
	Of copper alloys:						
7411.21	Of copper-zinc base alloys (brass)						
7411.21.10	Unworked	4.0%	Free	2.0%	0.8%	6.0%	6.5%
74.12	Copper tube or pipe fittings (for example, couplings, elbows, sleeves)						
7412.10	Of refined copper	10.3%	6.5%	5.1%	6.7%	6.5%	5.8%
7412.20	Of copper alloys	10.3%	6.5%	5.1%	1.9%[4]	6.5%	5.8%
7413.00	Stranded wire, cables, plaited bands and the like, of copper, not electrically insulated	10.3%	6.5%	5.1%	2.4%-3.4%[4]	Free-6.5%	7.2%
74.15	Nails, tacks, drawing pins, staples (other than those of heading No. 83.05) and similar articles, of copper or of iron or steel with heads of copper; screws, bolts, nuts, screw hooks, rivets, cotters, cotter-pins, washers (including spring washers) and similar articles, of copper						
7415.10	Nails and tacks, drawing pins, staples and similar articles	10.3%	6.5%	5.1%	3.0%	6.5%	5.8%
	Other threaded articles:						
7415.31	Screws for wood	10.2%	6.5%	5.1%	3.3%[4]	4.9%	5.8%

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States 1992; Official Journal of the European Communities, Vol. 35, No. L268, 1992, "Conventional" column; Customs Tariff Schedules of Japan, 1992.
[1] GATT rate is shown; lower tariff rates may apply circumstantially. [2] Certain copper plates, sheets and strip originating in Canada are free of duty.
[3] Worked foil of refined copper originating in Canada is free of duty. [4] Equipment, originating in Canada, intended for use in the repair or maintenance of certain motor vehicles is subject to accelerated staged rate reductions.

TABLE 1. CANADA, COPPER PRODUCTION AND TRADE, 1991 AND 1992P

Item No.		1991		1992P	
		(tonnes)	($000)	(tonnes)	($000)
SHIPMENTS[1]					
	Nova Scotia	x	x	–	–
	New Brunswick	10 476	28 356	15 597	43 206
	Quebec	113 931	308 370	92 114	255 167
	Ontario	261 899	708 862	258 547	716 205
	Manitoba	54 875	148 525	60 581	167 816
	Saskatchewan	x	x	120	332
	British Columbia	338 642	916 578	317 729	880 148
	Yukon	–	–	–	–
	Northwest Territories	–	–	–	–
	Total	780 362	2 112 152	744 687	2 062 873
	Refinery output	538 339	. .	545 000	. .
EXPORTS				**(Jan.-Sept.)**	
2603.00.10	Copper ores and concentrates				
	Copper content				
	Japan	255 091	518 626	169 213	334 110
	Spain	25 189	53 130	13 910	29 103
	Philippines	22 997	47 829	11 894	22 465
	South Korea	11 615	25 320	10 632	20 649
	Other countries	9 692	18 820	26 649	45 659
	Total	324 584	663 728	232 298	451 986
2604.00.10, 2607.00.10, 2608.00.10	Other ores and concentrates				
	Copper content				
	United States	273	448	7 077	15 086
	Japan	1 012	1 545	2 605	2 999
	Total	1 285	1 993	9 682	18 085
2825.50	Copper oxides and hydroxides				
	United States	1	4	–	–
	Total	1	4	–	–
2833.25	Copper sulphates	2 807	2 977	1 129	1 075
7401.10	Copper mattes				
	Norway	21 200	55 144	11 778	28 118
	United Kingdom	1 011	2 753	630	1 422
	Total	22 211	57 897	12 408	29 541
7403.11 to 7403.19	Refined copper				
	United States	195 989	531 363	175 288	479 176
	United Kingdom	53 644	145 178	37 340	103 306
	Italy	27 553	77 294	26 643	71 883
	Netherlands	41 620	117 223	14 267	38 529
	Sweden	13 839	37 261	7 318	20 116
	Other countries	45 340	126 080	29 826	81 009
	Total	377 985	1 034 399	290 682	794 019
7403.21 to 7403.29	Other copper alloys				
	United States	78	255	18	70
	Guyana	–	–	15	34
	Switzerland	–	–	. . .	15
	Other countries	158	480	9	35
	Total	236	735	42	154

TABLE 1 (cont'd)

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
7404.00	Copper waste and scrap				
	United States	73 490	153 023	65 424	138 811
	People's Republic of China	2 155	3 071	3 151	2 857
	Hong Kong	1 005	1 013	1 111	1 733
	South Korea	4 363	10 371	826	1 687
	India	1 260	2 188	806	1 347
	Other countries	4 045	9 145	1 448	2 401
	Total	86 318	178 811	72 766	148 836
7405.00	Master alloys of copper				
	Spain	–	–	...	2
	Total	–	–	...	2
7406.10, 7406.20	Copper powders and flakes				
	United States	88	670	43	405
	Taiwan	38	367	39	349
	South Korea	13	187	10	153
	Venezuela	1	10	5	51
	Other countries	51	336	22	234
	Total	191	1 570	119	1 192
7407.10 to 7407.29	Copper and copper alloy rods and profiles				
	United States	5 288	22 791	4 768	18 830
	Ireland	–	–	312	875
	Venezuela	...	2	49	140
	Other countries	517	1 571	2	10
	Total	5 805	24 364	5 131	19 855
7408.11 to 7408.29	Copper and copper alloy wire				
	United States	674	2 758	4 576	14 791
	Chile	97	599	7	61
	Other countries	107	359	8	83
	Total	878	3 716	4 591	14 935
7409.11 to 7410.22	Copper and copper alloy plates, sheets, strip and foil				
	United States	8 764	34 404	6 740	26 592
	Saudi Arabia	589	2 427	563	2 308
	Taiwan	51	219	218	934
	United Kingdom	119	493	78	332
	Other countries	132	567	17	89
	Total	9 656	38 110	7 616	30 255
7411.10 to 7411.29	Copper and copper alloy tubes and pipes				
	United States	7 447	38 833	5 483	29 599
	Israel	1 321	5 001	945	3 569
	Other countries	397	2 057	171	971
	Total	9 165	45 891	6 599	34 139
7412.10, 7412.20	Copper and copper alloy tube and pipe fittings				
	United States	..	5 222	..	8 671
	Spain	..	2 798	..	6 797
	Germany	..	11 433	..	6 042
	Other countries	..	1 554	..	3 830
	Total	..	21 007	..	25 340

TABLE 1 (cont'd)

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
7413.00	Stranded wire, cables, plaited bands and the like, of copper, not electrically insulated				
	United States	6	145	35	390
	Netherlands	3	11	3	20
	Other countries	32	52	...	2
	Total	40	208	38	412
7414.90, 7415.10 to 7415.39, 7416.00, 7419.10 to 7419.99	Cloth, fasteners and other items of copper				
	United States	..	8 241	..	7 315
	Saudi Arabia	–	–	..	1 239
	Malaysia	..	13 561	..	487
	Thailand	..	23	..	74
	Taiwan	..	31	..	40
	Other countries	..	820	..	115
	Total	..	22 676	..	9 270
IMPORTS[2]					
2603.00.00.10	Copper ores and concentrates				
	Copper content				
	Indonesia	–	–	26 660	57 292
	United States	39 014	82 177	22 996	50 497
	Portugal	19 312	36 970	8 263	15 753
	Other countries	10 090	11 920	5 139	8 716
	Total	68 416	131 070	63 058	132 261
2604.00.00.10, 2608.00.00.10	Other ores and concentrates				
	Copper content				
	Total	1 527	3 666	969	1 497
2825.50	Copper oxides and hydroxides	507	2 141	504	1 890
2833.25	Copper sulphates	3 967	3 524	2 295	2 219
7401.10	Copper mattes	4	17	–	–
7403.11 to 7403.19	Refined copper and copper alloys, unwrought				
	Refined copper				
	Total	2 321	7 351	6 023	17 465
7403.21 to 7403.29	Refined copper and copper alloys, unwrought				
	Other copper alloys				
	Total	3 534	10 894	2 743	8 518
7404.00	Waste and scrap, copper or copper alloy				
	United States	47 399	64 992	31 118	39 344
	U.S.S.R. (former)	163	273	152	214
	Taiwan	20	45	87	129
	Other countries	105	202	230	468
	Total	47 687	65 512	31 587	40 155
7405.00	Master alloys of copper	61	252	27	108
7406.10, 7406.20	Copper powders and flakes				
	Total	1 303	5 519	864	4 324

TABLE 1 (cont'd)

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
IMPORTS(cont'd)					
7407.10 to 7407.29	Bars, rods and profiles of refined copper				
	United States	19 416	58 545	20 061	61 583
	Poland	268	640	1 416	3 269
	Japan	1 344	4 092	332	974
	Germany	185	957	163	800
	United Kingdom	165	823	131	633
	New Zealand	248	859	166	569
	Other countries	1 747	4 963	524	1 523
	Total	23 373	70 881	22 793	69 351
7408.11 to 7408.29	Copper and copper alloy wire				
	Total	9 410	34 946	6 917	26 866
7409.11 to 7409.90, 7410.11 to 7410.22	Copper and copper alloy plates, sheets, strip and foil				
	Total	15 181	59 237	12 384	50 201
7411.10	Pipes and tubes, refined copper	8 568	31 400	4 578	19 791
7411.21	Pipes and tubes, copper-zinc base alloy	2 511	14 449	2 177	11 998
7411.22	Pipes and tubes, copper-nickel base alloy or copper-nickel-zinc base alloy	202	1 604	122	986
7411.29	Plates and tubes, copper alloy, n.e.s.	246	1 560	291	1 542
7412.10	Fittings, pipe or tube, of refined copper	1 093	7 787	981	8 458
7412.20	Fittings, pipe or tube, copper alloy	3 949	26 725	3 228	24 034
7413.00	Stranded wire, cable, plaited bands and the like, of copper, not electrically insulated	3 107	13 119	2 866	12 712
7414.90	Cloth, grill and netting of copper wire and expanded metal of copper	77	499	46	307
7415.10	Nails, tacks, drawing pins, staples and similar articles of copper or of iron or steel with copper heads	135	672	73	478
7415.21	Washers, copper, including spring washers	..	1 001	..	806
7415.29	Articles of copper, not threaded, n.e.s., similar to those of headings 7415.10 and 7415.21	..	869	..	695
7415.31	Screws, copper, for wood	..	211	..	213
7415.32	Screws, bolts and nuts of copper, excluding wood screws	..	2 927	..	2 236
7415.39	Articles of copper, threaded, n.e.s., similar to bolts, nuts and screws	..	1 584	..	843
7416.00	Copper springs	..	34	..	77
7419.10	Chain and parts thereof of copper	..	478	..	334
7419.91	Articles of copper, not further worked than cast, moulded, stamped or forged	758	4 869	245	1 549
7419.99	Articles of copper, n.e.s.	..	23 942	..	20 393

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available or not applicable; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified; p Preliminary; x Confidential.
1 Anode copper recovered in Canada from domestic concentrates plus exports of payable copper in concentrate and matte.
2 Imports from "other countries" may include re-imports from Canada.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, COPPER PRODUCTION, TRADE[1] AND CONSUMPTION, 1975, 1980, AND 1985-92

	Production		Exports			Imports	Consumption[3]
	Shipments[2]	Refinery Output	Concentrates and Matte	Refined	Total	Refined	Refined
				(tonnes)			
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
1985	738 637	499 626	320 619	280 033	600 652	19 131	222 466
1986	698 527	493 445	341 390	306 822	648 212	20 901	225 586
1987	794 149	491 124	381 126	288 800	669 926	16 583	231 288
1988	758 478	528 723	348 404	268 680	617 084	4 659	236 280
1989	704 432	515 216	348 739r	321 690	670 429r	4 408	218 571
1990	771 433	515 835	374 875	335 941	710 816	2 611r	184 497r
1991	780 362	538 339	348 080	377 985	726 065	2 321	185 055
1992p	744 687	545 000	254 388a	290 682a	545 070a	6 023a	177 023

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; r Revised.
a January to September 1992.
1 Beginning in 1988, Exports and Imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. 2 Anode copper recovered in Canada from domestic concentrate plus exports of payable copper in concentrates and matte. 3 Producers' domestic shipments of refined copper plus imports of refined shapes.

TABLE 3. WESTERN WORLD PRODUCTION OF RECOVERABLE COPPER IN CONCENTRATES, 1991 AND 1992

	1991	1992[e]
	(000 t)	
Chile	1 814	1 925
United States	1 634	1 750
Canada[1]	780	745
Zaire	292	180
Zambia	412	435
Peru	375	370
Australia	320	315
Mexico	267	275
Philippines	148	115
Papua New Guinea	205	205
Indonesia	212	295
Other	934	990
Total	7 393	7 600

Sources: Energy, Mines and Resources Canada; World Bureau of Metal Statistics.
[e] Estimated.
[1] Data are for shipments.

TABLE 4. WESTERN WORLD PRODUCTION OF REFINED COPPER,[1] 1991 AND 1992

	1991	1992[e]
	(000 t)	
United States	1 995	2 150
Chile	1 228	1 330
Japan	1 076	1 155
Canada	538	545
Germany	522	565
Zambia	424	460
Belgium	298	320
Australia	279	285
Peru	244	250
Other	1 921	1 665
Total	8 525	8 900

Sources: Energy, Mines and Resources Canada; World Bureau of Metal Statistics.
[e] Estimated.
[1] Includes primary, secondary and electrowon copper.

TABLE 5. WESTERN WORLD CONSUMPTION OF REFINED COPPER, 1991 AND 1992

	1991	1992e
	(000 t)	
United States	2 058	2 231
Japan	1 613	1 435
Germany	995	1 040
Italy	471	525
France	481	480
Belgium	372	350
United Kingdom	269	310
South Korea	343	350
Canada	185	177
Taiwan	399	425
Brazil	171	140
Other	1 611	1 637
Total	8 968	9 100

Sources: Energy, Mines and Resources Canada; World Bureau of Metal Statistics.
[e] Estimated.

TABLE 6. COPPER AND COPPER-NICKEL SMELTERS IN CANADA, 1992

Company and Location	Product	Rated Annual Capacity	Remarks
		(tonnes of concentrates)	
Falconbridge Limited Falconbridge, Ontario	Copper-nickel matte	600 000	Copper-nickel concentrate processed in fluid bed roasters and electric furnaces; 1800-t/d 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	500 000	Oxygen flash-smelting of copper sulphide concentrates. Copper converters produce blister copper. Through flotation separation of copper-nickel in Bessemer matte, copper sulphides returned for additional blister copper production.
Falconbridge Limited Timmins, Ontario	Molten "blister" copper	440 000	Mitsubishi-type smelting, separation and converting furnaces, acid plant and oxygen plant to treat continuous copper concentrate feed stream to yield molten 99% pure copper.
Noranda Inc. Horne smelter Noranda, Quebec	Copper anodes	770 000[a]	One continuous Noranda process reactor, five converters and acid plant. Treats concentrates from Noranda's mining operations in Quebec and Ontario as well as custom concentrates and scrap.
Noranda Inc. Gaspé smelter Murdochville, Quebec	Copper anodes	221 500[a]	Green charge reverberatory furnace, two converters, rotary anode furnace and an acid plant. Treats Gaspé and custom concentrates and scrap.
Hudson Bay Mining and Smelting Co., Limited (HBMS) Flin Flon, Manitoba	Copper anodes	320 000	Five roasting furnaces, one reverberatory furnace and three converters. Company treats its own copper concentrate as well as custom copper concentrates; zinc plant residues and stockpiled zinc plant residues fed to reverberatory furnace. Project under way to replace concentrate roasting and calcine smelting with Noranda continuous converter technology.

Source: Data provided by each company.
[a] Concentrate and copper scrap.

TABLE 7. COPPER REFINERIES IN CANADA, 1992

Company and Location	Rated Annual Capacity	Remarks
	(tonnes)	
Noranda Inc. Division CCR East Montréal, Quebec	350 000	Refines anodes from Noranda's Horne and Gaspé smelters, from the Flin Flon smelter, and also from purchased scrap and blister. Precious metals, selenium and tellurium recovered from slimes.
Inco Limited Copper Cliff, Ontario	170 000	Casts and refines anodes from molten converter copper from the Copper Cliff smelter; also refines purchased scrap. Gold, silver, selenium and tellurium cake recovered from anode slimes, which are further processed at Port Colborne to recover platinum metals concentrates. Recovers and electrowins copper from Copper Cliff nickel refinery residue.
Falconbridge Limited Timmins, Ontario	95 000	Refines anode from the Kidd Creek smelter.
Gibraltar Mines Limited McLeese Lake, British Columbia	5 000	Dissolved copper-in-solution from heap leaching operations is treated in a solvent extraction plant and then electrowinned to produce copper cathode.

Source: All data provided by the companies.

TABLE 8. SUPPLY OF WIRE MILL, BRASS MILL, FOUNDRY AND POWDER PRODUCTS, AND THEIR CONSUMPTION IN END-USE MARKETS, 1990 AND 1991

United States	1990		1991p	
	(000 t)	(% of total)	(000 t)	(% of total)
SUPPLY				
Domestic mill products				
Building wire	519	17.5	456	16.6
Magnet wire	228	7.7	230	8.4
Communication wire and cable	276	9.3	262	9.5
Power cable	142	4.8	114	4.2
Automotive wire and cable	103	3.5	98	3.6
Other wire and cable	202	6.8	197	7.2
Strip, sheet, plate and foil	404	13.6	389	14.2
Rod and bar	390	13.2	387	14.1
Tube and pipe	372	12.6	361	13.2
Mechanical wire	30	1.0	30	1.1
Foundry products	195	6.6	188	6.8
Powder products	17	0.6	16	0.6
Total	2 880	97.3	2 728	99.4
Imported mill products	81	2.7	17	0.6
Total supply	2 961	100.0	2 745	100.0
USES				
Building construction	1 215	41.0	1 111	40.5
Electrical/electronic products	725	24.5	670	24.4
Industrial machinery/equipment	407	13.7	370	13.5
Transportation equipment	336	11.3	317	11.5
Consumer and general products	278	9.4	277	10.1
Total	2 961	100.0	2 745	100.0

Source: Copper Development Association Inc.
p Preliminary.
Note: Percentages may not add due to rounding.

TABLE 9. YEARLY AVERAGE COPPER PRICES[1]

Year	LME
	(current US¢/lb)
1980	99.3
1981	79.5
1982	67.2
1983	72.2
1984	62.6
1985	64.9
1986	62.3
1987	80.1
1988	118.0
1989	129.0
1990	121.1
1991	106.2
1992	103.7

Source: Metals Week.
[1] Settlement price for highest grade of copper sold.

TABLE 10. MONTHLY AVERAGE COPPER PRICES, 1991 AND 1992

	LME[1]		COMEX[2]	
	1991	1992	1991	1992
	(current US¢/lb)			
January	111.0	97.0	110.6	96.2
February	111.0	100.0	110.7	100.5
March	109.6	101.0	109.1	101.6
April	112.1	100.5	108.4	100.3
May	104.5	100.5	101.1	100.6
June	100.6	104.3	99.7	104.7
July	101.4	114.3	99.9	113.7
August	101.3	114.4	101.5	112.3
September	105.4	109.5	106.9	107.4
October	107.2	102.0	106.9	100.1
November	107.9	97.9	105.3	96.2
December	100.8	100.1	98.3	99.1

Source: Metals Week.
[1] LME cash price for Grade A copper. [2] COMEX First Position Grade A price.

Diamonds

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SUMMARY

World production of natural rough diamonds in 1991, the latest year for which statistics are available, was close to 105 million carats (ct) with an estimated value of some US$5.2 billion, or US$50/ct.

Currently, Canada is not a producer of natural or synthetic diamonds, and diamonds have never been mined in Canada. However, Canada's potential to become a producer looks good and several companies were involved in exploration activities in Canada during the year, particularly in the Northwest Territories, but also in Alberta, Saskatchewan, Manitoba, Ontario and Quebec.

The year was marked by the following events: the world recession that started in the late 1980s continued to negatively affect the sales of gem-quality diamonds, especially in Japan; the opening of the new Venetia mine (6 million ct/y capacity) in South Africa; the development of the Jubilee mine and preparation to develop the Arkhangelsk project in Russia; deep-sea mining developments in Namibia; the closure of mines in Guinea and Indonesia; and production cutbacks announced at year-end in Namibia, South Africa, Australia and Russia.

CANADIAN DEVELOPMENTS

A large area of northern and central Canada is underlain by a huge craton (part of the earth's crust and upper mantle that has attained stability and has been little deformed for a prolonged period of time), segments of which are very old, that forms the nucleus of the North American continent. The study of the global distribution of diamond-bearing rocks, known as kimberlites, shows that these rocks are mainly confined to ancient cratons such as the one found in Canada. Also, diamond-indicator minerals[1] and diamonds have been found in glacial deposits in numerous localities in Canada. These observations lead us to believe that, given sufficient time and funds for exploration, the chances of discovering diamonds in Canada in commercial quantities are good.

In 1992, several companies were involved in exploration activities, particularly in the Northwest Territories, but also in Alberta, Saskatchewan, Manitoba, Ontario and Quebec. The major international companies involved in exploration work were De Beers Consolidated Mines Limited of South Africa, through its Canadian subsidiary Monopros Limited, Kennecott Canada Inc. (the U.S. arm of RTZ of Britain), and BHP Minerals Ltd. of Australia in association with Dia Met Minerals Ltd. Companies such as Cominco Ltd., Teck Corporation, Cameco Corporation, Uranerz Exploration and Mining Limited, Aber Resources Ltd., SouthernEra Resources Ltd., Ashton Mining, KWG Resources Inc., and many others, were also involved.

WORLD PRODUCTION

Natural Diamonds

World production of natural rough diamonds in 1991, the latest year for which statistics are available, was close to 105 million ct with an estimated value of some US$5.2 billion, or US$50/ct. Of this amount, 56 million ct consist of low-value ($0.50-5.00/ct) industrial diamonds, 35 million-40 million ct are near-gem-quality diamonds ($5-50/ct); and 15 million-20 million ct are gem-quality diamonds. In terms of value, gem diamonds represented between 75% and 80% of world production, near-gems accounted for close to 20%, and industrial diamonds accounted for 2%-5%. World production of natural diamonds grew from 55 million ct/y in 1983 to close to 105 million ct/y in 1991. This growth, mainly by Japan during the 1980s, represents an increase of about 6 million ct/y. Natural diamonds are produced by some 20 countries,

[1] Subcalcic high-chrome garnet, chrome diopside, high-magnesia ilmenite, and high-chrome chromite.

but close to 95% of world production by **weight** comes from only five countries: Australia (36 million ct), Zaire (20 million ct), Botswana (18 million ct), Russia (15 million ct) and South Africa (8.4 million ct). However, in terms of **value**, Botswana, Russia and South Africa are, in decreasing order, the most important diamond-producing countries, representing close to 65% of world production.

The quantity of diamonds in the ore (grade) varies widely from one mine to another but, generally, the grade falls between 0.3 and 1.3 ct/t. Grades as low as 0.05 ct/t and as high as 7.0 ct/t have been exploited. Gem-quality and near-gem-quality diamonds represent 30% by weight of the production in Ghana, 40% in Liberia, 50% in Australia, 70% in Botswana, 93% in Guinea, and 95% in Namibia.

Synthetic Diamonds

Synthetic diamonds compete with natural industrial diamonds as an abrasive mineral and as a cutting material; they compete mainly with silicon carbide (SiC) and alumina (Al_2O_3), but also with cubic boron nitride (CBN) as manufactured abrasive materials. World production of synthetic diamonds in 1991 is estimated by the U.S. Bureau of Mines at 360 million ct/y. Synthetic diamonds have been produced commercially since the late 1950s; they were invented in Sweden in 1953. The production of synthetic diamonds is labour-intensive and, contrary to SiC and alumina, their production is not electricity-intensive. In 1992, synthetic diamonds were produced in at least 16 countries. The most important producing countries were, in decreasing order, the United States, the C.I.S., China, Ireland, South Africa, Japan and Sweden. Smaller plants exist in Czechoslovakia, Yugoslavia, Romania, France, England, Korea and Greece. New plants were built in recent years in the United States, England and Korea. Leading producers are De Beers (South Africa), General Electric (United States), and Tomei (Japan). The consumption of synthetic diamonds is reported to be growing at some 10%/y. Although it is an expensive product compared to SiC and Al_2O_3, synthetic diamonds are more cost effective because they cut much faster and last much longer. In many applications, synthetic diamonds are preferred to natural industrial diamonds because they can be tailored to the customer's needs.

It is reported that Japan is at the forefront of the conversion of traditional abrasives (SiC and Al_2O_3), to super-abrasives[2] as 60% of all abrasive products used in Japan have diamond components. Currently, 40% of abrasives used in Europe and 20% in North America are super-abrasives. In Canada, the gradual conversion from traditional abrasives to newer and better-performing super-abrasives is slowly eroding our markets. As a producer of traditional abrasives, Canada is negatively affected by the trend. Although Canada is an important consumer of synthetic diamonds, it is still not a producer.

Canadian Trade and Consumption

Canada's imports of gem-quality diamonds and industrial diamonds were valued at $211 million in 1990 and $189 million in 1991; some 90% of the imports is estimated to be gem-quality diamonds. Imports of synthetic diamond dust or powder were 5.92 million ct valued at $4.64 million in 1990, and 7.36 million ct valued at $4.45 million in 1991.

Diamond Cutting (Manufacturing)

Natural diamonds are cut in some 32 countries. The major diamond-cutting centres in the world are Antwerp, Belgium; Tel Aviv and Ramat-Gan, Israel; New York City, United States; and Bombay, India. With the exception of India, which is a very small producer of diamonds, none of these countries mines diamonds. Other countries with important cutting centres are South Africa and the C.I.S. Newcomers include Australia, Thailand, China, Botswana, Sri Lanka, Indonesia and Malaysia. At year-end, it was reported that a new venture had been formed between an Israeli company and a company in Yakutia, a republic within the Russian Federation, to start cutting diamonds in Yakutia.

Diamond manufacturing is labour-intensive and, unless a factory is highly automated, it is not capital-intensive. Because of high labour costs, factories in the United States usually cut bigger and better-quality diamonds. Belgium and Israel are in the middle of the labour-cost spectrum and, as such, they are generally involved in cutting stones of intermediate size and quality. India, with its low labour costs, cuts the smallest and least expensive diamonds. Employment related to diamond cutting varies widely from factory to factory (from 1 to 1000 workers). It also varies widely from country to country (i.e., fewer than 500 cutters in the United States, close to 10 000 in the C.I.S., and over 700 000 in India). The major steps in diamond manufacturing

[2] Includes mainly synthetic and natural diamonds, but also cubic boron nitride (CBN), and polycrystalline synthetic diamond shapes (PDS) and compacts (PDC).

are: sawing (to remove flawed areas of the stone) with a saw and diamond dust, cutting with a laser, or cleaving; rounding, also called "bruting," "shaping" or "girdling" (to round the corners); facetting; brillianteering; and polishing.

VALUATION AND SALES PROCEDURES

Rough Diamonds

About 80% by weight of the rough diamonds produced in the world are marketed by De Beers through its Central Selling Organization (CSO). The valuation of rough mined diamonds is very complex and, according to the industry, diamonds are classified into over 5000 categories. Roughs are first sieved and sized. The stones are then separated into gems and near-gems. Gems are classified according to their shape (sawables "can be sawn with a diamond saw," and makeables "must be cleaved by hand"), clarity (five categories), and colour (five grades that are sub-divided into categories). Gems usually have a yield (weight of cut and polished stone/weight of rough) of 40%-50%.

Near-gems are roughs, with substantial impurities and other defects, which have low yield, usually of only 15%-25% and, depending on market conditions and labour costs, may or may not be cut and polished to produce a finished gem. Near-gems are divided into three basic categories: rejection #1, rejection #2, and rejection #3; these are further divided into cubes, and cleavage, which are chips (small and larger sizes). These pieces are taken from clean portions of a stone that can be sawn or cleaved off and polished into a gem. After classifying the gems and near-gems, coated (frosted) stones are classified. Often, the value of these stones can only be guessed at because it is impossible to see inside the stone to determine its quality.

The CSO has been very successful in maintaining a balance between the supply and demand for rough diamonds for some 60 years. It buys surplus production of rough diamonds from mines and stockpiles in periods of weak demand in the jewellery market and sells off its stockpiled roughs as demand picks up. De Beers can also apply production quotas to major producers when sales fall.

Rough diamonds are released into the market in a controlled way (to maintain a balance between the supply and demand of different quality diamonds) by the CSO at "sights" that are held about every five weeks in Europe (London and Lucerne) and South Africa to about 160 carefully chosen buyers known as "sightholders." The majority of the sightholders are manufacturers that cut and polish the stones in their factories, although some wholesale firms that deal in rough diamonds also attend the sights. Once the stones are cut and polished, they are sold to diamond merchants or wholesalers. Finally, the diamonds are sold to retailers and jewellers.

Cut and Polished Diamonds

To determine the value of a diamond, an appraiser looks at a combination of all of the four Cs: cut, colour, clarity and carat (weight).

Cut

The cut of a diamond is the most important. The cut quality of a diamond is not determined by its shape (round, pear shape, heart shape, etc.), nor by the number of facets. It is determined by the relative proportions of the table size, crown height, and the pavilion depth of the diamond, which determine brilliancy (i.e., the amount of light reflected through the stone), and by the angles of the facets, which determine the dispersion of light that creates the fiery rainbow colours.

Colour

The rarest and best colour in diamonds is no colour at all. The colour grade is a measure of the amount of colour present in a diamond. Most diamonds have a tinge of some colour (most often yellow or brown).

Clarity

This is a measure of the number of flaws (inclusions and imperfections). Inclusions are crystals of other minerals; imperfections are feathers, blemishes, cracks, etc.

Carat

One carat is equivalent to 0.2 g. A carat is normally divided into 100 points. Because larger diamonds are rare, a 1-carat diamond will cost more than a cluster of 20 diamonds weighing a total of 1 carat.

USES

Gem-quality diamonds are used mainly in jewellery. Credit Lyonnais Laing reports that the three major markets for diamond jewellery are the United States (30%), Japan (30%), and Europe (17%). Since a considerable proportion of rough stones are lost during cutting and polishing, only about 12%-15% by weight of the rough stones mined end up in jewellery.

Diamonds, both natural and synthetic, are the hardest substance known to man. They are used in equipment that drills, cuts, grinds and polishes rocks (such as granite and marble), other materials (such as nonferrous metals, carbon fibre and composites), and nonmetallic materials (like glass, refractories, ceramics, concrete, plastics, masonry bricks, etc.). Natural and man-made diamonds are also widely used in the automotive, high-technology and aerospace industries. Synthetic diamonds have certain advantages, from an environmental perspective, over conventional abrasive products, especially aluminum oxide.

PRICES

In 1991, published average mine prices of rough diamonds, including gem, near-gem and industrial diamonds, varied widely by country from US$6/ct in Australia, to US$27/ct in Zaire, US$67/ct in Botswana, US$95/ct in Russia, US$105/ct in South Africa, US$157/ct in Angola, US$208/ct in Sierra Leone, US$300/ct in Guinea, and US$315/ct in Namibia. The mines in South Africa produced roughs that varied in prices from US$60/ct to $300/ct. It is reported that the prices of rough diamonds have increased about 1800% during the past 42 years, which means that a rough diamond that sold for US$100 in 1949 would sell for about $1800 in 1991. By comparison, a consumer item costing US$100 in 1949 would sell for about $590 in 1991.

Prices of U.S. cut diamonds, by size and quality, are shown in Table 3. The average U.S. wholesale asking price of the top 25 grades (D through H colour, and IF through VS2 clarity) of a 1-carat diamond was US$7300 at the end of 1991. It is estimated that, taking into account losses during cutting and polishing, as well as commissions paid to intermediaries between the mine and the jeweller, the retail price of a diamond in jewellery is five to six times the price of the rough stone at the mine. Natural industrial diamond grit (40 microns to 1 mm) and powder (–40 microns), synthetic grit and powder, and industrial stones imported into the United States in 1991 were valued at US$0.63/ct, US$0.74/ct, and US$6.94/ct, respectively. There are hundreds of types of synthetic diamonds, and synthetic diamonds can be coated with metals, such as copper or nickel, for specific applications. The prices of synthetic diamonds vary widely from $0.20/ct for friable material with irregular shapes to $1-$2/ct for polishing material, to several dollars per carat for blocky, regular shapes with excellent crystal structure.

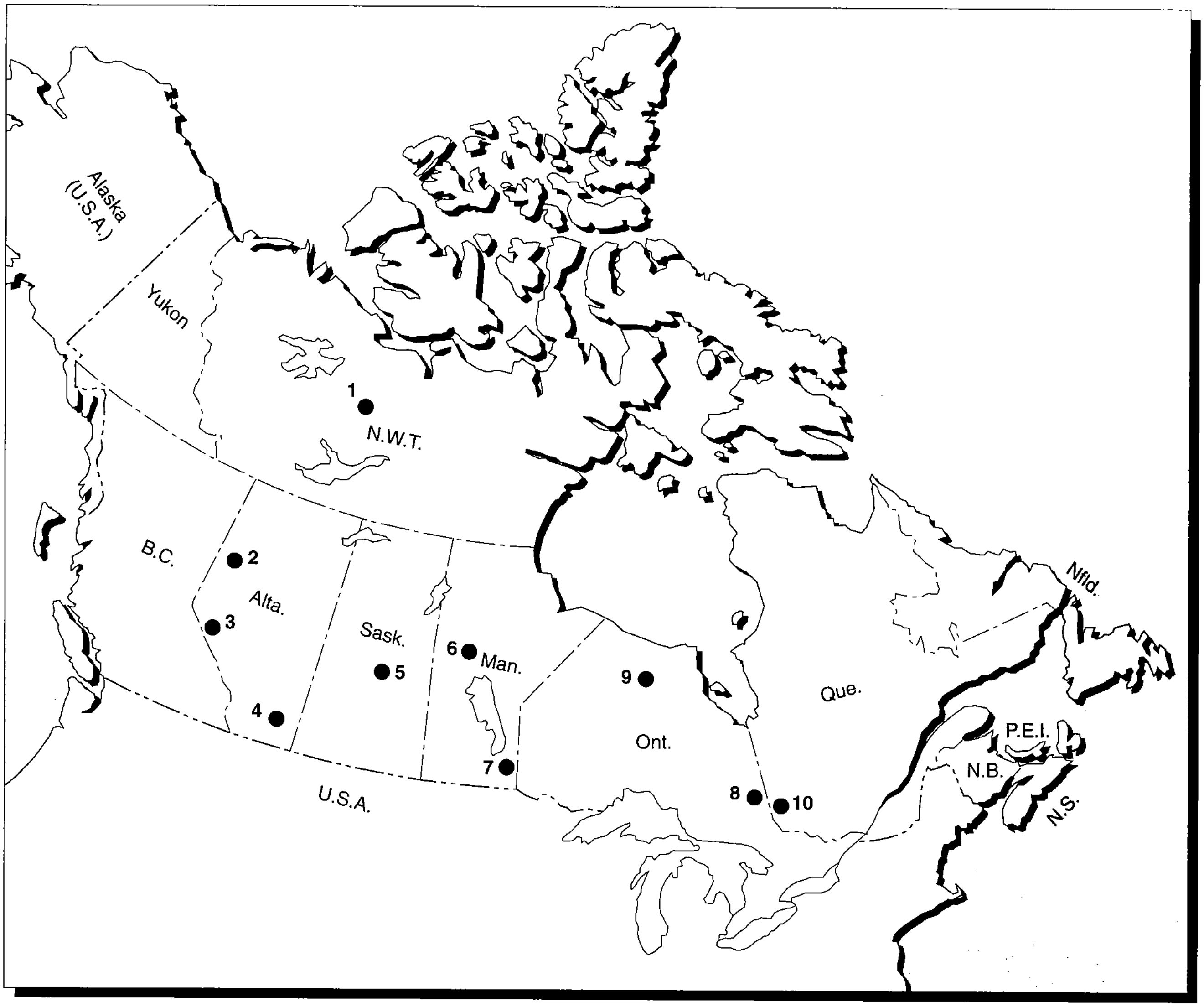
OUTLOOK AND PRODUCTION FORECAST

Currently, the demand for natural diamonds is weak as a result of the world recession, and smaller diamonds, rather than the larger ones, are being purchased for use in jewellery. World sales are not expected to increase substantially during the next couple of years; however, industry sources predict that by the mid-to-late 1990s, consumption of diamonds should increase as Western economies recover and as sales in Southeast Asian countries increase due to their rapidly growing economies. After the year 2000, sales to Eastern Europe are expected to pick up. Johnson, Marriott & von Saldern estimate that, by the year 2000, world production of natural diamonds will vary from 84 million ct/y to 136 million ct/y, with a best estimate of 113 million ct/y.

Note: Information in this review was current as of February 1, 1993.

Figure 1

Major Diamond Exploration Areas in Canada, 1992



Numbers refer to locations on map above.

1. Lac de Gras
2. Peace River
3. Jasper
4. Badlands
5. Prince Albert
6. Snow Lake
7. Southeastern Manitoba
8. Kirkland Lake
9. James Bay Lowlands
10. Temiscamingue

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
7102.10	Diamonds, unsorted, whether or not worked, but not mounted or set	Free	Free	Free	Free
7102.21	Diamonds, industrial, unworked or simply sawn, cleaved or bruted, but not mounted or set				
7102.21.10	Bort and black diamonds, for borers	Free	Free	Free	Free
7102.21.90	Other	10.2%	6.5%	Free	Free to 0.9%
7102.29	Diamonds, industrial, other, worked, not mounted or set				
7102.29.10	Bort and black diamonds, for borers	Free	Free	Free	Free
7102.29.90	Other	10.2%	6.5%	Free	Free
7102.31	Diamonds, non-industrial, unworked or simply sawn, cleaved or bruted	Free	Free	Free	Free
7102.39	Diamonds, non-industrial, other	Free	Free	Free	Free
7105.10.10	Diamond dust for borers; dust mixed with a carrier in cartridges or in tubes	Free	Free	Free	Free
7105.10.91	Natural diamond dust or powder	10.2%	6.5%	Free	Free
7105.10.92	Synthetic diamond dust or powder	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992.

TABLE 1. CANADA, DIAMOND TRADE, 1990-92

Item No.		1990		1991		Jan.-Sept. 1992p	
		(carats)	($000)	(carats)	($000)	(carats)	($000)
EXPORTS							
7102.10	Diamonds, unsorted, whether or not worked						
	United States	..	56	..	37	..	177
	Total	..	56	..	37	..	177
7102.21	Diamonds, industrial, unworked or simply sawn, cleaved or bruted						
	United States	1 277	10	4 257	30	14 106	98
	Total	1 277	10	4 257	30	14 106	98
7102.29	Diamonds, industrial, n.e.s., excluding mounted or set diamonds						
	United States	13 706	53	5 957	77	5 608	60
	Chile	–	–	15 284	76	–	–
	Total	13 706	53	21 241	154	5 608	60
7102.31	Diamonds, non-industrial, unworked or simply sawn, cleaved or bruted						
	United States	27	28	17	91	525	125
	New Zealand	–	–	103	89	40	40
	Total	27	28	120	180	565	165
7102.39	Diamonds, non-industrial, n.e.s., excluding mounted or set diamonds						
	United States	10 913	7 149	8 967	8 249	10 183	10 541
	Hong Kong	734	282	–	–	108	99
	Luxembourg	–	–	–	–	4	50
	Other countries	282	236	408	104	15	38
	Total	11 929	7 667	9 375	8 355	10 310	10 728
7105.10	Diamond dust or powder						
	United States	393 757	325	102 724	77	340 374	172
	Spain	–	–	–	–	2 000	4
	Other countries	11 155	37	–	–	270	1
	Total	404 912	362	102 724	77	342 644	178
IMPORTS							
7102.10	Diamonds, unsorted, whether or not worked, but not mounted or set						
	Belgium	..	21 275	..	20 464	..	19 033
	Israel	..	11 994	..	12 125	..	9 908
	United States	..	17 447	..	12 355	..	7 098
	India	..	4 309	..	3 911	..	2 782
	Former U.S.S.R.	..	407	..	1	..	931
	Other countries	..	2 835	..	1 200	..	530
	Total	..	58 267	..	50 056	..	40 282
7102.21.10	Diamonds, industrial, bort and black, for borers, unworked or simply sawn, cleaved or bruted, but not mounted or set						
	United States	328 748	1 026	202 273	848	132 493	574
	Zaire	106 974	462	73 676	304	24 209	82
	Ireland	136 405	662	56 382	262	21 223	71
	Austria	–	–	–	–	2 860	28
	Other countries	33 467	177	10 491	98	8 802	34
	Total	605 594	2 327	342 822	1 513	189 587	789
7102.21.90	Diamonds, industrial, other than bort and black, for borers, unworked or simply sawn, cleaved or bruted, but not mounted or set						
	United States	1 878	7	14 621	72	1 776	4
	Ireland	18 100	82	11 000	42	–	–
	Other countries	8 578	26	71	...	–	–
	Total	28 556	117	25 692	115	1 776	4

TABLE 1 (cont'd)

Item No.		1990		1991		Jan.-Sept. 1992p	
		(carats)	($000)	(carats)	($000)	(carats)	($000)
IMPORTS (cont'd)							
7102.29.10	Diamonds, industrial, bort and black, for borers, worked, but not mounted or set						
	Ireland	550 084	2 230	482 671	1 977	518 352	2 410
	United Kingdom	–	–	–	–	55 549	231
	United States	804 789	2 428	157 464	514	53 493	190
	Other countries	27 876	127	4 000	22	7 003	25
	Total	1 382 749	4 785	644 135	2 514	634 397	2 856
7102.29.90	Diamonds, industrial, other than bort and black, for borers, worked, but not mounted or set						
	United States	1 586	15	4 042	38	13 741	91
	Australia	–	–	–	–	334	5
	Zaire	332	11	–	–	235	3
	Other countries	173	2	7 014	26	–	–
	Total	2 091	29	11 056	64	14 310	100
7102.31	Diamonds, non-industrial, unworked or simply sawn, cleaved or bruted, not mounted or set						
	United States	545	136	81	22	50	50
	Belgium	2	1	12	1	10	11
	Other countries	6	4	6	5	–	–
	Total	554	141	99	29	60	61
7102.39.00.10	Diamonds, non-industrial, worked, of a weight not exceeding 0.5 carat each						
	Former U.S.S.R.	22 745	10 718	88 272	20 000	42 949	15 456
	Belgium	47 009	22 133	39 606	20 858	24 350	11 745
	United States	28 680	12 949	30 340	12 541	20 125	10 048
	Israel	19 702	14 700	15 524	11 554	9 248	6 308
	India	10 793	4 025	3 514	1 330	5 374	1 893
	Other countries	4 902	2 579	2 175	1 770	2 480	912
	Total	133 831	67 104	179 431	68 053	104 526	46 362
7102.39.00.20	Diamonds, non-industrial, worked, of a weight exceeding 0.5 carat each						
	Former U.S.S.R.	13 911	21 061	16 315	22 932	17 296	32 121
	Belgium	25 932	21 566	17 723	13 563	14 844	11 149
	United States	9 255	13 799	11 168	7 731	7 161	7 977
	Israel	12 155	12 708	10 319	12 490	6 701	5 095
	India	879	618	2 933	1 033	1 164	632
	Other countries	3 583	3 817	2 398	4 100	1 566	1 582
	Total	65 715	73 569	60 856	61 849	48 732	58 556
7105.10.10	Diamond dust for borers; dust mixed with a carrier in cartridges or in tubes						
	United States	180 849	379	197 789	429	131 590	279
	Denmark	5 832	29	5 258	26	5 749	28
	Other countries	56 289	73	20 969	27	12 008	22
	Total	242 970	484	224 016	483	149 347	329
7105.10.91	Natural diamond dust or powder						
	United States	987	4	2 200	3	1 059	2
	Total	987	4	2 200	3	1 059	2
7105.10.92	Synthetic diamond dust or powder						
	United States	240 748	234	672 500	1 405	652 887	1 273
	Former U.S.S.R.	5 002 407	1 999	6 395 317	1 715	3 933 263	1 096
	Ireland	658 847	2 322	288 442	1 311	185 748	872
	Germany	–	–	6 401	23	45 275	154
	Other countries	26 885	83	–	–	3 683	18
	Total	5 928 887	4 640	7 362 660	4 455	4 820 856	3 416

Source: Statistics Canada.
– Nil; . . Not available or not applicable; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified; p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 2. DIAMONDS, WORLD PRODUCTION, BY TYPE AND COUNTRY,[1] 1990 AND 1991

Country	1990 Gem[2]	1990 Natural industrial	1990 Total	1990 Synthetic[3]	1991[e] Gem[2]	1991[e] Natural industrial	1991[e] Total	1991[e] Synthetic[3]
				(thousand carats)				
Angola[e]	1 215[r]	85[r]	1 300[r]	–	1 215	85	1 300	–
Australia	17 331	17 331	34 662	–	17 978	17 978	35 956[a]	–
Botswana	12 146	5 206	17 352	–	12 000	6 000	18 000	–
Brazil	600[r]	900[r]	1 500[r]	–	600	900	1 500	–
Central African Republic	303[r]	78[r]	381[r]	–	300	70	370	–
China[e]	200	800	1 000	15 000	200	800	1 000	15 000
Ivory Coast[5]	9	3	12	–	11	4	15	–
Czechoslovakia[e]	–	–	–	5 000	–	–	–	5 000
France[e]	–	–	–	4 000	–	–	–	4 000
Ghana[6]	191[r]	446[r]	637[r]	–	210	490	700	–
Greece[e]	–	–	–	1 000	–	–	–	1 000
Guinea[6]	130	5	135[e]	–	85	6	91[a]	–
Guyana	3	5	8	–	3	5	8	–
India	3	12	15[e]	–	3	12	15	–
Indonesia[e]	7	23	30[e]	–	8	24	32	–
Ireland[e]	–	–	–	60 000	–	–	–	60 000
Japan[e]	–	–	–	25 000	–	–	–	30 000
Liberia	40	60	100[e]	–	40	60	100	–
Namibia	745[r]	16[r]	761[r]	–	1 170	24	1 194[a]	–
Romania[e]	–	–	–	4 500	–	–	–	4 500
Sierra Leone[5]	66[r]	12[r]	78[r]	–	175	68	243[a]	–
South Africa, Republic of:								
Finsch Mine	1 462	2 716	4 178	–	1 500	2 500	4 000	–
Premier Mine	724	1 604	2 328	–	700	1 500	2 200	–
Other De Beers' properties[4]	1 240	474	1 714	–	1 200	500	1 700	–
Other	400	88[r]	488[r]	–	400	112	512	–
Total	3 826	4 882[r]	8 708[r]	60 000[e]	3 800	4 612[r]	8 412[r]	60 000
Swaziland	25[r]	17[r]	42[r]	–	18	12	30	–
Sweden[e]	–	–	–	25 000	–	–	–	25 000
Tanzania	59[r]	26[r]	85[r]	–	56	24	80	–
U.S.S.R.[e]	7 500	7 500	15 000	41 000	7 500	7 500	15 000	60 000
United States	–	–	–	W	–	–	–	90 000
Venezuela	88	245	333	–	90	250	340	–
Yugoslavia[e]	–	–	–	5 000	–	–	–	5 000
Zaire	2 914[r]	16 513[r]	19 427[r]	–	3 000	17 000	20 000	–
Total	47 401[r]	54 165[r]	101 566[r]	245 500	48 462	55 924	104 386	359 500

Source: U.S. Bureau of Mines.

– Nil; [e] Estimated; [r] Revised; W Withheld to avoid disclosing company proprietary data.

[a] Reported figure.

[1] Table includes data through May 19, 1992. Total diamond output (gem plus industrial) for each country actually is reported, except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem diamond and industrial diamond are U.S. Bureau of Mines estimates except for Australia (1987), Brazil (1987-90), and Central African Republic (1987-90), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries, is based on the best available data at time of publication. [2] Includes near-gem and cheap-gem qualities. [3] Includes all synthetic diamond production. [4] Other De Beers' Group output from the Republic of South Africa includes Kimberley pool, Koffienfontein, Namaqualand and Venetia mines. [5] Figures are estimates based on reported exports and do not include smuggled diamonds. [6] Figures do not include smuggled artisanal production.

TABLE 3. PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY

Carat Weight	Description Colour[1]	Clarity[2] (GIA Terms)	Price range Per Carat[3] Jan. 1990-Jan. 1991 (dollars)	Average[4] July 1991 (dollars)
0.25	G	VS1	1 400 - 1 400	1 400
.25	G	VS2	1 200 - 1 200	1 200
.25	G	SI1	970 - 970	970
.25	H	VS1	1 200 - 1 200	1 200
.25	H	VS2	1 100 - 1 100	1 100
.25	H	SI1	950 - 950	950
.50	G	VS1	2 700 - 2 700	2 700
.50	G	VS2	2 500 - 2 500	2 500
.50	G	SI1	2 300 - 2 300	2 300
.50	H	VS1	2 600 - 2 600	2 600
.50	H	VS2	2 400 - 2 400	2 400
.50	H	SI1	2 100 - 2 100	2 100
.75	G	VS1	3 500 - 3 500	3 500
.75	G	VS2	3 200 - 3 200	3 200
.75	G	SI1	2 800 - 2 800	2 800
.75	H	VS1	3 000 - 3 000	3 000
.75	H	VS2	2 700 - 2 700	2 700
.75	H	SI1	2 500 - 2 500	2 500
1.00	G	VS1	4 600 - 4 600	4 600
1.00	G	VS2	4 100 - 4 100	4 100
1.00	G	SI1	3 500 - 3 500	3 500
1.00	H	VS1	4 100 - 4 100	4 100
1.00	H	VS2	3 600 - 3 600	3 600
1.00	H	SI1	3 200 - 3 200	3 200

Source: U.S. Bureau of Mines.
[1] Gemological Institute of America (GIA) colour grades: D–colourless; E–rare white; G-H-I–traces of colour. [2] Clarity: FL–flawless; IF–no blemishes; VVS1–very, very slightly included; VS1–very slightly included; VS2–very slightly included, but not visible; SI1–slightly included. [3] Jeweler's Circular-Keystone, V. 163, No. 3, Feb. 1991.
[4] Jeweler's Circular-Keystone, V. 163, No. 9, Sept. 1991.
Note: This table does not include prices for D, E, F, and I to Z, and the fancy colours' classification scale; nor does it include prices for FL, IF, VVS1, VVS2, SI2, I1, I2 and I3 clarities.

TABLE 4. DE BEERS' CSO ROUGH DIAMOND SALES AND STOCKS, 1985-92

Year	Sales	Stocks
	($ billions)	
1985	1.80	1.90
1986	2.56	1.85
1987	3.07	2.30
1988	4.17	2.00
1989	4.09	2.47
1990	4.17	2.68
1991	3.93	3.03
1992p	3.42	3.76

Sources: U.S. Bureau of Mines; American Diamond Industry Association.
CSO = Central Selling Organization.
p Preliminary.

Gold

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Canada's gold production, which had increased rapidly during the 1980s, decreased by 10.5% to 157.6 t in 1992 from a record 176.1 t in 1991. This compares to gold production of 167 t in 1990 and 30 t in 1980. In 1992, Canada was the fifth largest gold producer behind South Africa, the United States, Australia and Russia.

The average price of gold in 1992 was US$344/oz, the lowest level since 1985. Average prices were US$362/oz in 1991, $384/oz in 1990, and $381/oz in 1989. Price volatility in 1992 was low; the maximum gold price reached US$359/oz while the lowest price quoted was $330/oz (the lowest level since January 1986).

Lower average gold prices for Canadian producers were offset by a decline in the Canadian dollar from an average of US87¢ in 1991 to 83¢ in 1992.

Canadian Developments

There were about 50 primary gold mines in Canada at the end of 1992, accounting for 88% of the 157.6 t of gold produced during the year. A total of 11 mines closed while only 3 opened during the year. Total employment in primary gold mines decreased by more than 10% from 11 800 in 1990 to 10 500 in 1991.

British Columbia

In 1992, British Columbia's gold production declined to 15.3 t from 18.3 t in 1991.

Timmins Nickel Inc.'s Dome mine near Smithers opened in 1992 with an estimated production of 31 kg/m. Production at the Lawyers mine of Cheni Gold Mines Ltd. stopped in the summer of 1992 due to an exhaustion of reserves.

At the Eskay Creek project, Placer Dome Inc. converted its 44% indirect interest in Stikine Resources Ltd. to a 22% joint-venture interest in the gold property. Homestake Mining Company, through its takeover of Corona Corporation, became the majority partner and the mine operator. A preliminary study, based on a 450-t/d operation, estimated that the capital cost at Eskay Creek would be US$210 million for an operation that would produce 7.8 t/y of gold. In 1992, a $10 million feasibility study was completed. The project is estimated to contain 1 Mt of ore grading 26.4 g/t gold, 998.4 g/t silver, and recoverable zinc and copper. Production could start by the end of 1995. According to Homestake's plans, the ore will be trucked 550 km and milled at a site adjacent to the Equity Silver mine.

Placer Dome Inc. announced that it will not proceed with development of the Mount Milligan copper-gold property located near Prince George, British Columbia. According to feasibility estimates, the $420 million project could process some 60 000 t/d of ore. Placer Dome stated that the low price of gold was the main factor in its decision. The Mount Milligan deposit contains 300 Mt of reserves grading 0.23% copper and 0.56 g/t gold.

In the northwestern part of the province, the Windy Craggy copper-gold deposit of Geddes Resources Limited has been undergoing an environmental assessment. Current probable and possible reserves at the deposit are about 130 Mt grading 1.8% copper, 0.18 g/t gold, 3.62 g/t silver, and important cobalt values. Geddes Resources Limited has been seeking potential investors for the $500 million project.

Northwest Territories

Gold production in the Yukon and Northwest Territories decreased by nearly 15% from 20.6 t in 1991 to 17.6 t in 1992.

A bitter labour dispute started at the Giant mine of Royal Oak Mines Inc. in May 1992. In September, an explosion at the mine killed nine workers. The

Royal Canadian Mounted Police have indicated they are investigating the explosion as a multiple homicide. Despite the appointment of a mediation team by the Minister of Labour in September, both the union and management failed to agree on a number of issues, including the dismissal of 45 employees.

Saskatchewan

Claude Resources Inc. started production at the Seabee gold mine. Cost overruns and start-up delays substantially increased the cost of the $23 million project. The 400-t/d operation is targeted to produce 1.8 t/y of gold. Proven and probable reserves are estimated at 1 Mt grading 13.7 g/t gold. The company is currently undergoing a restructuring and has not traded on the stock market since the summer of 1992.

The Contact Lake property of Cameco, Uranerz Exploration and Mining Limited, and Westward Explorations Ltd. funded a feasibility study of a 635-t/d operation. The project's estimated capital costs would be $38 million to produce 2 t/y of gold.

Ontario

Ontario's gold production in 1992 totalled 74 t, a decrease of over 4% from the 1991 total. Production at the three mines in the Hemlo area accounts for over 50% of Ontario's total production.

Falconbridge Gold Corporation announced in October that the Bell Creek mine near Timmins would be re-opened. Falconbridge Gold Corporation purchased the Bell Creek gold mine and mill from Canamax Resources Inc. for $5 million, and re-opened the Bell Creek mill in 1992 to process ore from its nearby Hoyle Pond mine.

The Cheminis gold mine of Northfield Minerals Inc. (78.5%) and Towerland Properties Inc. (21.5%), which opened in 1991 near Virginiatown, was temporarily shut down in 1992. The mine had been brought on stream in July 1991 at a cost of $13 million. The Cheminis mine's proven and probable reserves are 250 000 t averaging 5 g/t gold. The Cheminis mine produced around 31 kg/m at a cost of $300/oz.

The Magino mine of Muscocho Explorations Ltd. was shut down in the summer due to low gold prices.

Quebec

In 1992, Quebec's gold production decreased by over 14% from 51.9 t in 1991 to 44.5 t in 1992. The substantial decline in production was caused by the closure of seven mines and by production decreases at several operations; no new mines started production in 1992.

The Sleeping Giant mine of Aurizon Mines Ltd., which closed in 1991 because of low gold prices, is expected to re-open in January 1993 with Cambior inc. as the operator. Cambior has earned a 50% interest in the property through a three-year $12 million exploration program to delineate new reserves.

The Casa Berardi Est mine of TVX Gold Inc. and Golden Knight Resources Ltd. had to be partially shut down following an inflow of overburden material into the mine. Full operation at the Est mine is expected to resume in early 1993.

The Simkar mine, which opened in late 1991, was closed due to low gold prices. The mine is jointly owned by Ronrico Explorations Ltd. and Louvicourt Gold Mines Inc.

A total of six mines closed in 1992 due to exhaustion of reserves: the Lac Shortt mine of Minnova Inc., the Camflo mine of American Barrick Resources Corporation, the Kierans and Norlartic mines of Aur Resources, and the Malartic Highgrade mine of Republic Goldfields Inc. In addition, Westminer Canada Ltd. announced in November that its Chibougamau operation would be put on care and maintenance until January 31, 1993, while Westminer searched for a buyer.

New Brunswick

At the Murray Brook mine of NovaGold Resources Inc., gold reserves ran out in the summer of 1992. NovaGold had produced 1300 t/d of ore grading 2 g/t gold and 39.5 g/t silver as feed to an indoor vat leaching process. NovaGold will mine the copper ore at the Murray Brook mine.

Newfoundland

The Hope Brook mine was purchased by Royal Oak Mines Inc. from BP Resources Canada Inc. in 1992. Royal Oak re-opened the mine in July 1992 after a one-year shut-down. The mine is expected to produce about 3 t/y of gold at full production. Prior to its purchase by Royal Oak, the Hope Brook mine had experienced a number of difficulties in meeting its original production plans, mainly because of effluent treatment problems, low recoveries and low throughput.

WORLD DEVELOPMENTS

South Africa

South Africa remains the world's largest gold producer with an output of 600 t in 1992. Its share of Western World production, however, has fallen from 70% in 1980 to 34% in 1990, and even further in 1992, due to increased production in several other countries. With a cumulative output approaching 44 000 t from 1870 to 1991, South Africa has been the dominant gold supplier. About 98% of South Africa's gold comes from mines in the Witwatersrand trial in the Johannesburg area. In 1992, by-product gold produced by the platinum, copper and antimony industry totalled 3 t, while the retreatment of tailings accounted for approximately 20 t.

South Africa has moved from being the lowest-cost gold producer in 1985 to being one of the highest-cost producers in 1991. Cash costs in South Africa in 1985 were approximately US$147/oz, while costs at other major Western World producers averaged about $200/oz. However, in 1991, South Africa was considered to be the highest-cost producer with a cash cost of $294/oz, compared to the average Western World cost of $259/oz. At a price of US$350/oz, about 30% of South African gold mine production is considered marginal. In order to maintain a high level of production in 1992 despite low gold prices, companies have been forced to mine high-grade ore zones. South African gold producers obtained some major changes in their collective bargaining agreements with the unions by reducing the pay increases to around 5% and by introducing profit-sharing with the workers. The continued devaluation of the Rand (R) helped gold producers remain competitive. Gold production, valued at around US$6 billion per year, accounts for over 35% of South Africa's export earnings.

Despite a large reserve base, South Africa's mine production faces major difficulties due to declining ore grades, deep gold reserves, and high domestic inflation. However, rationalization is taking place to increase productivity. Production cost increases in the gold mining industry in the last two years were reported to have been held at 2%/y. During the same period, employment in gold mining decreased at a rate of 3000 jobs per month. The South African mines' ability to keep reducing costs is limited by their relatively low-grade reserves. As most South African primary gold mines are over 30 years old, they have generally mined out their higher-grade reserves.

Fiscal measures, such as the replacement of the Goods and Services Tax (GST) by the Value-Added Tax (VAT) and the reduction in the import surcharge on capital goods from 10% to 5%, also helped to improve South Africa's competitive position. In addition, the South African mining industry is becoming less reliant on imports of mining equipment, thereby making successive devaluations of the Rand less inflationary.

The South African Department of Minerals and Energy Affairs estimates that the effective exchange rate of the Rand in comparison to a basket of currencies declined at a rate of 10%/y during the 1980s. The department also reported that the producer price index rose by an annual average of 14.1% in the 1980s. So, in balance, costs rose faster than devaluation could compensate, and producers' competitive positions suffered. In 1992, the inflation rate rose sharply to around 15% as food prices increased nearly 30% due to a severe drought.

According to the Chamber of Mines, a total of about 360 000 persons are employed in the gold mining industry in South Africa. Throughout its history, the Chamber of Mines has assumed responsibility for overall policy coordination, research, recruitment of labour and, until recently, marketing and promotion of the Krugerand through its former subsidiary, the International Gold Corporation.

Following the removal of various economic and political sanctions by the majority of its trading partners, South Africa is contemplating re-launching the Krugerand gold coin. Prior to the sanctions in 1984, the Krugerand coin accounted for between 40% and 60% of the Western World's gold coin market.

Anglo American Corporation of South Africa Ltd. is the world's most important mining company with a gold production of around 240 t in 1992. Anglo American and its subsidiaries account for 23% of the market capitalization of the Johannesburg Stock Exchange.

Anglo American announced development at the R1.7 billion Moab mine with a production start-up scheduled for 1997. The Moab mine is expected to produce 13 t/y of gold when it reaches full production in the year 2004. Anglo American also announced the closure of the Sallies gold mine due to the exhaustion of economic reserves.

In response to financial difficulties, the Harmony mine of Rand Mines Ltd. was allowed to work on Sundays. Sunday mining had previously been totally prohibited. In addition, the South African government offered a loan guarantee of approximately R30 million to the Harmony mine. Rand Mines Ltd. announced a restructuring plan in which the company will operate four divisions: exploration and platinum, coal, property, and gold.

Lorraine Gold Mines Ltd. applied to the government for permission to operate seven days per week to remain viable. Current reserves would permit Lorraine Gold Mines to operate until the end of 1993. Further reserves have been delineated that could add between three and four years to the operation's life.

GoldFields continued to review the future of the Doorfontein mine, which has been expected to close for some time. In other business, the company has announced the merger of the marginal Libanon and Venterpost mines with the profit-making Kloof mine.

Due to low gold prices during 1992, several projects were put on hold and only a few new projects were announced. Gencor announced that the first-phase development of the US$430 million Oryx mine in the Orange Free State is schedule to start in March 1993. Gencor's Weltevreden Mines Ltd. curtailed its R210 million first-phase operation which was intended to produce 30 000 t of gold-bearing ore. In addition, Gencor's Winkelhaak Mines Ltd. announced that it will stop work at the R700 million sub-vertical shaft because of low gold prices. This project would have provided access to 20 Mt of ore grading 5.7 g/t gold, representing 120 t of gold. In order to reduce costs, the St. Helena mine production was cut by half while the uneconomic West Rand Cons mine was sold.

The South African Department of Minerals and Energy Affairs indicated that 15 new mines could be developed if its mining industry could solve current financial and technical problems. These mines would require investments of US$20 billion. Most new major gold mines in the Witwatersrand Basin would operate at depths in excess of 2000 m.

United States

U.S. gold production increased from 44 t in 1981 to an estimated 320 t in 1991, thereby making the United States the second largest producer behind the Republic of South Africa. Nevada accounted for about two thirds of U.S. production with an estimated production of 210 t. The other major producing states are California, South Dakota and Montana. Growth in gold production in Nevada was made possible by the application of the heap leach process designed to treat low-grade ores. Newmont Gold Company, the largest U.S. gold producer, produced 50 t of gold in 1992, with the bulk coming from its Gold Quarry mine. Production at Gold Quarry is estimated at 30 t/y; this makes it the largest gold mine in North America.

A few kilometres away, American Barrick Resources operates the Goldstrike mine which produced 41 t in 1992 and could reach over 60 t/y by 1995 following the company's announcement of increased reserves. Following this announcement, American Barrick decided to postpone the production start-up at the Meikle deposit to the middle of 1996. In early 1992, American Barrick announced the development of the Meikle deposit 2 km north of the Goldstrike deposit. The Meikle deposit contains 6.5 Mt of ore grading 21.6 g/t gold. The Meikle underground mine is expected to produce 11 t/y for 11 years.

American Barrick and Newmont signed an agreement in principle in early 1992 for joint cooperation in the development of the Deep and Lower Post orebodies adjacent to the Goldstrike mine. Both companies agreed to jointly finance exploration and development along the common property boundaries and to share Newmont's bioleach technology. Newmont will construct and operate bioleach facilities on its land holdings with Barrick receiving 50% of the profits after recovery of capital. The agreement will permit Newmont to process all of American Barrick's refractory sub-economic ore, which grades below 2.2 g/t gold.

Other major developments in the United States were the start-up of the Hayden Hill and Castle Mountain mines in California, operated respectively by Amax Gold and Viceroy Gold Corporation. Both mines are expected to each produce in excess of 3 t/y of gold.

Major closures took place at the Summitville mine of Galactic Resources in Colorado and at the Richmond Hill mine of Lac Minerals Ltd. in South Dakota.

Battle Mountain Gold is expected to start production at the Crown Jewel mine in Washington State once the permits are obtained. The Crown Jewel mine is expected to produce about 5 t/y of gold.

Australia

Australian gold production has shown a spectacular increase over the past few years from 39 t in 1984 to an estimated 241 t in 1991. In 1988, Australia overtook Canada as the world's third largest gold-producing country after South Africa and the United States. As is the case for South African and Canadian producers, the decline in the gold price in U.S. dollars was offset by the fall in the Australian dollar.

Arimco has started production at its 51%-owned Mount McClure mine in Western Australia. Proven reserves are 1.8 Mt grading 3.96 g/t gold, or a total of approximately 7 t of gold. Annual production is expected to be 2 t/y.

Other mines starting up in Western Australia include Resolute Corporation's Marymia and Keilor mines, and Orion and Gasgoine companies' Yalgarn Star mine.

North Broken Hill (NBH) Peko Ltd. announced that it will proceed with the development of the Northparkes copper and gold mine in New South Wales. The mine has reserves of 1.7 Mt of oxide ore containing gold, 1.7 Mt of oxide copper ore containing gold, and 64.8 Mt of sulphide copper-gold ore. Total capital costs will amount to A$220 million. Also in New South Wales, CRA Ltd. opened its Peak mine. Production at the Peak mine is expected to reach 3.1 t/y.

In Queensland, production started at the Tick Hill and Rishton mines owned respectively by MIM Holdings Ltd. and Ashton Corporation.

Homestake Gold of Australia announced in April that it was closing its Fortnum mine in Western Australia due to lower grades. It produced 1.5 t of gold in 1991.

In the Northern Territory, the Gwalia and Amico Corporations closed their Molina mine. Production at Molina had been about 2 t/y.

Placer Dome Inc.'s subsidiary, Placer Pacific Limited, announced that it had sold its 50% interest in the Big Bell mine in Western Australia to Poseidon Gold Ltd. for US$8.6 million. Because of dilution difficulties, the Big Bell open-pit mine has never met its production forecasts.

North Broken Hill Peko Ltd. and Delta Gold announced that they will develop the Kanowna Belle mine in Western Australia in 1993. The deposit has reserves of 15 Mt grading 5.3 g/t gold, or a total of 84 t of gold. The first phase will be operated as an open-pit mine and will cost A$78 million. Production is expected to start in 1993. Mining of the open pit should last about six years with reserves of around 30 t of gold. Another phase is planned to treat refractory ore. Kanowna Belle is referred to as one of Australia's richest gold discoveries in the last few years.

Other major mine start-ups in 1993 are expected to take place at the Mt. Todd mine of CRA Ltd., and at the Rishton mine of Ashton Mining and Peak Gold Ltd.

The Australian Mint is one of the world leaders in gold coin production. The series of Australian Nugget coins issued in 1992 came in denominations of two ounces, ten ounces, and one kilogram. The Australian Mint also has a series of platinum and silver coins.

Papua New Guinea

Papua New Guinea's (PNG) gold production is expected to reach 70 t in 1992. This compares to production of 60 t in 1991 and 34 t in 1990.

The Porgera gold mine increased its production from 38 t in 1991 to 46 t in 1992. The increase is attributed to increased gold recovery and higher output levels. The increase in milling capacity to 8500 t/d should translate into a production increase in 1993, despite head grades that have fallen from 64 g/t gold in 1991 to about 20 g/t at the end of 1992.

The Porgera mine has one of the lowest cash operating costs of any mine in the world at US$92/oz in 1992. The operation has 130 Mt of mineable reserves grading 4.7 g/t gold. The mine, located in Enga Province, is owned by Placer Pacific (30%) and the operators, Highlands Gold (a 65% subsidiary of Australia's MIM Holdings) and Renison Goldfields Consolidated, each with 30%. The PNG government holds the remaining 10% stake. The newly elected government in PNG announced its intention to increase its stake in the mine to 30%.

Other operating gold mines in PNG were Placer Dome's 60%-owned Missima mine, with production of 11.6 t, and the O.K. Tedi mine of Broken Hill Pty. Co. Ltd., Amoco Corp., and the PNG government, with 11 t.

CRA Ltd. indicated that it has suspended operations at the Mount Kare alluvial deposit in the Hidden Valley region. The Mount Kare operation, which started in December 1990, had to be closed in January 1992 after being firebombed. CRA indicated that its 51% ownership will be transferred to 6000 land-owners who own the remaining 49% stake in Mount Kare.

A production decision on the Lihir gold project is expected in the first part of 1993, with a possible initial production by 1994. Lihir is owned by RTZ Corporation PLC (80%) and Niugini Mining (20%), a Battle Mountain Gold Co. subsidiary. However, RTZ has indicated its intention to find new partners to reduce its ownership in the $800 million project. The PNG government is expected to seek a 30% ownership of the project. The development plan was delayed several times because RTZ has been hesitant to proceed. RTZ has a stake in Bougainville Copper Ltd., which has remained closed since 1990 due to civil unrest. Lihir is considered to be one of the world's largest undeveloped deposits outside South Africa with mineable reserves of around 200 Mt at an average grade of 3.25 g/t gold, representing over 600 t of gold. The current owners plan to produce 18 t/y in the first five years of the project.

Commonwealth of Independent States

The Commonwealth of Independent States' (C.I.S.) gold production was estimated to be around 250 t in 1992. The general decline in production in the C.I.S. from a peak of over 285 t in 1989 is largely attributable to the exhaustion of placer deposits (particularly in Russia) and a shortage of hard currency to buy equipment and supplies. In addition, energy costs and labour problems have also been increasing and contributing to declining output. About 20% of the C.I.S.'s annual gold production is believed to originate as by-product from base-metal operations, with the copper industry accounting for 15% of gold production and the lead and zinc industry accounting for about 5%.

After the break-up of the U.S.S.R., the various producing republics decided to market their gold assets through their own local agencies. Rosalmazzoloto markets gold for Russia, Uzbekzoloto markets gold for Uzbekistan, and Kazzoloto markets gold for Kazakhstan.

Russia

Russian gold production in 1992 was reported to have fallen by 10% to around 165 t. Russia accounts for approximately 60% of total C.I.S. production. The largest areas of gold production are in western Siberia (near the Ural Mountains) and in northwest Siberia (near Magadan and in Yakutia). Decreased production can be attributed to declining reserves at several alluvial operations. About 70% of Russia's gold production comes from placer deposits, but these deposits account for only 30% of the total proven reserve base. As gold reserves are generally concentrated in large low-grade deposits, Russian gold production will likely continue to decline in the medium term.

Gold-trading rights were transferred from Vneshekonombank to Vneshtorgbank. Glavalmazzoloto, which controlled all gold-mining enterprises, has also been replaced by Rosalmazzoloto. Rosalmazzoloto has the state monopoly on precious metals and diamonds.

To address the problem of declining productivity, the various republics have negotiated an agreement with Russian Federation authorities whereby the republics receive between 10% and 25% of the proceeds of their gold production (in hard currency).

Russia's gold production is equally divided between state-owned enterprises and cooperatives known as Artels. The Artels generally operate small placer deposits and account for approximately 40% of total gold production. Many of the Artel members are also part of the Prospector's Union, which has a membership of 50 000. Gold production from individual prospectors has increased by 50% over the last six years.

The gold industry is of great importance to the Russian Federation. To address the problem of declining production, Russia has decided to open gold exploration to tenders in several regions. Until new mines enter into production, output is expected to continue to decline. Star Technology Systems of Australia entered into a joint venture, agreeing to invest US$250 million for a 31% interest in a local state company, Lenzoloto, to develop the Sukhoi Log in eastern Siberia. However, Lenzoloto still must receive a licence by the federal and local governments before the project can proceed.

Russia's gold exports in 1992 were estimated at only 100 t. The threat of major gold exports from C.I.S. countries has diminished considerably in the past few years following the reduction of the reserves estimate from 2000 t to around 170 t.

The high inflation levels of the past couple of years have prompted consumers to buy gold jewellery instead of holding rubles. There is also substantial usage of gold in dentistry. In the future, increasing pressure from the republics to receive a greater return from their gold sales, declining reserves, and increased domestic consumption will inhibit Russia's ability to sell gold to Western countries.

Uzbekistan

Uzbekistan's gold production in 1992 was estimated at 60 t. According to government authorities, production could double in the next five years. Uzbekistan is reported to have the fourth largest gold reserves in the world. The Muruntau low-grade open-pit mine in Uzbekistan was commissioned in 1969 and is reported to have an annual production of 55 t. The Government of Uzbekistan signed an agreement in early 1992 with Newmont Mining Corp. to create a joint venture to process gold tailings from the Muruntau mine. Newmont expects that the leaching of the stockpile will yield 87 t of gold. The project's capital cost has been estimated at US$75 million with a life of 15 years; start-up is expected in 1993. The initial reserve base at the Muruntau mine, which was estimated at 1150 t in 1969, has increased significantly beyond a 15-year mine life.

Kazakhstan

Kazakhstan's 12-t/y gold production is derived mostly from base-metal operations. The new country has announced plans to attract foreign investors to increase output. Minproc Corporation and Chilewich International have formed a joint venture with the Kazakhstan government to develop the Bakyrchik mine. It contains proven and estimated reserves of 21 Mt grading 9.4 g/t gold, equivalent to about 200 t of gold. The mine has been operating since 1965 with an estimated output of 1 t/y of gold. The capital cost to expand the Bakyrchik mine is estimated at US$100 million. Production from the expansion could start by 1995, raising total output to 8 t/y.

Goldbelt Resources of Vancouver is negotiating with Kazakhstan authorities to reprocess gold tailings containing 80 t of gold. The cost of this project is expected to be US$40 million.

Other C.I.S. Countries

Kyrghyzstan gold production is estimated at around 3 t/y of gold. Cameco Corporation has signed an agreement with Kyrghyzstan to assess the feasibility of mining the Kumtor gold deposit. Kumtor has estimated reserves of 450 t of gold. After completing the US$10 million feasibility study, Cameco will decide whether to invest an additional US$35 million to obtain a 33% interest in the project. The rest of the ownership would be held by the Government of Kyrghyzstan. Development at the Kumtor project could start by the end of 1993 with production start-up scheduled for 1997.

Armenia's gold production was cut by 80% to 1.5 t in 1992 because of the armed conflict with Azerbaijan, which affects the Zod gold mine. Prior to the conflict, the Zod gold mine was reported to produce around 10 t/y of gold.

China

China's gold production was estimated at 115 t in 1992. It is reported that the majority of China's 400 gold mines are producing less than 0.3 t/y. Gold production has increased by 10%/y due to a number of government actions including the introduction of the State Gold Administration in late 1988, the curtailment of gold smuggling, increased funding for mining and prospecting, and the banning of individual panning.

Under the 1991-96 economic plan, the country intends to invest between US$1.3 billion and $1.5 billion to develop new gold mines and improve mining technology. With investment nearly double the amount invested under the 1985-90 plan, production between 1992 and 1995 is expected to rise by 30%. Although small- and medium-sized gold mines account for 80% of the country's gold production, Chinese investments will focus primarily on large-scale operations. The small mines are reported to be high-cost operations producing at below capacity; some small mines with production levels of 1 t/y are reported to employ 3000 employees.

Several factors prevent China from increasing its gold yield production faster. Chinese gold producers must sell their entire production to China's Central Bank at well below the international market price. Furthermore, the inflation rate for fuel, electricity, and construction materials is close to 10%.

The State Gold Mining Bureau stated that seven new mines were brought into production in 1992. The Shandonc Province is reported to be the largest producer with about 25% (23 t) of China's gold production. The Linglong mine in the Shandonc Province is reported to be China's largest mine with a production of 2.5 t/y.

China mints gold and silver Panda coins which are 99.9% pure. The gold coins are available in five sizes ranging from one ounce to one twentieth of an ounce. The Chinese normally mint between 6 t and 9 t of the Panda gold coins annually.

Despite China's strong economic growth and strong balance of payments, the country has a significant external debt. This creates an incentive to increase gold production. However, China has not yet opened up its gold mining industry to foreign capital to improve its efficiency.

Japan

The Hishikari gold-silver mine of Sumitomo Metal Mining Co., Ltd., located on the Kyushu Island, has been in operation since 1985. In 1992, production increased to 10 t/y following Sumitomo's decision to start production in the Yamada zone. The Yamada zone contains reserves of about 50 t of gold, 20% of the total reserves of the Hishikara mine. Hishikari is reported to be the richest gold mine in the world with average grades of 70 g/t gold and 35 g/t silver.

Japan consumes around 260 t/y of gold, mainly in the jewellery and electronics industries. However, the recession has considerably dampened growth in these markets. The most encouraging prospect for future Japanese gold consumption is coinage. After completing the sale of 220 t of commemorative coins of former Emperor Hirohito in 1990 and 60 t of coins of the new Emperor Hakihito in 1991, the Japanese Mint is expected to announce the introduction of a new coin for the wedding of Crown Prince Naruhito. According to officials from the Ministry of Finance, the new gold coins will be made using existing stocks.

Indonesia

Gold output quadrupled in the last three years to reach 40 t in 1992. The bulk of Indonesia's production is a result of Freeport McMoran's Ertsberg/Grasberg copper-gold mine. The company is currently studying the feasibility of further expanding the operation by 1996. Indonesian gold production also increased due to the recent start-up of CRA's Kelian mine. Annual output of the Kelian mine is forecast at 8 t/y. The Mount Munro mine of Ashton Mining should come on stream in 1993 at a production rate of 2.5 t/y of gold.

Ghana

Ghana's gold production, which has grown steadily in the past five years, exceeded 30 t in 1992. According to Ghanean authorities, production should double from its current level by the end of the century due to good mineral potential and the recent liberalization of the country's mining laws.

Gold production at the Ashanti gold mine is estimated to be 20 t/y. This should increase to 30 t/y by 1995 following the construction of a 220 000-t/m bioleaching plant. The mine is owned by Goldfields Corp. (55%) and Lonrho plc (45%).

Ghana's other two major gold producers are Pioneer Inc.'s Terebie Goldfields mine and Billiton Metals' Bogosu mine, with a total production of 6 t in 1992. Expansions are expected at both of these mining operations.

The Government of Ghana announced that it plans to privatize the Presta and Tarkwa mines. These smaller operations together produced about 2 t in 1992.

Mali

Production at the Syama gold mine in Mali is expected to increase to around 6 t/y. The mine is owned by BHP Minerals (65%), the Government of Mali (20%), and the International Finance Corporation. Reserves of oxidized material at the Syama mine are 2.1 Mt grading 3.7 g/t gold and 4.5 Mt of sulphide ore grading 7.2 g/t gold.

Latin America

Major changes in investment and mining laws and relatively unexplored land have made Latin America a very active area for gold mining exploration and development. Currently, there are more than 150 Canadian companies with mining interests in South America, Central America, Mexico and the Caribbean. Mexico, Chile, Costa Rica, Bolivia, Guyana, Brazil and Venezuela account for about 80% of Canadian property interests in the region, with Mexico accounting for 25% of the interests.

Brazil

Brazil's estimated gold production declined to 73 t in 1992, compared to 80 t in 1991. For the first time in many years, 1992 gold production by Garimpeiros was less (48%) than conventional mining methods. The decline was due to the depletion of easily accessible alluvial gold deposits, more stringent environmental regulations, native concerns, and a commitment by government authorities to favour conventional mining companies who provide a guaranteed tax base. Some states have prohibited gold prospecting by the estimated 800 000 Garimpeiros, mainly because of pollution problems and because their presence usually discourages conventional mining companies from investing in the area.

At the request of Indian bands, Brazilian government authorities attempted to evict Garimpeiros from certain areas. Part of the concern results from the relatively uncontrolled mercury discharges from the Garimpeiros' operations. Several organizations are pressuring Brazilian authorities to ensure that each miner uses a retort for greater recovery of mercury.

Production by the state-owned Companhia Vale Rio Doce (CVRD) rose to 11.3 t from 8 t, making it Brazil's single largest producer. The company expects to increase its production to 17 t by 1995, largely because of production increases at the Igarape mine.

Also, Mineracao Morro Velho S.A. (a joint venture between Anglo American Corporation and the Bozzano Simonson) produced approximately 12 t of gold from its Raposos, Jacobina, Crixas, and Cuiaba mines. Rio Paracatu Mineracao S.A., an association between a Brazilian investor and RTZ Corporation PLC, produced around 5 t.

TVX Gold Inc. owns portions of three Brazilian operations. It has a 50% share in the Crixas Goias mine, a 23% share in the Brasilia mine, and a 50% share in the Novo Astro mine. Together these three mines produced 12 t of gold in 1992. TVX's share of the production was 4.5 t of gold.

Chile

In 1992, Chile's gold production was expected to reach 40 t, a 7-t increase over the 1991 total. In 1992, approximately 15% of Chile's production was as a by-product of copper. Placer Dome Inc. and TVX Gold Inc. produced for the first full year at their 16 500-t/d processing plant at the La Coipa mine. The US$218 million project produced 6 t of gold along with silver revenues equal to an additional 5.7 t of gold. The mine, at an altitude of 4000 m, should have a life of 12 years.

Lac Minerals Ltd.'s El Indio mine was Chile's largest producer with an estimated 7 t of gold produced in 1992.

Placer Dome was awarded the evaluation and development rights of the Andalco mineral property from Minera Carmen de Andacollo. The property is estimated to have 395 Mt of ore containing 2 Mt of copper and 1.6 million oz of gold.

Cia Minera Can Can indicated that the Can Can deposit will come on stream in the spring of 1993. The Can Can mine will produce nearly 1 t of gold at initial production rates. The deposit, which has an expected life of six years, should eventually produce nearly 2 t/y of gold.

Amax Gold Inc. acquired a 50% interest in the El Refugio property from Bema Gold Inc. The US$130 million heap leach gold mine is expected to start production by early 1994 at a rate of 7 t/y. Total reserves are estimated at 70 t of gold.

The Chilean government approved plans to develop the La Candeleria copper-gold mine owned by Phelps Dodge Corp. and Sumitomo Metal Mining Company Ltd. The US$1.5 billion project has reserves of 90 t of gold.

Codelco, with private joint-venture partners, has decided to proceed with the exploitation of the Pajonales Occidental and Silica Roja deposits in the Copiaco region. These deposits, with reserves of 2 Mt grading 1.4 g/t gold, are adjacent to the El Hueso deposits of Homestake Mining.

In July, Sociedad Contractual Minera Vilacollo (SCMV) announced that production would cease at the Choquelimpié mine due to reserve depletion. The Choquelimpié mine has produced around 3 t/y of gold since 1988.

Guyana

Commercial production began at Cambior inc.'s Omai mine in Guyana in December 1992. The US$160 million Omai gold project is expected to produce around 8 t/y of gold during the first seven years of operation. The mill, with a 12 000-t/d capacity, will process ore grading 1.7 g/t gold. Total reserves at Omai are 40.6 Mt. The new company, Omai Gold Mines Limited, is owned by Cambior (60%), Golden Star Resources Ltd. (35%) and the Guyana government (5%).

Bolivia

In Bolivia, Battle Mountain Gold Inc., RTZ Corporation PLC, and Jordex Resources Inc. are planning to start production at the Korri Kollo mine in 1993. The US$350 million mine is expected to produce around 8 t/y of gold.

CONSUMPTION AND USES

The industrial consumption of gold, or its fabrication demand, includes gold consumed in jewellery, electronics, dentistry, and both fake and official coins (even though the latter type of coin is often used for investment purposes). Table 4 provides an historical perspective of world gold consumption in these uses.

According to the World Gold Council (WGC), jewellery manufacturing grew at a rate of 14% in 1992 to reach 2400 t, despite the world's slow economic recovery. The outlook for jewellery fabrication demand looks very favourable over the next few years, particularly in China, India, Thailand, and Taiwan. Jewellery fabrication demand, including the use of scrap, has exceeded world production since 1988. The WGC also indicated that the gains in the jewellery market in the Far East were partially offset by a reduction in demand for gold bars and coins (down by 40% to 51 t in 1992).

In Canada, the largest use of gold is for official coins. The Royal Canadian Mint produces two official coins that contain gold: a numismatic gold coin containing one quarter of an ounce of gold, and the gold Maple Leaf coin. According to the Royal Canadian Mint, sales of gold Maple Leaf coins have increased by 24.2% in 1992 to reach 15.9 t. Since its introduction in 1979, the program has consumed some 470 t of gold, or 31.8% of total Canadian production during that period.

The domestic carat jewellery industry has two main components: smaller manufacturers producing jewellery pieces in Canada, and larger sales companies importing stock jewellery pieces for direct sale. On average, Canadian gold consumption for jewellery is estimated to be between 8 and 10 t/y.

Most other gold products used in Canada are imported either in end-use form or in semi-manufactured alloy form. Canadian consumption of gold in electronics, dentistry and other industrial uses totalled about 1 t in 1992.

MARKETS

India

India, with a population of 880 million people in 1992, has one of the world's largest gold inventories, estimated at 7000 t. Gold is preferred as a hedge against inflation, and gold jewellery is an essential part of a marriage dowry. Gold demand for marriage has been constant for several years at around 100 t/y. While India's fabrication demand for jewellery and ornaments is estimated at 300 t, its gold mine production is around 3 t.

Due to import restrictions, the gold price in India has been between 20% and 35% above the market price. Therefore, to meet the country's important demand, gold has been smuggled in from neighbourhood countries, mainly from the Middle East. Over 200 t/y are smuggled into India for sale on the black market.

However, India's recent decisions to allow Indian gold exporters to import gold for re-export may considerably boost internal jewellery fabrication demand. In addition, non-resident Indians and national citizens who live abroad for more than six months are allowed to bring back 5 kg of gold, provided they pay a duty.

China

According to estimates by the World Gold Council, China's gold consumption in pure gold jewellery in 1992 was approximately 250 t, a 47% increase over 1991. It is expected that Chinese consumers will continue to use gold as a hedge because of fear that Chinese currency will be devalued. China's prospect for strong economic growth (between 10% and 12% in 1993) should encourage further consumption of gold, particularly in jewellery. Also, it is expected that as the disposable income of Chinese people increases, an important portion of their savings will be held in the form of gold. Currently, China's Central Bank markets gold internally at a market price of around US$460/oz. This situation stimulates gold smuggling from Taiwan and Hong Kong.

Central Banks

Some major central banks sold gold from their reserves in 1992. The major sellers were: the Netherlands (400 t), Belgium (202 t), Russia (100 t) and Canada (94 t). Central banks, with total holdings of approximately 35 000 t, may become more active sellers in the gold market in the future. The high national deficits in many countries, as well as the possible creation of the European Central Bank, may affect the policies of several countries with respect to their gold holdings. In addition, several central banks have been dissatisfied with the return on their gold assets in the past decade. Furthermore, currency holdings have proven to be more useful than gold as a means to even out the major fluctuations in the money market. However, several central banks still continue to rely on gold, claiming that its intrinsic value as the ultimate storehouse of value cannot be replaced by paper money.

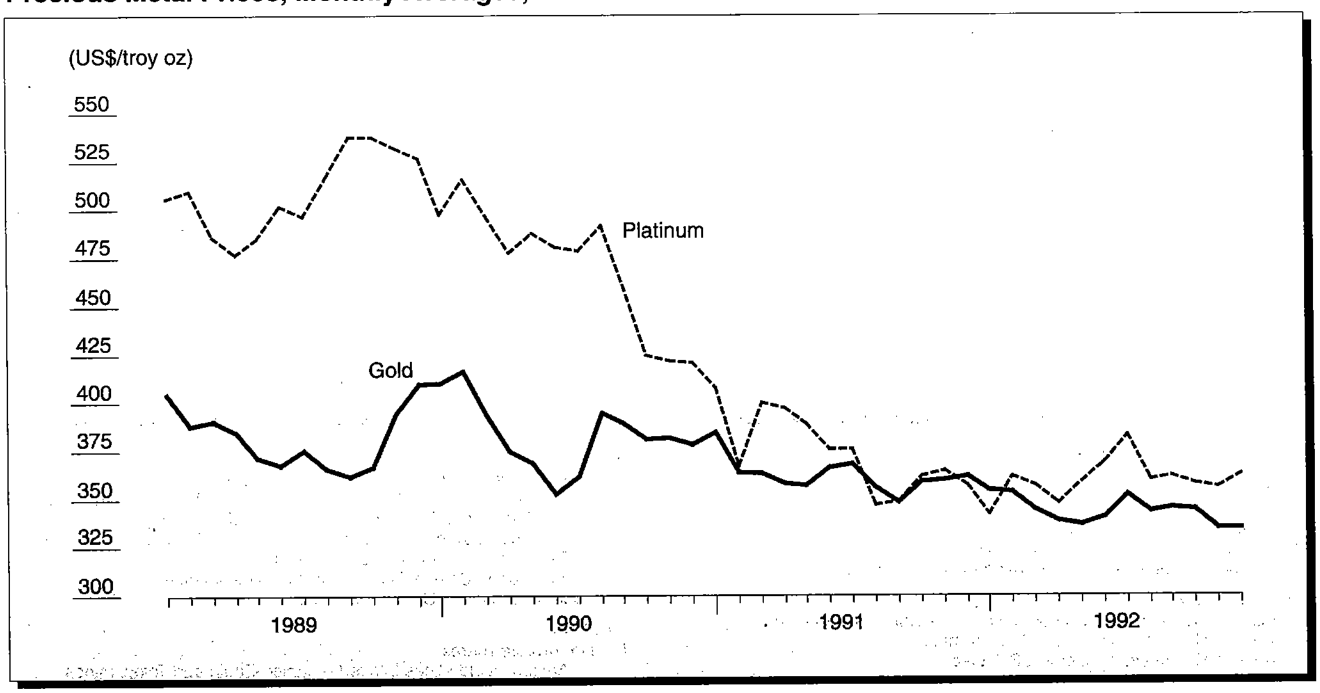
OUTLOOK

The current widespread economic slowdown, low inflation rates, high real interest rates, and the relative political stability in the world should encourage gold prices to remain near current levels. In 1993, the average gold price should be around US$350/oz. In the medium term, the combined effect of increased demand for gold products along with the peaking of world gold production should result in some strengthening in the gold price. For the rest of the decade, a gold price between US$330 and $390/oz in constant 1992 dollars is forecast.

Canadian gold production is expected to decline further to around 150 t over the next two to three years, assuming prices remain close to current levels. With an average cash production cost of about US$233/oz in 1991, Canada generally has a strong competitive position.

Note: Information in this review was current as of February 1, 1993.

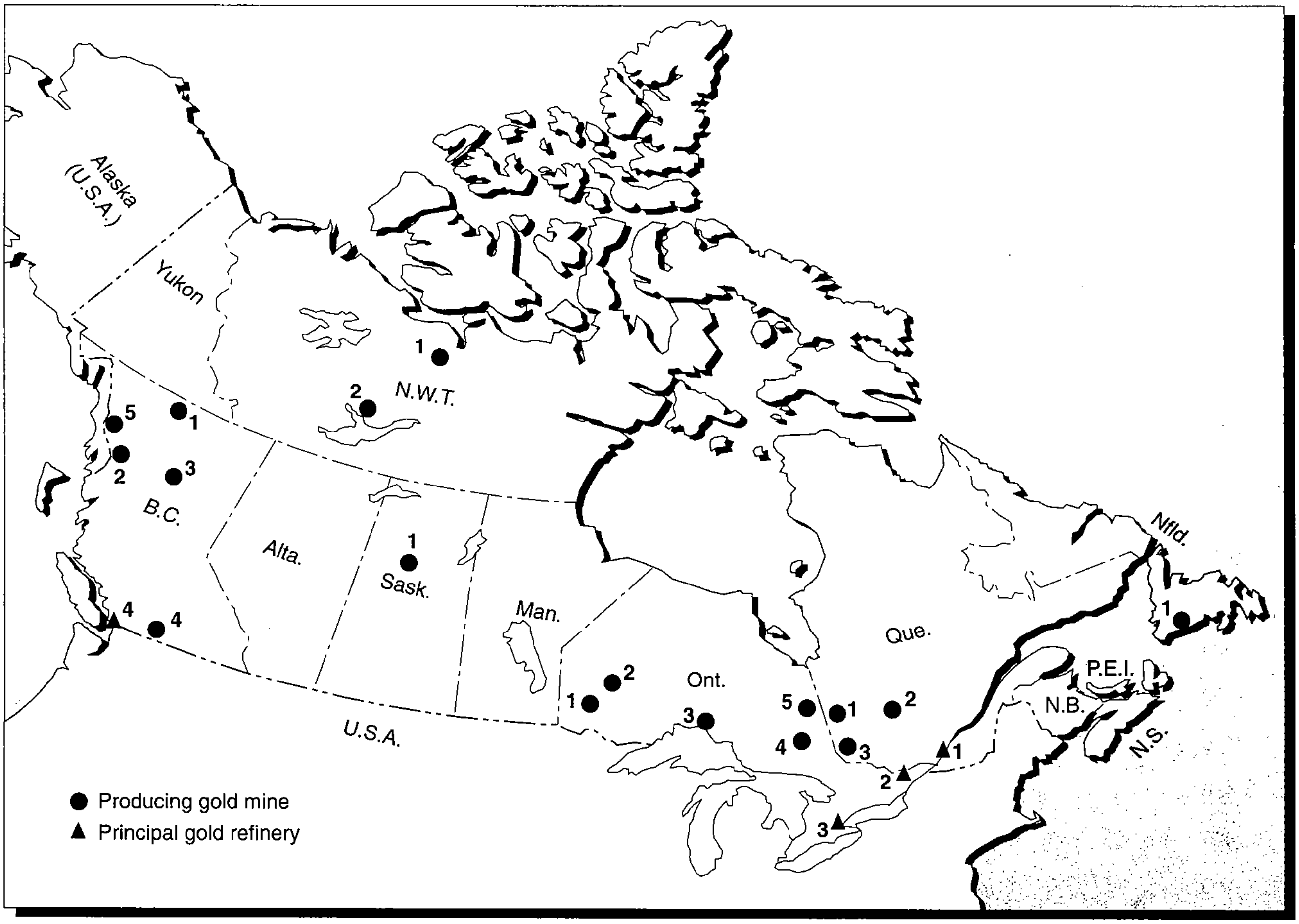
Figure 1
Precious Metal Prices, Monthly Averages, 1989-92



SOURCES: London Bullion Market Association; Johnson Matthey Public Limited Company.

Figure 2

Primary Canadian Gold Mines and Principal Gold Refineries, 1992



PRIMARY GOLD MINES

Northwest Territories
1. Echo Bay Mines Ltd. – Lupin mine
2. Royal Oak Mines Inc. – Giant mine
   NERCO Minerals Company – Con mine
   Treminco Resources Ltd. – Ptarmingan and Tom mines

British Columbia
1. Golden Bear Operating Company Limited – Golden Bear mine
2. Westmin Resources Limited – Premier mine
   Westmin Resources Limited – SB Project
3. Timmins Nickel Inc. – Dome Mountain mine
4. Homestake Mining Company – Nickel Plate mine
5. Cominco Limited – Snip mine

Saskatchewan
1. La Ronge Area
   Claude Resources – Seabee mine

Ontario
1. Red Lake Area
   Placer Dome Inc. – Campbell mine
   Dickenson Mines Limited – Arthur W. White mine
2. Pickle Lake Area
   Lac Minerals Ltd. – Golden Patricia mine
   Placer Dome Inc. – Dona Lake mine
3. Hemlo Area
   Homestake Mining Company/Teck Corporation – Williams mine
   Hemlo Gold Mines Inc. – Golden Giant mine
   Teck-Homestake Operating Corporation – David Bell mine
4. Timmins – Kirkland Lake Area
   Placer Dome Inc. – Dome mine

Ontario (cont'd)
   Royal Oak Mines Inc. – Pamour and Hoyle mines
   Falconbridge Gold Corporation – Hoyle Pond and Bell Creek mines
   Lac Minerals Ltd. – Macassa and Lake Shore tailings project
   American Barrick Resources Corporation – Holt-McDermott mine
   Deak Resources Corporation – Kerr mine
   St. Andrew Goldfields Ltd. – Stock Township mine
5. Placer Dome Inc. – Detour Lake mine

Quebec
1. Northwestern Area
   Agnico-Eagle Mines Limited – Agnico-Eagle and Telbel mines
   TVX Gold Inc. – Golden Pond Est and Ouest mines
2. Desmaraisville – Chibougamau Area
   Campbell Resources Inc. – Joe Mann mine
3. Rouyn-Noranda – Val-D'Or Area
   Lac Minerals Ltd. – Doyon and Bousquet 1 and 2 mines
   Agnico-Eagle Mines Limited – LaRonde mine
   Placer Dome Inc. – Sigma and Kiena mines
   Aur Resources Inc. – Ferderber and Dumont mines
   Cambior Inc. – Pierre Beauchemin, Lucien C. Béliveau, Chimo and Mouska mines
   Noranda Minerals Inc. – Silidor mine
   Mine Richmont Inc. – Francœur mine

Newfoundland
1. Royal Oak Mines Inc. – Hope Brook mine

PRINCIPAL GOLD REFINERIES
1. Noranda Minerals Inc. Canadian Copper Refiners
2. Royal Canadian Mint
3. Johnson Matthey Limited
4. Nesmont Precious Metals Corporation

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
71.08	Gold (including gold plated with platinum) unwrought or in semi-manufactured forms, or in powder form						
	Non-monetary						
7108.11.00	Powder	11%	7%	Free	Free	4.1%	Free
7108.12.00	Other unwrought forms containing by weight not less than 99.95% of gold	Free	Free	Free	Free	Free	Free
7108.13	Other semi-manufactured forms						
7108.13.10	Of a purity of 10 carats or more	Free	Free	Free	Free	0.5%-1.8%	Free
7108.13.20	Of a purity of less than 10 carats	10.3%	6.5%	Free	Free	0.5%-1.8%	Free

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992; Official Journal of the European Communities, Vol. 35, No. L268, 1992, "Conventional" column; Custom Tariff Schedules of Japan, 1992.

[1] GATT rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. CANADA, GOLD PRODUCTION AND TRADE, 1991 AND 1992

Item No.		1991		1992p	
		(kilograms)		(kilograms)	
PRODUCTION					
	Newfoundland	x		x	
	Prince Edward Island	–		–	
	Nova Scotia	–		–	
	New Brunswick	x		x	
	Quebec	51 923		44 544	
	Ontario	77 170		73 928	
	Manitoba	2 921		2 629	
	Saskatchewan	2 899		1 834	
	Alberta	34		35	
	British Columbia	18 331		15 261	
	Yukon	3 865		3 831	
	Northwest Territories	16 752		13 799	
	Total	176 126		157 554	
	Total value ($000)	2 349 872		2 086 803	
	Mine output (kg)	176 552		158 049	
EXPORTS				(Jan.-Sept.)	
		(kilograms)	($000)	(kilograms)	($000)
2600.00	Gold in ores and concentrates	8 401	96 300	4 920	54 960
7108.11	Gold powder				
	United States	542	7 218	110	1 459
	United Kingdom	201	2 606	–	–
	Total	743	9 824	110	1 459
7108.12	Other unwrought forms				
	United States	95 931	1 292 468	74 373	986 259
	Switzerland	20 485	276 154	37 808	502 531
	Hong Kong	29 913	393 740	15 414	203 995
	United Kingdom	65	860	4 180	57 254
	Taiwan	4 421	59 949	3 897	50 528
	Japan	3 306	44 217	2 274	33 117
	South Korea	–	–	1 550	20 936
	Germany	1 893	25 574	1 060	14 106
	Singapore	3 912	55 626	572	9 395
	Other countries	1 911	25 095	1 076	14 251
	Total	161 837	2 173 683	142 204	1 892 372
7108.13	Other semi-manufactured forms				
	Austria	1	25	820	10 304
	United Kingdom	–	–	127	1 814
	United States	8	99	94	954
	Other countries	1	10	57	702
	Total	10	134	1 098	13 774
	Total refined gold exports	162 590	2 183 641	143 412	1 907 605
IMPORTS					
2600.00	Gold in ores and concentrates	698	7 282	3 597	38 010
7108.11	Gold powder				
	United States	4	98	6	76
	Other countries	...	1	–	–
	Total	4	99	6	76
7108.12	Other unwrought forms				
	United States	22 510	236 251	20 932	212 143
	Peru	1 385	17 858	3 791	50 198
	Guyana	1 872	25 047	1 560	20 622
	Nicaragua	1 707	11 227	2 269	12 891
	Other countries	1 146	14 770	64	686
	Total	28 620	305 153	28 616	296 540
7108.13	Other semi-manufactured forms				
	United States	1 404	5 407	255	2 996
	Switzerland	72	603	77	831
	Germany	35	430	17	216
	Other countries	22	261	14	178
	Total	1 533	6 701	363	4 221
	Total refined gold imports	30 157	311 953	28 985	300 837

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . . Amount too small to be expressed; p Preliminary; x Confidential.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, GOLD PRODUCTION BY SOURCE, 1975, 1980, AND 1985-92

	Auriferrous Quartz Mines		Placer Operations		Base-Metal Ores		Total	
	(kg)	(%)	(kg)	(%)	(kg)	(%)	(kg)	(%)
1975	37 530	73.0	335	0.6	13 569	26.4	51 433	100.0
1980	31 929	63.1	2 060	4.0	16 632	32.9	50 620	100.0
1985	67 241	76.8	3 464	4.0	16 857	19.2	87 562	100.0
1986	83 197	80.9	2 802	2.7	16 900	16.4	102 899	100.0
1987	94 723	81.8	4 009	3.5	17 086	14.8	115 818	100.0
1988	112 404	83.4	4 879	3.6	17 530	13.0	134 813	100.0
1989	138 211	86.6	5 354	3.4	15 930	10.0	159 494	100.0
1990	147 355	88.0	3 993	2.4	16 025	9.6	167 373	100.0
1991	154 703	87.8	3 834	2.2	17 589	10.0	176 126	100.0
1992p	139 366	88.5	3 555	2.2	14 633	9.3	157 554	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 3. CANADA, GOLD PRODUCTION, AVERAGE VALUE AND PERCENT OF TOTAL MINERAL PRODUCTION, 1975, 1980, AND 1985-92

	Total Production	Total Value	Average Value[1]	Gold as a Percent of Total Mineral Production
	(kg)	($000)	($/g)	(%)
1975	51 433	270 830	5.27	2.0
1980	50 620	1 165 416	23.02	3.7
1985	87 562	1 219 653	13.93	2.7
1986	102 899	1 689 292	16.42	5.2
1987	115 818	2 204 472	19.03	6.1
1988	134 813	2 331 989	17.30	6.3
1989	159 494	2 315 860	14.52	5.9
1990	167 373	2 407 654	14.38	5.9
1991	176 126	2 349 872	13.34	6.7
1992p	157 554	2 086 803	13.25	5.9

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary.
1 Value is based on average reported sales.

TABLE 4. GOLD FABRICATION IN DEVELOPED AND DEVELOPING COUNTRIES, 1980, AND 1987-91

Fabricated Gold	1980	1987	1988	1989	1990	1991
			(tonnes)			
DEVELOPED COUNTRIES						
Carat jewellery	315	585	672	815	862	876
Electronics	94	118	126	129	138	137
Dentistry	63	46	48	48	49	51
Other uses	58	52	54	57	57	56
Medals and fake coins	18	7	8	8	9	9
Official coins	170	170	98	98	99	126
Total	718	978	1 006	1 155	1 214	1 255
DEVELOPING COUNTRIES						
Carat jewellery	196	612	843	1 059	1 174	1 235
Electronics	2	6	7	8	9	10
Dentistry	2	2	3	3	4	4
Other uses	4	5	6	7	9	9
Medals and fake coins	3	9	11	11	11	14
Official coins	21	32	31	37	19	16
Total	228	666	901	1 125	1 226	1 288
TOTAL						
Carat jewellery	511	1 197	1 515	1 874	2 036	2 111
Electronics	96	124	133	137	147	147
Dentistry	65	48	51	51	53	55
Other uses	62	57	60	64	66	65
Medals and fake coins	21	16	19	19	20	23
Official coins	191	202	129	135	118	142
Total	946	1 644	1 907	2 280	2 440	2 543

Source: Consolidated Gold Fields PLC, "Gold 1992."

TABLE 5. GOLD MINE PRODUCTION IN THE NON-COMMUNIST WORLD, 1980 AND 1987-91

	1980	1987	1988	1989	1990	1991
			(tonnes)			
South Africa	675.1	607.0	621.0	607.5	605.1	601.1
Canada[1]	50.6	115.8	134.8	159.5	167.4	175.3
United States	30.5	154.9	201.0	265.5	294.2	300.0
Other Africa						
Ghana	10.8	11.7	12.1	15.3	17.3	25.8
Zimbabwe	11.4	14.7	14.8	16.0	16.9	17.8
Other	11.0	37.0	40.0	35.8	34.3	40.3
Total, other Africa	33.2	63.4	66.9	67.1	68.5	83.9
Latin America						
Brazil	35.0	84.8	102.2	101.2	84.1	80.0
Colombia	17.0	32.5	33.4	31.7	32.5	32.2
Chile	9.3	23.3	26.7	29.0	33.3	32.5
Peru	5.0	10.8	10.0	12.6	14.6	15.1
Venezuela	1.0	16.0	20.0	17.1	14.2	13.2
Bolivia	2.0	6.0	9.0	11.5	10.4	10.0
Mexico	5.9	9.0	10.4	10.8	9.6	8.5
Ecuador	0.7	8.0	9.0	11.3	9.3	7.5
Other	15.6	15.0	13.8	11.7	11.5	11.5
Total, Latin America	91.5	205.4	234.5	236.9	219.5	210.5
Asia						
Philippines	22.0	39.5	39.2	38.0	37.2	30.5
Indonesia	2.1	12.2	12.3	10.8	13.3	18.4
Japan	6.7	8.6	7.3	6.1	7.3	8.3
Other	5.0	8.1	11.1	13.5	13.0	13.5
Total, Asia	35.8	68.4	69.9	68.4	70.8	70.7
Europe	11.8	21.9	23.2	29.5	32.2	32.4
Oceania						
Australia	17.0	110.7	157.0	203.6	243.1	234.2
Papua New Guinea	14.3	33.9	36.6	33.8	33.6	60.6
Other	1.0	4.0	6.6	9.4	10.1	11.5
Total, Oceania	32.3	148.6	200.2	246.8	286.8	306.3
Total, non-communist	960.8	1 385.4	1 551.5	1 681.2	1 744.5	1 780.2
Other countries						
U.S.S.R.		277.0	280.0	285.0	270.0	242.0
China		72.0	78.0	86.0	95.0	110.0
North Korea				9.5	13.0	13.0
Mongolia		8.5	9.5	10.0	10.0	10.0
Total, other countries		357.5	367.5	390.5	388.0	375.0

Source: Consolidated Gold Fields PLC, "Gold 1992."
[1] Production figures for Canada were obtained from Energy, Mines and Resources Canada.

TABLE 6. AVERAGE ANNUAL GOLD PRICES, 1934-92, AND MONTHLY, 1989-92

Year	US$/oz	C$/oz	Year	US$/oz	$C/oz
1934-67	35	. .	1980	614.38	719.08
1968	38.82	41.82	1981	459.22	550.57
1969	41.13	44.29	1982	375.52	463.51
1970	35.97	37.54	1983	423.52	521.82
1971	40.87	41.27	1984	360.63	466.99
1972	58.22	57.66	1985	367.58	510.73
1973	97.22	97.24	1986	367.58	510.73
1974	158.80	155.36	1987	446.66	592.18
1975	160.96	163.76	1988	436.45	554.76
1976	124.78	123.01	1989	381.27	451.33
1977	147.80	157.10	1990	383.72	447.79
1978	193.51	220.74	1991	362.34	415.09
1979	305.69	358.12	1992	343.86	415.23

Month	1989		1990		1991		1992	
	(US$/oz)	(C$/oz)	(US$/oz)	(C$/oz)	(US$/oz)	(C$/oz)	(US$/oz)	(C$/oz)
January	404.45	481.70	410.12	480.32	384.59	444.35	354.44	409.66
February	387.97	461.21	416.54	498.35	363.75	420.08	353.85	418.14
March	390.28	466.31	393.67	464.76	363.39	420.37	344.70	410.88
April	384.72	457.23	374.93	436.49	358.05	412.85	338.63	402.36
May	371.35	442.65	368.85	433.20	357.12	410.54	336.95	404.10
June	367.73	440.64	352.66	413.69	366.45	419.08	340.78	407.68
July	375.21	446.15	361.83	418.71	367.98	422.65	352.45	420.05
August	365.53	429.54	394.86	452.18	356.31	408.00	343.60	408.99
September	361.80	427.70	389.56	451.05	348.50	396.19	345.30	421.51
October	366.80	430.78	381.33	442.08	358.82	404.88	344.28	428.73
November	394.36	461.21	381.71	444.11	359.96	406.78	334.92	424.48
December	409.71	475.94	378.16	438.76	361.88	414.40	334.66	425.96

Source: London Gold Market. Compiled by Energy, Mines and Resources Canada.
. . Not available.

Graphite

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SUMMARY

In 1992, natural flake graphite was produced in Quebec by Stratmin Inc. and in Ontario by Cal Graphite Corporation. Graphicor Resources Inc., who owns a processing plant adjacent to Stratmin's Quebec operation, remained inactive in 1992 mainly due to declining markets and low recoveries from its Diotte orebody. Although world demand for natural graphite continued to decrease in 1992 because of the recession, Canada's production and shipments increased substantially. For example, shipments of natural graphite jumped from 8300 t in 1991 to 21 800 t in 1992, an increase of about 160%. World prices for natural flake graphite continued to decline in 1992. Mart Mining & Exploration of Labrador City continued the development of its Labrador deposit, which is reported to contain some 6 Mt of flake graphite grading 17.3% graphitic carbon.

NATURAL GRAPHITE

Graphite is a natural form of carbon. Natural graphite is a lustrous 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 relatively soft with a hardness of 1-2 on the Mohs scale. It has a black colour and a black streak on glazed porcelain. Its specific gravity is 2.26 g/cm^3. Graphite is an excellent conductor of heat and electricity and has a high melting temperature of 3500°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. Commercially, natural graphite is classified as amorphous, crystalline lump (or vein), and flake. Amorphous graphite is a microcrystalline graphite formed by crystallization of the carbon from organic sediments. The graphite occurs as distorted seams of minute microcrystalline particles intermixed with ungraphitized materials. The graphite content may vary from 15%-98%, depending on the degree of metamorphism and the original carbon content in the sediments. Crystalline lump occurs in the form of massive vein or circular accumulation probably formed from hydrothermal origin. Deposits are found in fissures or other cavities in igneous or metamorphic rocks. The size of the particles varies from fine grains to large lumps. The vein deposits vary widely in width from 2 mm to more than 2 m. Flake graphite is found disseminated in metamorphosed siliceous or calcareous sediments such as marble, gneiss and schist. Flake is defined as thin flakes which are classified from coarse to fine and which are graded according to their graphitic carbon content.

OCCURRENCES

Graphite deposits of potentially commercial interest 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 pegmatitic 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.

Fine-to-coarse flake graphite deposits have been reported mainly in Quebec and Ontario, but also in New Brunswick, Nova Scotia, Saskatchewan, Labrador and British Columbia.

In Quebec, graphite deposits are located mainly along the Grenville series in several townships of western Quebec: 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 deformations and where metamorphism has reached amphibolitic or granulitic phases.

Graphite also occurs in Esmanville Township, south of Fermont. Several graphite-rich schist zones, measuring 1-25 m in thickness, are found inter-layered with quartz-feldspar gneiss. Some graphite zones locally contain more than 15% graphite in the form of fine and well-crystallized flakes.

In Ontario, graphite deposits are found in several townships of eastern Ontario in rocks of the Grenville Geological Province. Flake graphite occurs disseminated in marble and gneiss. The occurrences of major interest are in semipelitic and pelitic gneiss units within paragneiss sequences. Graphite is present in amounts up to 10%. Accessory minerals consist of biotite, garnet and pyrite; trace elements in these graphitic rocks are nickel, cobalt, boron and vanadium.

CANADIAN PRODUCTION AND DEVELOPMENT

In 1992, Canada's production of natural flake graphite came from Stratmin Inc., who operates a mine and concentrator at Lac-des-Îles, Quebec, and from Cal Graphite Corporation, who operates a mine and processing plant near Kearney, Ontario.

The year 1992 was again marked by a decline in exploration and development activity in both Ontario and Quebec. The only company involved in development work was Mart Mining & Exploration Ltd. of Labrador City, Labrador. In 1991, Mart Mining completed a 600-m diamond drilling program on its graphite deposit, which is located 14 km south of Labrador City. Five holes with a maximum hole depth of 154 m were drilled along a 600-m strike distance. The property's reserves are estimated at 6 Mt grading 17.3% graphitic carbon. During 1992, beneficiation work on the ore was carried out by Canmet, Asbury Graphite Mills Inc., and Graphicor.

Stratmin Graphite Inc. produced close to 17 000 t of graphite concentrates from its Lac-des-Îles mill in 1992. During the year, the company continued to improve the mill circuit at Lac-des-Îles to further increase productivity. The Notre-Dame-du-Laus mill remained closed in 1992 and will most likely remain closed in 1993. Stratmin's objectives for 1993 is to produce 20 000 t of graphite concentrate and to increase sales to 22 000 t.

Cal Graphite Corporation reports that its flake graphite production continues to improve at its mill. Currently, the company produces at the rate of 30 t/d, a quantity which is close to 50% of the mill's capacity. The company reports that the quality of its products is maintained at the target of 94%-96% carbon. The mill, which presently operates on a five-day-per-week basis to allow some time for plant modifications, should, according to the company, reach full production in late 1993. In 1992, the company reported a production of 4500 t of natural flake graphite.

Victoria Graphite Inc. is seeking financing to start production on its 400-ha graphite property at Portland, half way between Ottawa and Kingston. So far, diamond drilling has been done to outline the graphite ore deposits and pilot-plant testing has been carried out. Research has indicated that the Portland graphite is suitable for the production of exfoliated graphite, a product which is used in the manufacture of graphite foil.

Stewart Lake Resources Inc. of Oakville, Ontario, reported no new developments in 1992. The feasibility study on its Kirkham, Ontario, flake graphite project, which was completed in 1990, concluded that the project could be successfully developed and placed into production at an estimated cost of $9.8 million. Graphite ore would be mined by open-cast method at the beginning, moving to an underground operation eventually. Approximately 8000 t of graphite concentrate would be produced annually.

Consolidated North Coast Industries Ltd. is seeking financing to develop its flake graphite property at Bissett Creek, Ontario. The deposit has established reserves of 20 Mt of proven and probable flake graphite ore with an average grade of 3.2% carbon. The company is proposing an annual production of 17 000 t of flake graphite grading 92%-94% carbon. To market its future graphite products, the company continues to work with European and North American distribution agents. During the year, the company upgraded the ownership status of the graphite property from mineral claims tenure to leasehold ownership of the land.

Mazarin Inc. of Québec City is seeking financing to develop its Fermont, Quebec, flake graphite deposit. A feasibility study on putting the property into production was prepared a couple of years ago. The study proposed an open-pit mining operation for six months of the year, which would supply enough ore to feed a 400-t/d concentrator on a year-round basis for an annual production of 23 000 t of graphite concentrate. A second feasibility study was prepared in early 1991 by Cambior inc. The total capital cost of the project was estimated by Cambior at $30.6 million. Geological reserves are 8.1 Mt averaging 16.7% carbon. The 20-year mining reserves are 2.5 Mt grading 17.4% carbon after dilution, and they are mineable by open-pit with a waste-to-ore ratio of 1.0/1.0. The graphite from that deposit is suitable for all major applications without chemical upgrading. The project is ready for construction and could be in production within 13 months.

Graphicor Resources Inc., who faced a declining graphite world market and low recoveries from its Diotte orebody, suspended its operations and mothballed its Lac-des-Îles beneficiation plant in December 1991. However, laboratory work to further improve the recovery process continued in 1992, both in-house and with metallurgical consultants. Graphicor also surveyed and carried out diamond drilling at its property in the municipality of Ste. Véronique. At that locality the company is seeking, through the courts, the right to mine the deposit.

CONSUMPTION AND TRADE

Reported Canadian consumption of natural flake graphite in 1991, the latest year for which data are available, amounted to 4063 t. Graphite was used mainly in foundries, but also in the metallurgy and refractories industries.

In 1992, imports of natural graphite for the first nine months were 6199 t and exports were 15 802 t. Some 90% of Canada's trade is with the United States. Crude graphite is used mainly in Ontario (70%) and Quebec (15%).

USES AND SPECIFICATIONS

The uses of natural graphite flow from 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 is used in the manufacture of crucibles 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.

Carbon refractories consist of more than 7% carbon in a blend with either microcrystalline or flake graphite, and are known as magnesia carbon brick. Mag-Carbon brick is used in high-temperature and corrosion-prone applications such as in steel furnace linings, ladles, slag-lines, hotpots, nozzles and blast furnaces. Graphite is used because of its thermal conductivity and thermal and chemical resistances. Flake graphite must have a carbon content of between 90% and 97% and sizes ranging from 75 to 180 microns.

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%, although a concentrate of 90% can be used if abrasive impurities such as silica are at a low level.

Graphite has traditionally 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 of between 85% and 90%, is required. Alkaline batteries require a purer natural graphite with a carbon content of at least 98%, 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% is required. Lump graphite, low-silica microcrystalline graphite and synthetic graphite are usually suitable.

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 five microns and must have a carbon content of between 96% and 99%.

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 between 96% and 99%.

In paint manufacture, graphite is used to protect metal surfaces exposed to a corrosive environment and to eliminate the accumulation of static electricity in floor coatings. Microcrystalline graphite of low carbon content, 50%-55%, is usually required.

In the manufacture of lead pencils, 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%, is used in the cheaper grades of leads.

However, a finely ground graphite with a higher carbon content, over 90%, 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 and 75 microns, with a low carbon content of 40%-70%.

Iron foundries use microcrystalline graphite as a recarburizer for raising the carbon content of iron melted in electrical furnaces from charges containing large proportions of scrap. A wide variety of material, such as synthetic graphite and coke, may serve as a substitute.

Other uses for natural graphite include engineering components, polishes, rubber products and explosives.

Growth Areas

Growing markets include exfoliated flake graphite rolled into sheet for the manufacture of gaskets and seals used in the automotive industry, heat exchangers, and other products; high alumina and magnesia graphite bricks for the refractory industry; zirconia-graphite; alumina-SiC-graphite refractories; and friction materials. Other growing markets are very high-purity graphite for specialty applications, metal powders and motor brushes.

Flexible Graphite

According to UCAR Carbon Company Inc., a manufacturer of graphite foil (grafoil or flexible graphite) in the United States, the world market for flexible graphite products was 5700 t in 1992. That market required some 8000 t of flake graphite raw material due to losses in the manufacturing process. Natural flake graphite normally used to manufacture flexible graphite comes from mines located in Madagascar, China, Brazil, Canada, India, Zimbabwe, Sri Lanka, Mexico and Norway. The flake quality and price are dependent upon the flake size distribution, fines content, carbon content, and ash content and distribution. Ash is defined as those elements present other than graphite. The size of ash particles, as well as the content, has an effect on the quality of the finished flexible graphite product. The ash normally consists of varying amounts of trace elements plus larger quantities of silica, sulphur, iron, aluminum and magnesium. The quality of the graphite raw material is also dependent on the quality and process control of the benefication process at the mine site, and must be closely monitored by the flexible graphite manufacturer.

The following table shows the markets for flexible graphite by use and geographic region.

FLEXIBLE GRAPHITE MARKETS (1992)

	Industrial	Automotive
	(t/y)	
North America	500	2 600
Japan	100	1 700
Europe	400	250
Other	100	50
Total	1 100	4 600

Source: UCAR Carbon Company Inc.

As mentioned earlier and as shown in the above table, the world market for flexible graphite was 5700 t in 1992, compared to 5500 t in 1990. World producers of flexible graphite include: UCAR Carbon Company Inc. and Polycarbon in the United States; SIGRI GmbH in Germany; Le Carbone Lorraine in France; and Nippon Carbon, Hitachi Chemical, and Toyo Tanso in Japan. There are very small producers in China and the C.I.S. UCAR is the world's largest producer of grafoil. It is reported by industry that markets for grafoil in the automotive industry are still growing. Prices for flexible graphite averaged US$12/kg in 1992, the same as in 1990.

WORLD PRODUCTION, TRADE AND CONSUMPTION

Preliminary figures for 1991 indicated that world production of natural graphite was close to 630 000 t. Some 35%-40% was flake graphite. The major producers of graphite were China, with an estimated 200 000 t, followed by South Korea (100 000 t), the C.I.S. (75 000 t), Brazil (32 000 t), and Mexico (31 000 t).

The major producing countries, by type of graphite and by decreasing order of importance, are as follows:

- **Flakes:** China, the C.I.S., Brazil, India, Madagascar, Germany, Canada and Norway.

- **Microcrystalline:** China, South Korea, Mexico, Czechoslovakia, Austria, North Korea, the C.I.S. and Zimbabwe.

- **Lump:** Sri Lanka.

A summary of the largest exporter and importer countries of graphite in recent years is as follows:

MAJOR EXPORTER AND IMPORTER COUNTRIES OF GRAPHITE IN RECENT YEARS

Country	Exports	Country	Imports
	(000 t/y)		(000 t/y)
China	100-130	Japan	90-95
South Korea	35-45	United States	40-45
Mexico	20	Germany	35-40
Canada[1]	15-18	United Kingdom	23-25
Madagascar	15	Taiwan	12-15
Zimbabwe	15	Italy	7
Brazil	15	France	6
Austria	7-10	Austria	5
Norway	3		
Germany[2]	2		

[1] Exports are expected to increase during the next five years as production capacity increases. [2] Excludes re-exports.

The largest consumers of graphite are the large producers of iron and steel, base metals and precious metals. Together they consume about 50% of all graphite and are the largest users of flake graphite. The largest consumer countries are the C.I.S., Japan, the United States, China, Germany, the United Kingdom, Italy, France and Brazil.

PRICES

Published prices for natural graphite provide only a range and are not representative of market prices, which are contracted prices negotiated between suppliers or distributors and consumers. The prices of flake graphite and lump graphite are higher than those for microcrystalline (amorphous) graphite because of the nature of the mining and processing operations. Prices for flake graphite concentrate vary depending on the carbon content, the size of the flakes and their distribution, and the ash content.

Prices have been reduced considerably in recent years due to lower demand and stronger competition; it is reported by industry that prices of some grades of graphite have declined about 40% during the past two years.

SUBSTITUTES

Molybdenum disulfide competes as a dry lubricant, but it is more sensitive to oxidizing conditions. Finely ground coke mixed with olivine is a potential competitor in foundry facing applications. Kish, a residue from steelmaking, is a potential substitute for flake graphite, and is under study by the U.S. Bureau of Mines in cooperation with the steel industry and Asbury Graphite Mills Inc.

OUTLOOK

Natural graphite has excellent physical and chemical properties; its resource base is large and it is readily available from several countries. For these reasons, growth should continue unless substitutes are developed. Canadian deposits are of the flake type, relatively easy to upgrade to +90% carbon, and many contain graphite that is expandable. Products made from expandable graphite command high prices and the outlook for growth for these products is good. The world's supply of natural graphite will continue to be abundant as many deposits await development.

Note: Information in this review was current as of February 1, 1993.

PRICES

"Industrial Minerals"1 pricing quotation, c.i.f., United Kingdom port, US$ per tonne

		1988	1989	1990	1991	1992
		Dec.	Dec.	Dec.	Dec.	Dec.
Crystalline lump	92%-95% C	750 – 1 500	750 – 1 500	750 – 1 500	750 – 1 500	750 – 1 500
Crystalline large flake	85%-90% C	820 – 1 300	820 – 1 300	820 – 1 300	650 – 1 200	400 – 800
Crystalline medium flake	85%-90% C	770 – 1 120	770 – 1 120	770 – 1 120	450 – 1 000	350 – 750
Crystalline small flake	80%-95% C	540 – 900	540 – 900	540 – 900	400 – 600	300 – 550
Powder (200 mesh)	80%-85% C	325 – 360	325 – 360	325 – 360	325 – 360	325 – 360
	90%-92% C	520 – 600	520 – 600	520 – 600	520 – 600	520 – 600
	95%-97% C	770 – 1 000	770 – 1 000	770 – 1 000	770 – 1 000	770 – 1 000
	97%-99% C	1 000 – 1 300	1 000 – 1 300	1 000 – 1 300	1 000 – 1 300	1 000 – 1 300
Amorphous powder	80%-85% C	220 – 440	220 – 440	220 – 440	220 – 440	220 – 440

c.i.f. Cost, insurance and freight.
1 "Industrial Minerals," December 1988, December 1989, December 1990, December 1991, and December 1992.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
25.04	Natural graphite				
2504.10.10	In powder	9.2%	6%	Free	Free
2504.10.20	In flakes	4%	2.5%	Free	Free
2504.90	Other	Free	Free	Free	Free
69.02	Refractory bricks, blocks, tiles and similar refractory ceramic constructural goods, other than those of siliceous fossil meals or similar siliceous earths				
6902.90.10	Other, containing by weight 85% or more of carbon or graphite	6.8%	4.5%	3.4%	Free
6902.90.90	Other	Free	Free	Free	2.9%
69.03	Other refractory ceramic goods (for example, retorts, crucibles and muffles, nozzles, plugs, supports, cupels, tubes, pipes, sheaths and rods), other than those of siliceous fossil meals or of other similar siliceous earths				
6903.10	Containing by weight more than 50% of graphite or other forms of carbon or of a mixture of these products				
6903.10.10	Crucibles and covers therefor	6.8%	Free	3.4%	2.9%
6903.10.91	Containing by weight 85% or more of graphite or other forms of carbon	6.8%	4.5%	4.6%	2.9%
6903.10.99	Other	Free	Free	Free	2.9%
8545.20	Carbon or graphite brushes	10.2%	6.5%	5.1%	2.2%[a]

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992.
[a] Equipment, originating in Canada, intended for use in the repair or maintenance of certain motor vehicles is subject to accelerated rate reductions.

TABLE 1. IMPORTS[1] OF CRUDE GRAPHITE AND GRAPHITE-RELATED PRODUCTS, 1991 AND 1992

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
2504.10	Natural graphite in powder or flake				
	United States	1 280	1 241	902	951
	People's Republic of China	66	31	98	47
	Germany	13	29	11	16
	Switzerland	–	–	5	11
	Other countries	62	108	11	24
	Total	1 421	1 411	1 027	1 050
2504.90	Natural graphite n.e.s.				
	United States	3 976	1 069	5 172	1 580
	Switzerland	18	53	–	–
	Total	3 994	1 122	5 172	1 580
6902.90	Refractory bricks, etc., n.e.s. (containing by weight more than 50% carbon or graphite)				
	United States	18 934	14 049	14 985	8 992
	United Kingdom	1 246	1 237	1 615	1 618
	Japan	443	1 370	273	998
	Italy	633	1 528	356	687
	Germany	1 075	2 414	795	551
	Other countries	1 641	3 255	254	137
	Total	23 972	23 853	18 278	12 983
6903.10	Refractory ceramic goods n.e.s., more than 50% of graphite or other forms of carbon, etc. (including crucibles)				
	United States	..	1 327	..	644
	France	..	229	..	237
	United Kingdom	..	635	..	230
	South Africa	..	107	..	138
	Germany	..	41	..	119
	Other countries	..	636	..	63
	Total	..	2 978	..	1 433
8545.20	Carbon or graphite brushes				
	United States	170	4 320	150	4 191
	Germany	3	138	6	338
	Japan	7	233	8	145
	Brazil	3	65	5	92
	France	2	95	3	62
	Other countries	6	173	3	102
	Total	191	5 024	175	4 930

Source: Statistics Canada.
– Nil; . . Not available; n.e.s. Not elsewhere specified; p Preliminary.
[1] Imports from "other countries" may include re-imports from Canada.
Note: Numbers may not add to totals due to rounding.

TABLE 2. EXPORTS OF NATURAL GRAPHITE, 1991 AND 1992

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
2504.10	Natural graphite in powder or flake	7 127	6 938	14 462	11 629
2504.90	Natural graphite n.e.s.	774	379	1 340	870

Source: Statistics Canada.
n.e.s. Not elsewhere specified; p Preliminary.

TABLE 3. REPORTED CONSUMPTION[1] OF GRAPHITE IN CANADA, 1986-91

	1986	1987	1988a,r	1989	1990	1991p
	(tonnes)					
Natural graphite						
Foundry facing	2 703	3 030	2 722	1 723	1 892	1 605
Refractories	757	740	673	643	415	274
Other uses[2]	1 050	1 499	1 522	1 625	2 876	2 184
Synthetic graphite						
Foundry facing	7 591	7 003	3 928	3 790	2 680	1 265
Other uses[3]	1 656	2 131	7 002	5 626	4 287	918
Total	13 757	14 403	15 847	13 407	12 150	6 246

Source: Energy, Mines and Resources Canada.
p Preliminary; r Revised.
a Increase in number of companies being surveyed.
1 Reported from EMR survey on the consumption of nonmetallic minerals by Canadian manufacturing plants.
2 Includes brake linings, chemicals, abrasives, primary steel and other end uses. 3 Includes abrasives, batteries, bearings and brake linings, cement, chemicals, primary steel and other uses.

TABLE 4. WORLD GRAPHITE PRODUCTION, BY COUNTRY[1]

Country[2]	1987	1988	1989	1990	1991[e]
			(tonnes)		
Argentina	216	24	100	100[e]	100
Austria	39 391	7 577	15 307	22 205[r]	10 000
Brazil (marketable)[3]	31 404	34 520	31 700[r]	30 000[r]	32 000
Burma[4]	–	–	–	45[r]	40
China[e]	185 000	200 000	200 000	200 000	200 000
Czechoslovakia	20 000[r]	15 000[r]	14 676[r]	12 171[r]	12 000
Germany	9 891	9 666	10 600[r]	10 437[r]	10 500
India (mine)[a]	42 589	57 325	58 000[r]	61 000[r]	60 000
Korea, North[e]	25 000	25 000	35 000	35 000	35 000
Korea, Republic of					
Amorphous	106 507	107 767	100 282	98 987[r]	100 000
Crystalline flake	838	678	1 186	703[r]	700
Madagascar	13 169	14 106	15 863	18 036[r]	18 000
Mexico					
Amorphous	36 674	47 871	38 304	23 916[r]	30 148
Crystalline flake	1 787	1 735	1 942	997[r]	1 256
Norway	–	–	1 800	6 930[r]	650
Romania[e]	12 000	12 000	10 000[b]	10 000[r]	10 000
Sri Lanka	9 400	8 547	4 163	5 469[r]	5 000
Turkey (mine)	11 760	12 911	11 302	12 000[e]	12 000
U.S.S.R.[e]	84 000	84 000	84 000	80 000	75 000
United States	–	w	w	–	–
Zimbabwe	13 530	11 441	18 147	16 383[r]	16 500
Total	643 156[r]	650 168[r]	652 322[r]	644 379[r]	628 894

Source: U.S. Bureau of Mines.
– Nil; e Estimated; r Revised; w Withheld to avoid disclosing company proprietary data.
[a] Indian marketable production is 10%-20% of mine production. [b] Reported figure.
[1] Table includes data available through May 9, 1991. [2] In addition to the countries listed, Canada produced graphite during the period covered by this table but output is unreported because of company confidentiality. [3] Does not include the following quantities sold directly without beneficiation: 1985, 16 425 t; 1986, 19 074 t; 1987, 10 505 t; 1988, 18 269 t (estimated); and 1989, 20 000 t (estimated). [4] Data are for fiscal year beginning April 1 of that stated.

Gypsum and Anhydrite

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GYPSUM

Weakness throughout most of the construction sector in 1992, except in British Columbia, continued to restrict demand for gypsum products. Total shipments of crude gypsum were 6.9 Mt valued at $79.2 million in 1992 (preliminary), compared to 6.7 Mt (final) valued at $71.7 Mt in 1991. Shipments from Nova Scotia, mainly dependent on captive markets for gypsum wallboard in the United States, remained about the same, whereas shipments from British Columbia were higher. Shipments from both Ontario and British Columbia are destined mainly for local captive use.

The Canadian Industry

Most deposits of gypsum being mined in the Atlantic provinces are characterized by high quality, amenability to inexpensive mining methods, and close access to coastal bulk-shipping facilities. Nova Scotia accounts for more than 75% of Canada's output and nearly all of its exports. Ontario production is used on site, except in the case of Westroc Industries Limited at Drumbo, which ships to the company's Mississauga wallboard plant. Production from Manitoba and from Windermere, Canal Flats (Lussier River), and Falkland, British Columbia, serve the Prairie region and a portion of the B.C. market not served by imports. Domtar Inc. meets most of the requirements of its wallboard plant in Surrey, British Columbia, with gypsum provided under a long-term contract by a 49% Domtar-owned Mexican affiliate, which supplies other company-owned plants further south along the U.S. west coast. About 60% of Canadian shipments of crude gypsum of domestic origin are moved by rail, according to the National Transportation Agency.

Canadian operations are mainly subsidiaries of U.S. gypsum product manufacturers. In Nova Scotia, National Gypsum (Canada) Ltd. is owned by the National Gypsum Company, and both Fundy Gypsum Company Limited and Little Narrows Gypsum Company Limited are owned by USG Corporation, the leading manufacturer of gypsum products in the United States.

Gypsum mining and related manufacturing plants are listed in Table 2. During the past few years, there has been a trend toward closing smaller, less efficient plants and improving the distribution systems associated with larger, more efficient plants.

Domtar Inc. of Caledonia, Ontario, used continuous mining technology at its No. 3 mine to supply the company's adjacent board complex (the new east plant) at Caledonia, Ontario. This allowed the complete phasing out of the No. 2 mine. Domtar's long-established mine at Flat Bay, Newfoundland, continued to supply the company's new US$35 million board plant in Newington, New Hampshire. In addition, the Flat Bay mine supplied raw material for about one half of the year to the wallboard manufacturing plant owned by Atlantic Gypsum Limited, a subsidiary of Lundrigans-Comstock Ltd. The manufacturing plant was closed during the latter part of 1992 because Lundrigans fell into receivership. CGC Inc., owned 75% by USG, continued its six-year project, which began in 1989, to develop ore reserves at Hagersville, Ontario. Production from the new eastern reserves will be phased in gradually as present reserves are depleted. CGC's wallboard plant in St-Jérome, Quebec, was mothballed in 1991 as a result of weak demand.

Louisiana-Pacific Corp., a major Oregon-based wood products manufacturer, continued to operate its new $65 million fibre-gypsum board plant at Port Hawkesbury, Nova Scotia, at a reduced level. Gypsum is purchased locally, perlite is imported, and large quantities of recycled paper are back-hauled, mainly from the United States. This project marks the first time that a local gypsum board product has been produced for both regional and export markets.

Eastern Gypsum Inc. of McAdam, New Brunswick, which operated a gypsum wallboard plant for a short period in 1991, remained inactive following its receivership in the same year.

Several companies now use recycled gypsum wallboard in the manufacturing process; Domtar's Surrey, British Columbia, wallboard plant was the first in North America to use large quantities. This was possible through arrangements with a reclaimer, New West Gypsum, of Vancouver, which operates a plant with a capacity of about 40 000 t/y. The source of the material is about 75% scrap from new construction sites and 25% waste from wallboard plants. In Ontario, CGC Inc., Domtar, and Westroc Industries Limited developed programs for accepting scrap wallboard from construction sites. This initiative was taken mainly because the city of Toronto banned the tipping of wallboard scrap into landfill sites reaching capacity levels.

Occurrences of gypsum, other than reserves being mined, are known to exist in a number of locations: 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, at Loos, and at O'Connor River in British Columbia; on the shores of Great Slave Lake, the Mackenzie River, Great Bear River and Slave River in the Northwest Territories; and on several Arctic islands. Of recent interest, Industrial Mineral Background Paper No. 12 entitled *Gypsum in Northern Ontario* describes the resources and market potential for high-purity gypsum in the Moose River Basin. This paper was published in 1990 by the Ontario Ministry of Northern Development and Mines.

World Developments and Trade

Gypsum-related projects are generally limited to the industrialized countries because of dependence on the building construction sector. However, world reserves are widespread and are conservatively estimated to be more than 2.4 billion t. World production of gypsum in 1992 was an estimated 98 Mt, according to the U.S. Bureau of Mines. The United States ranked number one with 14.8 Mt, followed by China (8.1 Mt), and Canada (6.9 Mt).

International trade has become more important in North American markets in recent years as a result of low production costs and competitive shipping rates. In particular, U.S. imports of gypsum from Spain remain relatively high, amounting to several hundred thousand tonnes per year. Relatively low east-to-west backhaul freight rates are the main factors at work. Canada's imports of gypsum from Mexico, as described earlier, as well as those from the United States, are used by both wallboard and cement manufacturers. Imports from Spain, however, are used only by specific cement manufacturers.

Imports of low-priced wallboard from the United States into Canada have increased since 1986, and amounted to about 9% of domestic consumption in 1991. Following a complaint by the three major wallboard manufacturers, Revenue Canada determined in late 1992 that U.S. gypsum exporters dumped product in Canada. Eight U.S. exporters were identified; the overall weighted average percentage margin was estimated to be about 27%. (Gypsum wallboard capacity in the United States is an estimated 2.2 billion m^2, an amount much more than sufficient to meet current demand.)

Processing and Markets

Gypsum is a hydrous calcium sulphate ($CaSO_4 \cdot 2H_2O$) 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. This is particularly suited to products including wallboard, lath, and tile. Anhydrite, an anhydrous calcium sulphate ($CaSO_4$), is commonly associated geologically with gypsum but is not a suitable substitute for most uses.

The type of processing necessary depends upon end-use requirements. Crude gypsum is crushed, pulverized and calcined to make a stucco mainly for the manufacture of wallboard, lath, and sheathing, which together account for more than 75% of end uses in North American markets. These products are formed by introducing a slurry of stucco, foam, pulp, and starch between two unwinding rolls of absorbent paper, resulting in a continuous "sandwich" of wet board. As the stucco hardens, the board is cut to pre-determined lengths, dried, bundled and stacked for shipment. These products may also be manufactured with asphalt-impregnated paper and with asphalt added to the gypsum core to improve water resistance. Stucco may also be adapted for other construction uses after mixing with water and aggregate (sand, vermiculite or expanded perlite) for application over wood, metal or gypsum lath to form interior wall finishes.

In general, the wallboard industry serves the residential, institutional and commercial building sectors. Housing starts have become a less reliable indicator of the demand for gypsum wallboard because its improved fire-retardant qualities, along with increased renovation activity, has encouraged its broader use.

The Portland cement industry accounts for about 15% of the gypsum used in North America. Crushed, uncalcined gypsum, acting as a set regulator, in a proportion up to 5% by total weight, is ground with the primary stage clinker to produce the final cement product. Based on this proportion of gypsum, crushed to about –13 mm, the total amount required by cement producers in Canada is estimated to be about 400 000 t/y.

For agricultural purposes, specifications mainly relate to the degree of fineness. Gypsum combines with potassium aluminum silicates in the soil resulting in the release of potassium for use as a nutrient. Also, gypsum serves to reduce sub-soil acidity, which is particularly beneficial in aluminum-rich lateritic soils. In addition, it provides a source of calcium and sulphur trioxide and helps break up hard soils, allowing better aeration and water penetration and retention.

For filler uses, gypsum is dried and finely ground to a range of particle sizes for use in joint compounds (mainly with gypsum wallboard), plastics, paint and paper. Relatively pure uncalcined gypsum, depending on glass batch chemistry, may also substitute for salt cake (sodium sulphate) in glass manufacturing. Special high-purity gypsum may be used in foods and pharmaceutical products.

Ortech International is planning a third conference, the "Third International Conference on FGD Gypsum and Power Plant By-Products," to be held in Toronto in 1993. By-product gypsum produced by the acidulation of phosphate rock during the manufacture of phosphate fertilizer has not been utilized in Canada. In the case of phosphogypsum produced from sedimentary phosphate rock, which can contain significant quantities of uranium and radium, studies have indicated that a potential radiation hazard exists. In the United States, interest is increasing in flue-gas derived (FGD) gypsum. At least partial substitution of this by-product for natural gypsum has been accomplished at several wallboard plants.

Gypsum and Anhydrite is one of a series of 19 reports published by the Canada Centre for Mineral and Energy Technology (CANMET Summary Report No. 7). Each of these industrial mineral reports summarizes information on mineral occurrences, deposits of specific interest, product uses and specifications, and process technology.

Canadian Standards Association (CSA) Standards A 91.20 and A 91.31 relate to gypsum and gypsum products.

PRICES

Prices for gypsum in non-captive markets are negotiated, the only published figure being an approximate minimum price for crude material, ex-mine or c.i.f. United Kingdom, published in *Industrial Minerals*. In the United States, prices for crude material, f.o.b. mine, have fallen from US$8.03/t in 1989 to US$6.72/t in 1992, according to preliminary information from the U.S. Bureau of Mines.

OUTLOOK

In 1993, shipments of gypsum are expected to be in the range of 7.2-7.6 Mt, tending to be lower than the average of 7.6 Mt shipped during the three-year period from 1989 through 1991 (based on final figures). Canadian housing starts were 182 000 in 1990, 156 000 in 1991, and 168 000 in 1992. The recovery is expected to continue in this sector with an estimated 180 000 starts in 1993. Non-residential building construction is expected to remain weak given the relatively high office and industrial vacancy rates.

Construction spending in the United States rose more than 6% in 1992, the largest increase in six years. Most of the increase was in single-family housing; this strength is expected to continue to boost the overall construction sector.

Although new construction materials are being introduced, the demand for gypsum wallboard is expected to remain popular because of its low price, ease of installation, and well-recognized fire-retarding properties. The present structure of the industry in Canada is not expected to change greatly, although future availability of by-product gypsum based on satisfying stricter environmental controls will likely influence developments in some areas. The recycling of scrap and waste gypsum from construction sites and wallboard manufacturing lines is expected to become more important in both Canada and the United States.

ANHYDRITE

Production and trade statistics for anhydrite are included with gypsum.

Anhydrite, the anhydrous form of gypsum (about twice as hard and also heavier than gypsum), is produced by Fundy Gypsum Company Limited at Wentworth, Nova Scotia, and by Little Narrows Gypsum Company Limited at Little Narrows, Nova Scotia.

Production of anhydrite in 1991 was 132 800 t based on final figures, and in 1992 was an estimated 153 000 t, according to the Nova Scotia Department of Natural Resources. Shipments were mainly to the United States for use in manufacturing Portland cement and as a peanut crop fertilizer. Also, minor quantities were shipped to Quebec and Ontario for the manufacture of cement.

Testwork was conducted in Nova Scotia on the utilization of anhydrite in floor screed and suspended floor systems. This was undertaken as part of the Canada-Nova Scotia Mineral Development Agreement (MDA-II, 1990-93). The project, involving the Canada Centre for Mineral and Energy Technology (CANMET) of Energy, Mines and Resources Canada, and the private sector, relates to optimizing compressive strength and dry shrinkage using suitable plasticizers. Product demonstrations are planned at a later date.

On-site testing continued for using anhydrite (in combination with water and special chemicals) as a mine "pack" construction material to improve underground support in coal mines. This work is based on an earlier cooperative program (MDA-I) involving CANMET and the Technical University of Nova Scotia.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2520.10	Gypsum; anhydrite	Free	Free	Free	Free
68.09	Articles of plaster or of compositions based on plaster: Boards, sheets, panels, tiles and similar articles, not ornamented				
6809.11	Faced or reinforced with paper or paperboard only				
6809.11.10	Gypsum wallboard	9.4%	Free	4.7%	1.4%
6809.11.90	Other	9.2%	Free	4.6%	1.4%
6809.19.00	Other	10.2%	6%	5.1%	3.6%
6809.90	Other articles				
6809.90.10	Models and casts, of a kind used in the manufacture of dental prosthesis	Free	Free	Free	2.5%
6809.90.90	Other	10.2%	6.5%	5.1%	2.5%

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992.

TABLE 1. CANADA, GYPSUM PRODUCTION AND TRADE, 1990-92

Item No.		1990		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
PRODUCTION (SHIPMENTS)							
	Crude gypsum						
	Nova Scotia	5 971 222	52 818	5 229 127	49 856	5 222 705	55 164
	Ontario	1 123 719	17 090	804 653	13 388	857 495	13 924
	British Columbia	410 616	x	308 298	x	475 689	x
	Manitoba	x	x	x	x	x	x
	Newfoundland	x	x	x	x	x	x
	Total[1]	7 977 685	80 080	6 727 221	71 654	6 891 875	79 206
IMPORTS						(Jan.-Sept.)	
2520.10	Gypsum, anhydrite						
	Mexico	105 133	3 352	158 917	4 325	143 848	3 423
	United States	126 442	1 962	48 171	1 376	30 922	958
	Spain	85 997	985	42 448	341	–	–
	Other countries	542	27	327	20	187	10
	Total	318 114	6 326	249 863	6 062	174 957	4 391
		(square metres)		(square metres)		(square metres)	
6809.11	Plasterboards, etc., not ornamental; faced or reinforced with paper or paperboard						
	United States	18 668 598r	20 317r	18 628 643	20 741	13 791 189	13 499
	United Kingdom	. .	191	1 227	99	20 335	127
	Total	18 668 598r	20 509r	18 629 870	20 840	13 811 524	13 627
6809.19	Plasterboards, etc., not ornamental; faced or reinforced, n.e.s.						
	United States	. .	1 751	. .	1 233	. .	1 475
	United Kingdom	. .	103	–	–	. .	22
	Other countries	–	–	. .	52	–	–
	Total	. .	1 854	. .	1 286	. .	1 497
6809.90	Articles of plaster or compositions based on plaster, n.e.s.						
	United States	. .	1 469	. .	1 600	. .	1 477
	United Kingdom	. .	788	. .	733	. .	654
	Taiwan	. .	52	. .	68	. .	88
	Italy	. .	257	. .	80	. .	61
	Other countries	. .	345	. .	104	. .	126
	Total	. .	2 911	. .	2 585	. .	2 406
	Total imports of gypsum and gypsum products	. .	31 600r	. .	30 773	. .	21 921

TABLE 1 (cont'd)

Item No.		1990		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
EXPORTS							
2520.10	Gypsum, anhydrite						
	United States	5 756 919	52 554	4 929 036	44 381	3 873 326	35 933
	Other countries	408	181	11 157	119	7	1
	Total	5 757 327	52 735	4 940 193	44 500	3 873 333	35 934
		(square metres)		**(square metres)**		**(square metres)**	
6809.11	Plasterboards, etc., not ornamental; faced or reinforced with paper or paperboard						
	United States	27 996 949	28 914	9 919 679	9 500	8 429 074	8 083
	Other countries	76 383	92	43 200	96	234 832	651
	Total	28 073 332	29 006	9 962 879	9 596	8 663 906	8 734
6809.19	Plasterboards, etc., not ornamental; faced or reinforced, n.e.s.						
	United States	. .	3 150	. .	5 364	. .	3 473
	Other countries	. .	204	. .	420	. .	172
	Total	. .	3 354	. .	5 784	. .	3 645
6809.90	Articles of plaster or compositions based on plaster						
	United States	. .	3 561	. .	967	. .	962
	Other countries	. .	124	. .	66	. .	18
	Total	. .	3 685	. .	1 033	. .	980
	Total exports of gypsum and gypsum products	. .	88 780	. .	60 913	. .	49 293

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available; n.e.s. Not elsewhere specified; p Preliminary; r Revised; x Confidential.
1 Totals do not include gypsum produced or shipped for use by Canadian Portland cement producers.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, GYPSUM MINING AND GYPSUM PRODUCTS MANUFACTURING OPERATIONS, 1992

Company	Location	Operation
NEWFOUNDLAND		
Domtar Inc.	Flat Bay	Open-pit mining
Atlantic Gypsum Limited	Corner Brook	Wallboard manufacture
NOVA SCOTIA		
Domtar Inc.	McKay Settlement	Open-pit mining
	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, Sugar Camp	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
QUEBEC		
CGC Inc.	Montréal	Wallboard manufacture
	St-Jerome	Wallboard plant mothballed
Domtar Inc.	Montréal	Distribution terminal only
Westroc Industries Limited	Ste. Catherine d'Alexandre	Wallboard manufacture
ONTARIO		
CGC Inc.	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.	Amaranth	Open-pit mining
	Winnipeg	Wallboard manufacture
Westroc Industries Limited	Amaranth	Open-pit mining
	Winnipeg	Wallboard manufacture
SASKATCHEWAN		
Domtar Inc.	Saskatoon	Closed wallboard manufacturing plant in 1988
ALBERTA		
Domtar Inc.	Edmonton	Wallboard manufacture
Westroc Industries Limited	Calgary	Wallboard manufacture
BRITISH COLUMBIA		
Domtar Inc.	Canal Flats	Open-pit mining
	Vancouver	Gypsum products manufacture
Westroc Industries Limited	Vancouver	Gypsum products manufacture
	Windermere	Open-pit mining

Source: Energy, Mines and Resources Canada.

TABLE 3. CANADA, GYPSUM PRODUCTION, TRADE AND CONSUMPTION, 1975 AND 1980-92

	Production[1]	Imports[2]	Exports	Apparent Consumption[3]
		(tonnes)		
1975	5 719 451	553 338	3 691 676	2 083 113
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
1985	7 760 783	121 802	5 879 664	2 002 921
1986	8 802 805	221 644	5 921 982	3 102 467
1987	9 093 926	217 625	5 704 853	3 606 698
1988[a]	8 813 760	274 917	5 651 286	3 437 391
1989	8 179 588	291 373	5 357 055	3 113 906
1990	7 977 685	318 114	5 757 327	2 538 472
1991	6 727 221	255 538	4 940 614	2 042 145
1992[p]	6 891 875	260 505	5 041 755	2 110 625

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[p] Preliminary.
[a] Beginning in 1988, imports and exports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Imports and exports include HS class 2520.10.00 gypsum; anhydrite.
[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, 1990 AND 1991

	Starts			Completions			Under Construction		
	1990	1991	% Diff.	1990	1991	% Diff.	1990	1991	% Diff.
Newfoundland	3 245	2 836	–13	3 127	3 219	+3	3 201	2 867	–10
Prince Edward Island	762	553	–17	683	722	+6	463	281	–39
Nova Scotia	5 560	5 173	–7	5 477	4 905	–10	3 376	3 567	+6
New Brunswick	2 683	2 872	+7	2 959	2 858	–3	1 359	1 366	+1
Subtotal (Atlantic provinces)	12 250	11 434	–7	12 246	11 704	0	8 402	8 081	–4
Quebec	48 070	44 654	–7	52 630	42 720	–19	14 719	15 662	+6
Ontario	62 649	52 794	–16	80 562	59 622	–26	47 808	40 599	–15
Manitoba	3 297	1 950	–41	4 028	2 190	–46	1 316	1 029	–22
Saskatchewan	1 417	998	–30	1 575	1 241	–21	809	509	–27
Alberta	17 227	12 492	–17	17 467	12 959	–26	5 973	5 497	–8
Subtotal (Prairie provinces)	21 941	15 440	–30	23 070	16 390	–29	8 098	7 035	–13
British Columbia	36 720	31 875	–13	37 655	29 578	–21	21 645	23 658	+9
Total Canada	181 630	156 197	–14	206 163	160 014	–22	100 672	95 035	–6

Source: Canada Mortgage and Housing Corporation.

TABLE 5. CANADA, VALUE OF CONSTRUCTION BY TYPE,[1] 1990-92

	1990	1991	1992
		($ millions)	
BUILDING CONSTRUCTION[2]			
Residential	41 012	36 776	41 115
Industrial	4 344	3 416	2 840
Commercial	16 574	14 009	12 637
Institutional	5 536	5 630	6 189
Other building	2 581	2 550	2 527
Subtotal	70 047	62 382	65 307
ENGINEERING CONSTRUCTION[2]			
Marine	586	627	681
Highways, airport runways	6 463	6 308	6 478
Waterworks, sewage systems	2 925	2 742	2 972
Dams, irrigation	456	459	445
Electric power	6 132	7 285	7 557
Railway, telephones	3 612	3 040	3 296
Gas and oil facilities	8 325	9 914	9 219
Other engineering	3 820	3 370	3 303
Subtotal	32 320	33 743	33 952
Total construction	102 367	96 125	99 259

Source: Statistics Canada.
[1] Actual expenditures 1990; preliminary 1991; intentions 1992. [2] Includes total value of new and repair work purchased.
Note: Numbers may not add to totals due to rounding.

TABLE 6. WORLD PRODUCTION OF GYPSUM, 1991 AND 1992

	1991	1992[e]
	(000 tonnes)	
United States	14 021	14 800
People's Republic of China	8 165	8 200
Iran	8 001	8 000
Thailand	7 197	7 300
Canada	6 727	6 900
Japan	6 350	6 400
Mexico	5 534	5 600
France	5 602	5 600
Spain	4 990	5 000
United Kingdom	3 502	3 500
Australia	2 000	2 100
Other countries	20 570	23 400
Total world	92 659	96 800

Sources: Energy, Mines and Resources Canada; U.S. Bureau of Mines, Mineral Commodity Summaries, January 1993.
[e] Estimated.

Iron Ore

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World iron ore production in 1992 declined for the third year in a row in response to lower demand by steel producers. At 930 Mt, it was 6% lower than the record established in 1989. Japanese steel production fell by 12% in 1992, which was the major cause of a 10% drop in world trade in iron ore. World trade fell to 360 Mt, after four years at close to 400 Mt.

The prices for internationally traded iron ore, which reached peaks in 1982 and 1991, weakened in 1992 as the market adjusted for lost production in Liberia and steel production faltered in Europe and Japan. With a weak market at the end of the year, prices negotiated for 1993 delivery were reduced by 10%-14%.

Canadian iron ore producers had a difficult year in 1992 because exports, which represent 80% of Canadian shipments, were 2.2 Mt lower than in 1991 and prices had been cut at the beginning of the year. Pellet shipments fell to their lowest level since 1983. The value of all shipments decreased by 9% to $1.1 billion.

After a difficult year in 1990, the Canadian steel industry continued along the road to recovery in 1991 and 1992. However, at best, only seven blast furnaces were operating during 1992 compared to ten in October 1989. Domestic consumption of iron ore exceeded 13 Mt, of which 7.7 Mt was Canadian ore, an increase of 11% over the use of domestic ore in 1991. Imports, mainly from the United States, remained high, accounting for 40% of Canadian steel plant consumption of iron ore.

CANADIAN DEVELOPMENTS

The four Canadian iron ore mines and ancillary plants produced 34.4 Mt of concentrate, pellets and sinter from hematite and siderite ores in 1992.

The production of concentrate that was not further processed to pellets or sinter decreased 15% to 13.8 Mt as demand for fines and concentrate in Europe declined. Acid and fluxed pellet production was steady at 14.1 Mt and 5.5 Mt respectively. Sinter produced at the mine site amounted to 985 336 t, of which 457 473 t was attributed to siderite ore and the remainder to recycled oxides and reverts from steel plants. Iron ore shipments were some 1.4 Mt lower than production for the year. As a consequence, producer stockpiles increased and the two largest mines closed for part of the summer. The stockpile situation also led to planned shut-downs and layoffs at some mines in 1993.

Employment at Canadian iron ore mines, concentrators, agglomerating plants and support services declined below 5700 by the end of 1992; more layoffs, announced at year-end, will take effect in 1993.

There are three mines in the Labrador Trough area of northern Quebec and Labrador, and these account for over 96% of Canadian iron ore production. The mines belong to Quebec Cartier Mining Company (QCM), Iron Ore Company of Canada (IOC), and Wabush Mines. There is also one mine in Ontario. Other iron ore mines, which were operating in various provinces over the last 20 years, have closed due to high operating costs and depleted reserves. In British Columbia, by-product iron concentrate production is less than 15 000 t/y. QIT-Fer et Titane Inc. makes pig iron from ilmenite mined near Havre St. Pierre, Quebec; its production is counted in primary iron statistics (refer to chapter on Primary Iron).

QCM produced 15.3 Mt of ore in 1992, 1 Mt less than in 1991. QCM shipped 14.1 Mt of ore, of which 7.2 Mt was concentrate destined mainly for Europe. The remaining shipments were low-silica pellets for direct reduction, acid pellets and fluxed pellets. Because of the surplus production, QCM shut down operations for four weeks in July and from December 15, 1992 to January 12, 1993. Furthermore, the work force was reduced by 70 unionized employees in the last quarter of 1992. In 1993, QCM plans an eight-week summer shut-down and workforce reductions of 55 management and 175 unionized employees. Forecast sales for 1993 are 14.5 Mt.

QCM is researching magnetic separation and column flotation of tailings from the concentrate circuit to improve iron recoveries. Success in this research would also increase QCM's supply of low-silica concentrate and pellets, which could be marketed for direct reduction and new smelting techniques.

IOC produced 13.5 Mt of iron ore concentrate in 1992, from which it produced 6.7 Mt of acid pellets, 1.4 Mt of fluxed pellets, and 5.4 Mt of concentrate for shipment. The mine, concentrator and pellet plant operated at about 80% of capacity during the year. IOC closed for five weeks in the summer in response to low demand for iron ore and to permit rebuilding of primary crusher No. 1.

Some 12.8 Mt of iron ore was shipped by IOC in 1992, almost 2.5 Mt less than in 1991. The major change was a drop in concentrate exports to Europe. Sales of the highest value product, fluxed pellets, were down by 0.4 Mt.

Between January 1992 and January 1993, IOC reduced its workforce by 400 through early retirements and layoffs. The workforce reduction was necessary to control costs during the current period of low sales volume and low prices. In 1993, IOC is expecting a further decrease in sales and is planning a five-week shut-down in July.

IOC invested in a replacement rotary dumper at Sept-Îles and in three new trucks and a drill at Carol Lake. IOC and the Canada Centre for Mineral and Energy Technology (CANMET) continued research on improving the iron ore recovery rate and the production of low-silica pellets.

Mitsubishi Corporation completed the purchase of 20% of IOC, buying most of the shares that had belonged to M.A. Hanna Company. Under the new structure, the ownership is: Bethlehem Steel, 34.52%; National Steel, 19.96%; Labrador Mining & Exploration, 11%; Mitsubishi Corporation, 20%; M.A. Hanna, 8.14%; and Dofasco Inc., 6.38%. Mitsubishi also purchased half of the IOC sales agency, which it now runs with M.A. Hanna Company.

Wabush Mines produced six products in 1992: concentrate, fluxed pellets, and acid pellets, each available with either 1% or 2% manganese content. Wabush shipped 4.6 Mt of pellets (about evenly split between 1% and 2% manganese) and 0.5 Mt of concentrate. Because the market for pellets was depressed, Wabush reduced its production capacity from 6.1 Mt/y to 4.6 Mt/y in 1992, and reduced the workforce by some 200 people.

Wabush continued research on improving iron ore recovery rates and removing manganese from the concentrate. It intends to increase the proportion of 1% manganese from 50% of total concentrate production in 1992 to 70% of production in 1993.

The Algoma Ore Division (AOD) of Algoma Steel Inc. produced 985 000 t of superfluxed sinter at its plant at Wawa, Ontario. The plant used siderite ore from the adjacent mine, but over 40% of the feed was recycled material from steel mills. Shipment figures in Table 1 have been revised and show only the volume of sinter that can be attributed to the iron ore mined in Canada. Algoma is examining the possibility of closing the mine and sinter plant as part of a restructuring of operations.

The export market for Canadian iron ore was affected by a 3% decline in world steel production in 1992 relative to 1991. Although influenced by the drop in steel production in Japan, the greatest effect on Canadian exports came from reduced sales to Germany and the United Kingdom. Canadian iron ore exports were about 2 Mt lower in 1992 than in 1991.

WORLD DEVELOPMENTS

World iron ore production in the first six months of 1992 amounted to about 456 Mt; EMR estimates full-year production at 930 Mt, the lowest level since 1986. China, Brazil, Australia and the Ukraine are the world's largest iron ore producers, accounting for over half of the total.

World trade in iron ore was 180 Mt for the first six months of 1992 and, by EMR estimates, reached only 360 Mt for the year. Brazil, at 110 Mt, again led the world in iron ore exports but, because of lower sales in Europe and Japan, was unable to maintain the 114-Mt level of the previous three years. Australia was second (108 Mt), and the next largest exporters were India (31 Mt) and Canada (26 Mt). Japan's imports of iron ore dropped to 101 Mt from an average of 126 Mt in the previous four years, while the European Economic Community took about 128 Mt after two years at 133 Mt.

Exports account for more than three quarters of Canada's iron ore shipments and, although the largest single customer is the United States, European destinations account for 50% of all shipments of Canadian iron ore. The Canadian industry is, therefore, very sensitive to competition from U.S. mines in the North American market and to competition from countries that ship to the European market.

In the United States, steel production recovered a little in 1992 and iron ore consumption increased by 4.7 Mt. The consumption of U.S. ore returned to the 1990 level of 55 Mt, an increase of nearly 6 Mt over 1991. Consumption of ore imported from Canada declined from 7.2 Mt to 6.8 Mt.

Brazil's largest iron ore producer, Companhia Vale do Rio Doce (CVRD), cut back production in 1992 in response to lower demand in Japan and Europe. On the other hand, Brazil's second largest iron ore company, Minerações Brasileiras Reunidas SA, continued the construction of mining and rail facilities to replace depleted mines and to increase production capacity by about 10 Mt over the next 10 years.

Australian iron ore production capacity is in the process of being increased and consolidated at about 140 Mt/y. However, in 1992, its production was 115 Mt and exports were 108 Mt, both down by about 5% relative to 1991. Major expansions and new mines planned in the Pilbara region of Western Australia will replace less profitable mines and depleted reserves for a net increase in production capacity of some 20 Mt/y.

The Ukraine produced 86.8 Mt of iron ore in 1991, of which 22.1 Mt was pellets. Estimated production of iron ore in all forms for 1992 is 74 Mt. Iron ore exports, estimated at 15 Mt for the year, included between 4 and 5 Mt of pellets. Russia, with an iron ore industry nearly as large as the Ukraine's, has not released data for 1992, but its exports were an estimated 12 Mt.

The Swedish iron ore industry produced 19.5 Mt and exported just under 16 Mt in 1992. With the closure of the Dannemora mine after 500 years of operation, the industry now consists of two mines, both north of the arctic circle.

The civil unrest in Liberia continued to hinder mining and rail transportation of iron ore to the ports in that country. Shipments are estimated at 1.6 Mt in 1992.

UNCTAD Work on Iron Ore

In 1989, several countries, including Canada, cooperated in setting up a trust fund under the United Nations Conference on Trade and Development (UNCTAD) to collect and publish statistics on iron ore for all the major producing, consuming and trading countries. The project is the primary source of trade flow data on the major importing and exporting countries, giving exports by destination and imports by source. The trust fund project produced two statistical reports and a market review in 1992. Supporting countries will provide sufficient funds to continue the project until March 1994, but the size of the publications will be reduced.

The Intergovernmental Group of Experts on Iron Ore (IGE), also under UNCTAD, met in Geneva October 26-28, 1992, with representation from 32 countries and several international agencies. The quality of the information benefitted from the active participation of industry advisors. The UNCTAD Secretariat, working for the IGE, also published iron ore statistics which were complementary to the trust fund project publications. The UNCTAD reports cover more countries, include the iron content of the ore, and provide forecasts on iron ore, pig iron and steel. The Secretariat has contacts in 87 countries covering all significant producers and consumers. For example, the Ukraine and Latvia supplied their own statistics separate from the Commonwealth of Independent States in 1992.

The IGE is scheduled to meet again in October 1993 to discuss developments in the production, marketing and consumption of iron ore.

Price

Iron ore exporters were obliged to take price reductions for deliveries in 1992. In Europe, the price decreased by 4.2% for fines and concentrate used as sinter feed, and by 6.89% for pellets. The Japanese steel mills negotiated decreases of 4.8% for fines and concentrate and 6.89% for lump ore.

The price difference between pellets and fines narrowed, for the second year running, to 16.2¢ on the basis of US¢/Fe unit.[1] The pellet producers had regarded the 1990 premium of 21¢ for pellets as reasonable, given the higher costs of production relative to concentrate.

Negotiations for 1993 deliveries led to price cuts again in both the European and Japanese markets. In Europe, prices were cut by 14% for fines and concentrate, and by 10.3% for pellets; the premium for pellets was thereby reduced to 15.75¢. Japanese steel-makers made price cuts of 11% on fines and 9% on lump ore in negotiations with their Australian suppliers.

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[1] Price is reported in cents, U.S. currency, for each percentage point of iron in a tonne of ore; e.g., at 30¢/Fe unit, ore grading 65% iron would bear a price of 65 x 30¢ = US$19.50/t.

OUTLOOK

The International Iron & Steel Institute (IISI) has forecast growth in steel production worldwide at less than 2%/y. If a more conservative linear growth rate is assumed, the increase would be between 10 and 15 Mt/y. Unfortunately, that growth is mainly in developing countries and is not forecast for the regions where Canadian iron ore is currently sold. In North America, for example, steel production is not expected to recover to the 1988 level until 1997. In Europe, the steel industry and the Commission of the European Communities are examining ways to reduce steel production by 25%.

Furthermore, the steel industry is using less iron ore per tonne of steel each year in our traditional market areas. The lower consumption of iron ore is due to an increased proportion of steel production at electric arc furnaces using scrap, and higher efficiency in steel production at the basic oxygen furnaces.

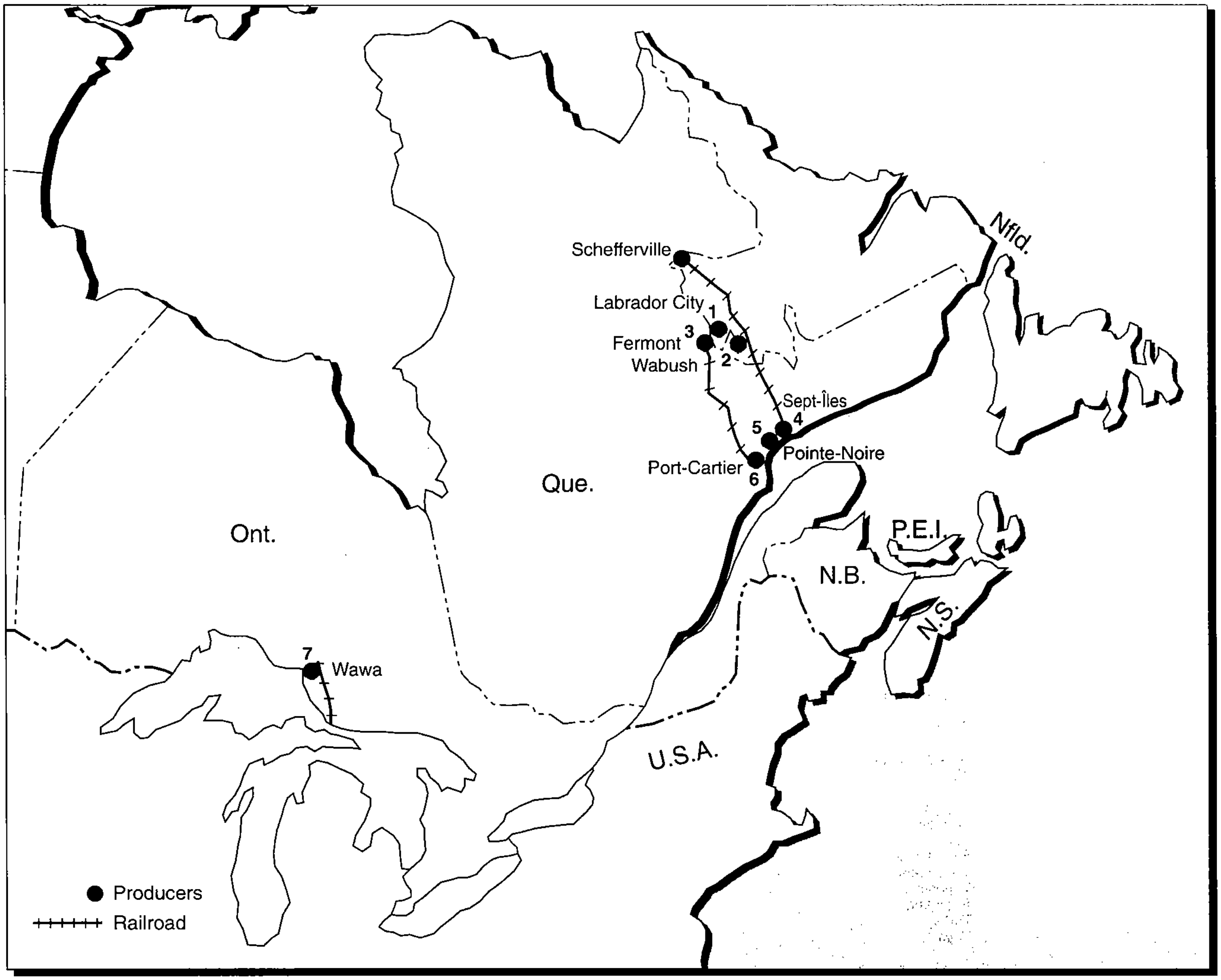
With the opening of Eastern European countries to Western development, the German steel industry is taking a lead role in restructuring the steel mills in those countries in transition. At the same time, the German industry is constructing new electric arc furnaces which will use ferrous scrap as their primary source of iron units. These activities are related since the countries in transition are believed to have very large scrap resources, some of which are at the sites of existing steel mills.

The use of electric arc furnaces is expected to continue to increase in areas with scrap supplies because: a) the electric furnaces can be small and close to the customer; b) they require lower capital investment than integrated mills; c) they have lower labour costs per unit output; d) they are operated as batch processes so they can adjust quickly to changes in the market; and e) as long as they are using recycled material (i.e., scrap), the energy consumption per tonne of steel is lower than at integrated mills.

In the long term, the outlook for iron ore is good. Scrap supply is expected to tighten and scrap prices are forecast to rise. In addition, the quality of scrap is compromised by the alloying and tramp elements that are included. Therefore, iron ore-based feed continues to hold advantages in the production of higher grades of steel. Finally, new direct smelting processes using iron ore, which use energy more effectively than before, are being developed. Consequently, the consumption and prices of iron ore in Canada's traditional markets are forecast to recover in the next decade.

Note: Information in this review was current as of February 1, 1993.

Figure 1
Iron Ore in Canada, 1992



Numbers refer to locations on map above.

Producers

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. Algoma Ore, division of Algoma Steel Inc. (mine/concentrator/sinter plant)

TABLE 1. CANADA, IRON ORE PRODUCTION AND TRADE, 1991 AND 1992

Item No.		1991		1992p	
		(tonnes)[1]	($000)	(tonnes)[1]	($000)
PRODUCTION (mine shipments)					
	Newfoundland	19 799 248	714 885	18 399 000	680 247
	Quebec	14 905 248	x	13 861 000	x
	Ontario	649 746	x	450 246	x
	British Columbia	67 005	1 514	61 700	1 292
	Total[2]	35 421 247	1 228 188	32 771 946	1 129 371
IMPORTS				(Jan.-Sept.)	
2601.11	Iron ore concentrates, non-agglomerated				
	United States	14 693	509	19 436	582
	Brazil	–	–	6 499	340
	Total	14 693	509	25 935	922
2601.12	Iron ore, agglomerated				
	United States	4 899 350	193 122	3 692 002	155 372
	Brazil	61 163	1 844	41 087	1 471
	Venezuela	–	–	5 000	600
	Total	4 960 513	194 966	3 738 089	157 444
EXPORTS					
2601.11	Iron ore concentrates, non-agglomerated				
	Germany	3 126 173	74 842	2 020 655	49 754
	United Kingdom	2 676 550	60 583	1 354 672	33 606
	France	1 481 914	33 010	1 201 212	28 088
	Netherlands	2 734 769	51 233	1 157 574	21 647
	Japan	1 880 306	29 955	790 564	12 475
	Belgium	290 243	7 500	349 169	9 974
	Italy	331 791	8 287	394 846	9 599
	South Korea	1 162 277	21 553	515 358	9 230
	United States	359 960	8 684	201 899	4 611
	Spain	280 177	6 870	149 141	3 845
	Philippines	422 933	6 527	219 699	3 466
	Sweden	301 491	7 176	74 848	1 906
	Portugal	78 585	2 004	71 176	1 699
	Finland	–	–	31 027	566
	Israel	154 868	2 826	–	–
	Yugoslavia	30 836	562	–	–
	Venezuela	217	30	–	–
	Total	15 313 090	321 649	8 531 840	190 473
2601.12	Iron ore, agglomerated				
	United States	6 906 133	293 005	4 210 555	182 015
	Netherlands	1 281 353	43 686	1 218 927	40 824
	Germany	1 843 835	70 281	1 015 714	38 868
	Belgium	957 689	35 893	958 669	35 726
	United Kingdom	1 226 054	43 315	901 003	31 546
	Italy	523 204	25 005	512 661	24 500
	Spain	413 653	16 107	323 809	12 075
	France	619 121	22 626	233 696	8 323
	Portugal	111 704	4 060	173 837	6 335
	Poland	56 483	2 696	62 625	2 989
	Switzerland	200 104	3 817	91 444	2 935
	Venezuela	109	13	396	83
	Yugoslavia	120 006	4 121	–	–
	Argentina	60 856	2 904	–	–
	Turkey	54 121	2 583	–	–
	Total	14 374 425	570 119	9 703 336	386 225
	Total exports, all classes				
	United States	7 266 093	301 689	4 412 454	186 626
	Germany	4 970 008	145 123	3 036 369	88 622
	United Kingdom	3 902 604	103 898	2 255 675	65 152
	Netherlands	4 016 122	94 919	2 376 501	62 471
	Belgium	1 247 932	43 393	1 307 838	45 700
	France	2 101 035	55 636	1 434 908	36 411
	Italy	854 995	33 292	907 507	34 099
	Spain	693 830	22 977	472 950	15 920
	Japan	1 880 306	29 955	790 564	12 475
	South Korea	1 162 277	21 553	515 358	9 230
	Portugal	190 289	6 064	245 013	8 034
	Philippines	422 933	6 527	219 699	3 466
	Poland	56 483	2 696	62 625	2 989
	Switzerland	200 104	3 817	91 444	2 935
	Sweden	301 491	7 176	74 848	1 906
	Finland	–	–	31 027	566
	Venezuela	326	43	396	83
	Yugoslavia	150 842	4 683	–	–
	Argentina	60 856	2 904	–	–
	Israel	154 868	2 826	–	–
	Turkey	54 121	2 583	–	–
	Total	29 687 515	891 768	18 235 176	576 698
Consumption of iron ore at Canadian iron and steel plants		12 505 944	..	13 018 010	..

Sources: Energy, Mines and Resources Canada; Statistics Canada; American Iron Ore Association.
– Nil; .. Not available; p Preliminary; x Confidential.
[1] Dry tonnes for production (shipments) by province; natural weight for imports and exports. [2] Total iron ore shipments include shipments of by-product iron ore.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, IRON ORE SHIPMENTS, 1989-92

Company and Location	Ore Mined	Product Shipped	1989	1990	1991	1992p
				(000 tonnes, natural or wet)		
Adams Mine Kirkland Lake, Ont.	Magnetite	Fluxed pellets	1 078	244	–	–
Algoma Ore Division Algoma Steel Inc. Wawa, Ont.	Siderite[1]	Sinter	1 243	735	1 137	1 037
Iron Ore Company of Canada Schefferville, Que.	Hematite, goethite and limonite	Direct shipping	177	38	264	120
Carol Lake, Lab.	Specular hematite and magnetite	Concentrate	5 130	5 543	7 096	4 818
		Acid pellets	8 106	5 473	5 927	6 346
		Fluxed pellets	1 732	2 797	1 873	1 467
		Chips	–	147	106	18
Quebec Cartier Mining Company Mount Wright, Que.	Specular hematite	Concentrate	7 734	7 573	7 655	7 213
		Acid pellets	6 031	3 743	4 630	3 115
		Fluxed pellets	857	2 952	1 864	2 727
		Low Si pellets	1 176	1 038	925	1 041
Sherman Mine Temagami, Ont.	Magnetite	Fluxed pellets	1 023	281	–	–
Wabush Mines Wabush, Lab. and Pointe-Noire, Que.	Specular hematite and magnetite	Acid pellets	5 953	3 921	2 997	3 097
		Fluxed pellets		1 771	1 693	1 522
		Concentrate			106	475
British Columbia producers	Magnetite	Concentrate	73	100	67	62
Other Ontario	Magnetite	Concentrate	1	–	–	
Total			40 314	36 357	36 314	33 058

– Nil; p Preliminary.
1 Includes 504 197 t of iron bearing material not from the mine.

TABLE 3. RECEIPTS, CONSUMPTION AND INVENTORIES OF IRON ORE AT CANADIAN IRON AND STEEL PLANTS, 1991 AND 1992

	1991	1992
	(000 tonnes)	
Receipts imported	5 225	5 128
Receipts from domestic sources	6 885	7 613
Total receipts at iron and steel plants	12 112	12 112
Consumption of iron ore	12 507	13 060
Inventory at docks, plants, mines and furnace yards, December 31	8 360	9 491
Inventory change	885	1 132

Source: American Iron Ore Association.

TABLE 4. WORLD IRON ORE PRODUCTION, 1990-92

	1990	1991	1992e
		(000 tonnes)	
People's Republic of China	169 360	175 300	183 400
Brazil	152 300	150 660	146 000
Ukraine (included with C.I.S.)	105 866	86 813	74 000
U.S.S.R. (C.I.S.)	236 200	198 860	187 000
Australia	113 530	121 820	115 000
India	53 702	56 884	58 000
United States	56 410	55 520	56 200
Canada	36 360	36 383	34 449
Republic of South Africa	30 290	28 950	25 100
Venezuela	20 119	19 959	17 000
Sweden	19 877	19 328	19 500
Mauritania	11 420	10 190	10 000
Other countries	80 852	75 329	77 000
Total	980 420	949 183	928 649

Source: Trust Fund Project on Iron Ore Information.
e Estimated by EMR.

TABLE 5. CANADIAN CONSUMPTION OF IRON-BEARING MATERIALS BY INTEGRATED[1] IRON AND STEEL PRODUCERS, 1991

Material Consumed	Consumed In				
			Iron and Steel Furnaces		
	Sinter Plants at Steel Mill	Direct Reduction Plants	Production of Pig Iron	Steel Furnaces	Total in Furnaces
			(tonnes)		
Iron ore					
Crude and concentrate	17 723	60 781	–	–	–
Pellets	70 238	750 686	7 647 396	25 163	7 672 559
Sinter	–	–	1 143 147	–	1 143 147
Sinter produced at steel plant	–	–	365 260	–	365 260
Direct reduced iron	–	–	–	535 068	535 068
Other iron-bearing materials including flue dust, mill scale, cinder, slag, etc.	279 199	–	355 532	47 650	403 181
Total	367 159	811 467	9 511 335	607 881	10 119 216

Source: Company data.
– Nil.
[1] Dofasco Inc.; Sidbec-Dosco Inc.; Sydney Steel Corporation; The Algoma Steel Corporation, Limited; Stelco Inc.

TABLE 6. NORTH AMERICAN PRICES OF SELECTED ORES AT YEAR-END 1980, 1985, AND 1990-92

	1980	1985	1990	1991	1992
			(US$/t)		
Mesabi non-bessemer[1]	27.61	29.557-31.03	29.557-31.03	29.557-31.03	29.557-31.03
Old range non-bessemer and manganiferous	27.85	32.264	32.264	32.264	32.264
			(US¢/t iron unit)[2]		
Pellets					
Lake Erie base price[3]	71.36	85.53	71.31-73.47	71.31-73.47	71.31-73.47
USX Corporation[4]	–	–	36.756	36.756	36.756
Upper Lakes[5]	–	58.46	46.10-58.46	46.10-58.46	46.10-58.46
Wabush[6]	–	62.5	62.5	62.5	62.5
Cyprus Northshore[7]	–	–	47.99	47.99	47.99
			(US$/t)		
Direct reduced iron	–	115-135	115-135	115-135	115-135

Sources: Skillings Mining Review; Iron Age.
– Nil.
[1] US$/t, 51.5% of iron natural, at rail of vessel, lower lake port. [2] One iron unit equals one percentage point of iron content in a tonne of ore; therefore, an ore containing 60% iron has 60 iron units. [3] Cleveland-Cliffs Inc., M.A. Hanna Company, Oglebay Norton Company at rail of vessel, lower lake port. [4] At mine. [5] Pickands-Mather & Co. and Inland Steel Mining Co. in hold of vessel, upper lake port. [6] F.o.b. Pointe-Noire. [7] F.o.b. Silver Bay.

TABLE 7. SELECTED PRICES OF IRON ORE BOUND FOR JAPAN AND EUROPE, 1986-92

Ore	Market	Source	1986	1987	1988	1989	1990	1991	1992
					(US¢/Fe Unit Dmt, f.o.b.)				
Fines (including concentrate)	Europe	CVRD	26.26	24.50	23.50	26.56	30.80	33.25	31.62
		Iscor	22.70	–	20.55	20.70	24.75	–	–
		Kiruna	27.90	25.25	26.00	30.00	35.70	37.10	36.50
		Carol Lake	26.50	24.03	23.69	27.00	31.78	34.60	33.15
		Mt. Wright	26.50	24.03	23.69	27.00	31.78	34.60	33.15
	Japan	CVRD	23.29	21.89	20.90	23.61	27.38	30.05	28.60
		Iscor	20.23	18.85	17.75	20.05	23.25	25.09	–
		Hamersley[1]	25.56	24.28	23.31	26.34	30.54	32.96	31.35
		Carol Lake	22.09	20.93	19.93	22.52	26.11	28.18	27.26
Lump	Europe	CVRD Carajas	–	–	–	–	–	–	–
		Hamersley[2]	36.20	33.15	36.00	43.00	49.97	50.25	48.28
	Japan	CVRD Itabira	23.29	21.89	21.89	25.20	29.22	30.96	29.00
		Iscor	23.53	21.99	21.86	25.64	29.73	31.51	–
		Hamersley[1]	29.81	28.33	27.88	33.23	38.53	40.83	38.23
Pellets	Europe	CVRD	35.60	36.70	40.35	47.33	51.60	52.15	48.47
		Kiruna	38.15	41.15	46.35	53.50	59.00	57.50	53.47
		Carol Lake	36.50	37.15	39.95	48.35	52.58	53.00	49.35
		Mt. Wright	36.50	37.15	39.95	48.35	52.58	53.00	49.35
	Japan	CVRD (Nibrasco)	34.73	35.04	37.93	44.49	48.50	49.03	45.57
		Savage River	35.45	34.17	35.89	42.10	34.17	46.39	43.12

Source: The Tex Report.
– Nil; Dmt Dry metric tonne; f.o.b. Free on board.
1 F.o.b. Dampier; 2 C.i.f. Rotterdam.

Lead

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Western World lead consumption decreased for the second year in a row and was estimated at 4.43 Mt in 1992, a decrease of 0.8% from 1991. Metal production, including both primary and secondary, increased slightly in 1992 to 4.42 Mt. Total metal stocks at year-end were estimated at 640 000 t, an increase of 40% from the previous year.

The increase in stock levels continued to place downward pressure on prices, which averaged US24.5¢/lb on the London Metal Exchange (LME) compared to 25.3¢ in 1991.

CANADIAN DEVELOPMENTS

Canadian lead mine output in 1992 rose for the second year in a row. The increased output to 342 000 t from 276 000 t in 1991 was primarily the result of new mines completing a full year of production and existing mines returning to more normal capacity utilization levels.

Lead metal output also rose in 1992, for the second year in a row. Primary production increased by 38% to 146 000 t, while secondary output from recycled materials declined slightly by 2% to 104 000 t. The substantial increase in output largely reflects a return to more normal levels of production for primary smelters.

Nova Scotia

Dundee-Palliser Resources of Toronto announced that it was considering the acquisition and re-opening of Westminer Canada Limited's Gays River mine. The mine and 800-t/d mill closed in 1991 after production difficulties were encountered due to poor ground conditions and water problems.

New Brunswick

Production at Brunswick Mining and Smelting Corporation Limited's Brunswick mine was higher during 1992 compared to 1991. The mine completed a full year of operation without production difficulties. It was reported that since the strike of 1991, productivity had increased and operating costs had fallen. The increased efficiency was attributed to a number of factors such as a reduction in manpower levels, a switch to open-stope mining from mechanized cut and fill, and energy savings from the installation of a new mine ventilation system. Brunswick Mining has also, since last year's strike, reduced the workforce at its Belledune lead smelter as part of a restructuring program to cut operating costs.

Quebec

Nova Pb installed a $1.5 million after-burner at its secondary lead smelter near Montréal. The company also installed an acid mister and wet scrubber to precipitate and extract chloride and chlorine from the off-gas stream. The new technologies will enable Nova to safely process PVC (polyvinyl chloride) battery separators and lead-bearing organic waste, such as spent cleaning solvents, transmission fluid, and oils high in aeromatics or chlorides. The process will recoupe BTUs (British thermal units), carbon and lead, which will result in energy savings and reductions in raw material purchases. Start-up of the new system is planned for early 1993.

Ontario

In October, The Canada Metal Company closed its 12 000-t/y lead smelter in Toronto for an indefinite period due to weak metal markets and high scrap prices.

British Columbia

In Kimberley, Cominco Ltd. commenced construction of a new lead re-grind circuit to improve the grades of lead and zinc concentrates at its Sullivan mine. Included in the $8 million expansion project are two vertical grinding mills, a column cell, and a hyperbaric pressure filter. The new circuit is designed to treat finer ore and is expected to come on stream during the first quarter of 1993.

The Sullivan mine has a projected mine life of about nine years based on ore reserves of 18.4 Mt averaging 4.7% lead, 7.6% zinc and 28 g/t silver. Cominco has already commenced reclamation of the waste dumps and tailings area through resloping, capping and revegetation. The company has also diverted a stream away from acid-generating waste rock. Surface water from the waste dumps is being collected and treated at a water treatment plant along with mine drainage and tailings water.

In Trail, Cominco introduced a restructuring program to cut operating costs and improve productivity at its metallurgical complex. It was reported that the plan includes a reduction in 500 jobs as well as savings in energy, transportation and other costs. The company indicated that, given the landlocked location of the smelter, its growing dependency on offshore concentrates, and higher power costs, it would have to cut operating costs to remain competitive. Cominco also indicated it is considering early retirement and voluntary severance packages as methods to reduce the impact of labour force reductions. The company's labour contract with unionized employees at the Trail complex and Sullivan mine expired on September 30, 1992. Although a labour agreement had not been reached by the end of 1992, both facilities continued to operate normally.

Also at Trail, Cominco's new 160 000-t/y QSL lead smelter remained idle during 1992. The new smelter was commissioned in December 1989, but closed early in 1990 due to technical problems. The German manufacturer Lurgi GmbH continued to perform tests at a 100 000-t/y QSL plant in Germany aimed at resolving problems at Trail. Cominco is also considering alternate technology. Tests from zinc leach residues and concentrate sent to a KIVCET lead smelter in Kazakhstan were reported to be encouraging. The company is expected to make a decision on an acceptable smelter technology during 1993.

In August, Cominco announced that it would advance, by 18 months, a plan to stop discharging slag from its Trail lead smelter into the Columbia River. The decision was made in response to results from new laboratory tests on the slag by the federal departments of Fisheries and Oceans and the Environment. The tests indicated the slag posed a danger to aquatic life. Cominco has started feasibility work and permitting procedures for a land disposal system that is scheduled to begin operation by mid-1995.

The polymetallic Samatosum mine, owned by Minnova Inc. (70%) and Rea Gold (30%), closed in September due to the depletion of ore reserves. The mine, located north of Kamloops, opened in 1989 and produced about 361 000 kg of silver, 636 kg of gold, 4300 t of copper, 4850 t of lead and 2500 t of zinc during its life. Environmental protection was an ongoing initiative at the mine. Waste rock was continually interlayered with carbonate-rich mafic rocks to reduce acid generation. Reclamation activities completed in 1992 included the recontouring, revegetation and fertilizing of the waste dumps. The establishment of tree corridors is scheduled for 1993. The effluent treatment plant will also operate during peak run-off periods to process additional surface drainage.

Curragh Inc. received the necessary permits to develop the Stronsay (formerly Cirque) deposit 240 km northwest of Fort St. John. Development work has been deferred due to a lack of project financing. Curragh announced that it may consider selling part of its interest in the Stronsay deposit through a share offering if partners could not be found. The mine is expected to produce 28 000 t/y of lead and 100 000 t/y of zinc in concentrate.

Recycling is an important component of the lead industry. To facilitate the collection and return of lead-acid batteries, the Government of British Columbia implemented a lead-acid battery recycling system in 1991. The government provides a cash incentive to offset the transportation costs of retrieving batteries. Revenue is generated by the government to pay for the program through a $5.00 green tax that consumers pay when they purchase a new battery. Foreign recycling facilities are also reimbursed for the B.C. portion of their transportation costs. In 1992, it was reported that during the first 10 months of the program, battery recycling rates averaged 108% of estimated replacement sales. It was also noted that batteries that had been in storage for over 30 years were being collected.

Yukon Territory

Total lead-in-concentrate production for Curragh Inc. is expected to have increased during 1992, compared to the 1991 level. It is believed the increase is a result of the addition of output from the Sa Dena Hes mine (formerly Mt. Hundere) which started up in June 1991. Curragh planned to commence mining the Grum deposit in 1992; however, the company was unable to raise $40 million to complete pre-development stripping. Production from the Grum deposit is to replace depleted reserves at the Faro pit and ore from the Vangorda pit, which will be exhausted in 1993.

In August, Curragh temporarily closed the Faro operation for annual maintenance. The three-week shut-down was planned to coincide with the closure of the Skagway Highway for bridge maintenance. The highway is used by Curragh to transport concentrate to port at Skagway, Alaska.

In December, Curragh announced that it would temporarily shut down its Faro operation and Sa Dena Hes mine due to poor metal prices. The Faro mill started to process stockpiled material in January 1993; however, the Sa Dena Hes mine is not expected to come back on stream until the end of February 1993.

Northwest Territories

Minnova Inc. and Metall Mining Corp. completed over 18 000 m of drilling on the Izok Lake base-metal property located 360 km north of Yellowknife. The property hosts two shallow massive sulphide lenses that could be mined by open pit. The new drilling has increased reserves to 13.6 Mt averaging 1.6% lead, 14.6% zinc, 2.5% copper, and 77.7 g/t silver. A new lense, called Inukshuk, was also identified with reserves estimated at 2 Mt averaging 8% zinc and 2% copper. Further drilling is planned for 1993, along with metallurgical, transportation and environmental studies.

San Andreas Resources Corp. began drilling on its Prairie Creek massive sulphide property to expand and upgrade reserves and test other known zones. The property is located over 300 km west of Yellowknife. Previous work by the Hunt brothers in the early 1980s focused on vein-type mineralization. Recent drilling to test the vein structures at depth intersected significant widths of Pine Point-style lead-zinc-silver mineralization that also contained copper and cadmium.

World Developments

Primary Production

The International Lead and Zinc Study Group (ILZSG) indicated that Western World lead mine production decreased to 2.32 Mt in 1992 from 2.37 Mt in 1991. Increases in output from Canada, Mexico and Sweden helped to offset declines in Yugoslavia and the United States.

Asia/Oceania

Aztec Mining continued with an expansion project at the Woodcutters mine in Australia. Modifications include a new heavy media plant and changes to the flotation circuit. When completed in 1993, ore throughput is expected to increase from 370 000 t/y to 500 000 t/y, with lead-in-concentrate output increasing by 7000 t/y to 27 000 t/y.

CRA Limited continued to carry out definition drilling and feasibility studies of the Century orebody in northern Queensland. The indicated resource is reported at 118 Mt averaging 1.5% lead, 10.2% zinc and 35 g/t silver. Additional metallurgical testing and information on the best mining method (e.g., open-pit or underground) will be carried out prior to commencement of a full feasibility study.

Enterprise Metals opened The Peak polymetallic gold mine near Cobar, New South Wales. Although primarily a gold mine, The Peak will also produce 5000 t/y of lead and 3500 t/y of zinc in concentrate.

Pasminco Ltd. closed the Broken Hill North mine, downsized its Elura operation, and ended treatment of Que River ore at the Rosebery operation during 1992.

Mount Isa Mines (M.I.M.) (72%) and ANT Minerals (28%) announced plans to proceed with development of the McArthur River deposit in the Northern Territory at a cost of about US$175 million. ANT Minerals is owned by Nippon Mining Co. Ltd. (15%), Mitsubishi Materials Corp. (5%), Mitsui Mining and Smelting Co. Ltd. (5%), and Marubeni (3%). In 1991, M.I.M. outlined a high-grade zone of 47 Mt grading 6.5% lead, 15.7% zinc, and 66 g/t silver. The total deposit has been outlined to contain 227 Mt of mineralization. Initial feasibility studies indicate that the mine might produce 50 000 t/y of lead and 120 000 t/y of zinc in bulk concentrate. It was reported that, depending on metal and concentrate market conditions, construction could begin in 1993 with start-up scheduled for 1994.

M.I.M., Nippon Mining, Mitsubishi and Mitsui also jointly own Pacific Zinc, which plans to develop an Imperial Smelting Furnace (ISF) plant near Hachinohe, Japan. The plant is scheduled to come on stream in 1994 with a rated capacity of 60 000 t/y of lead and 120 000 t/y of zinc.

In December, M.I.M. announced that it would cut production by 15% at its Mount Isa and Hilton mines in response to weak metal markets.

In China, construction of a new lead and zinc mine began at Lanping, in the Yunnan Province. The state-owned mine is expected to come on stream in 1995 and produce 5000 t/y of lead and 60 000 t/y of zinc when it reaches full production in 1996. The mine's life is estimated at 35 years based on reserves of 14.32 Mt of lead and zinc metal contained in 150 Mt of ore.

In Northern Iran, Calcimine Mining Co. completed an expansion program at the Angouran mine. Lead and zinc-in-concentrate production has increased by 6000 t/y and 24 000 t/y, respectively, to 17 000 t/y of lead and 59 000 t/y of zinc. Mine reserves were reported to be 24 Mt averaging 6% lead and 24% zinc. It is expected that the mine will provide concentrate to the National Iranian Lead and Zinc Company's newly commissioned 40 000-t/y Boliden/Kaldo lead smelter in Angouran.

In India, Hindustan Zinc's new ISF plant, which was commissioned in 1991, reportedly reached full capacity of 35 000 t/y of lead and 70 000 t/y of zinc in early 1992. However, maximum output could not be sustained due to start-up problems and the plant was temporarily shut down in the fourth quarter for a six-week period.

In Korea, the Korea Zinc Co. Ltd. commissioned its new 80 000-t/y QSL lead smelter in early 1992. It was reported that the smelter was operating at 75% of capacity by September.

Russia is reported to have introduced a new levy on the extraction of mineral resources that ranges from 1% to 10% of production costs. The tax for lead is about 2.5% of production.

Africa

Compagnie Minière de Guemassa officially opened the Hajar mine near Marrakesh, Morocco. The mine has operated on a trial basis since 1990 producing 1500 t/y of lead and 20 500 t/y of zinc in concentrate. The mine is expected to produce 20 500 t/y of lead and 72 000 t/y of zinc in concentrate when it reaches full capacity in 1993. A mine life of over 16 years was projected, based on estimated reserves of 12 Mt.

In Tunisia, development work continued at the Bougrine deposit. The mine is scheduled to open in 1994 and produce 8000 t/y of lead and 35 000 t/y of zinc in concentrate. Metall Mining Corp. owns a 45% interest in the project.

Americas

The Doe Run Company's labour contract with unionized employees at the 225 000-t/y Herculaneum primary lead smelter expired on April 30, 1992. The 300 unionized workers walked out on July 30 after an agreement was not reached. Salaried staff were reported to be operating the smelter at 55% of capacity through the remainder of 1992.

In September, Fluor Corporation offered for sale its 100% interest in Doe Run. According to press reports, Fluor has since classified Doe Run as a discontinued operation for accounting purposes and plans to divest itself of the company within a year. Doe Run is one of the largest primary lead producers in the United States. The company also opened a state-of-the-art 60 000-t/y secondary lead smelter at Buick, Missouri, in 1991.

In August, Equinox Resources re-opened its Van Stone mine in Washington State after metal prices began to rise due to speculative demand for lead and zinc. The mine had been on care and maintenance since it closed in response to weak metal prices in 1991. The mine's production capacity is rated at 4500 t/y of lead and 17 000 t/y of zinc.

Minnova Inc. completed an underground drilling program at the Pend Oreille lead-zinc mine in Washington State. The program delineated a probable geological resource of 3.4 Mt averaging 1.8% lead and 10.7% zinc. A final feasibility study is under way. The property is owned by Resource Finance Corp. (RFC). In August, Minnova acquired a 45.8% interest in RFC.

In November, Cominco Metals reduced output to 60% of design capacity at the Magmont operation in Missouri. The production cutback and resulting reduction in the labour force is a result of ore reserve depletion. The mine is expected to produce through 1994.

The U.S. Defense Department announced plans to dispose of its 553 400 t of lead stocks over the next 10 years. The Annual Materials Plan, which establishes the maximum quantity to be sold in a given year, has allotted 47 000 t of lead for sale in 1993. However, according to legislation, the sales should not adversely disrupt markets and may therefore be deferred to future years depending on market conditions.

Brazil's only refined lead producer, Plumbum Mineracao e Metalurgia S.A., closed two mines during 1992. The Boquira mine in Bahia was shut down due to ore reserve exhaustion, and the

Furnas mine in Parana closed because of the poor quality of its ore and high operating costs.

Peruvian lead-in-concentrate production was down in 1992 by about 3% from its 199 000 t in 1991. The reduction in output was, in part, as a result of a shortage of hydro-electric power due to a drought. It is reported that the reduction could have been greater, but a number of mines responded to weak prevailing metal prices by extracting higher-grade ore.

Europe

In February, Metaleurop S.A.'s lead-zinc smelter at Noyelles-Godault, France, closed for about one week after a fire cut an electrical cable. It was reported that the temporary shut-down resulted in a loss of production of 1500 t of lead.

In Bulgaria, the KCM lead smelter at Plodiv closed during the first half of 1992 because of lead emission problems. The plant reportedly re-opened after new equipment was installed to meet Bulgaria's national emissions standards. It was also announced that dozens of unprofitable base-metal mines would close over the next few years. Lead-in-concentrate output is expected to be reduced from about 80 000 t/y to 30 000 t/y.

In Italy, Nuova Samim closed its 100 000-t/y Porto Vesme Kivcet lead smelter for six weeks for routine maintenance starting in March. Analysts suggested that the temporary closure resulted in a 9000-10 000-t loss in production. Later, in December, an explosion in a ventilation shaft halted production for two days.

Delineation drilling was completed by Ivernia West and Chevron Minerals at the Lisheen lead-zinc deposit in Ireland. Proven and probable reserves are calculated at 18.4 Mt averaging 2.4% lead, 13.4% zinc and 38.7 g/t silver. A full feasibility study was reported to have commenced.

The Greenland Home Rule Government rewrote regulations on mining development and opened the door to new mining exploration. Previously, if a company received the right to explore, it did not necessarily have the right to exploit; however, this has changed. The government has also relinquished the right to back-in to a mine development project by being allowed to acquire at least a 20% interest. It is also reported that up to 100% of exploration and development costs can be written off in the first year of operation. Greenland has previously had several lead-zinc producers, such as the Black Angel and Blyklippen mines.

In Spain, Sociedad Minera y Metalurgica de Penorroya-España S.A. closed its 90 000-t/y lead smelter at Santa Lucia in Cartegena. The company indicated that the closure was a result of adverse economic and financial conditions as well as local political and environmental factors.

In Yugoslavia, embargoes imposed by the United Nations are reported to be adversely affecting production at the 35 000-t/y Titov Veles ISF smelter in Macedonia.

Secondary Production/Recycling

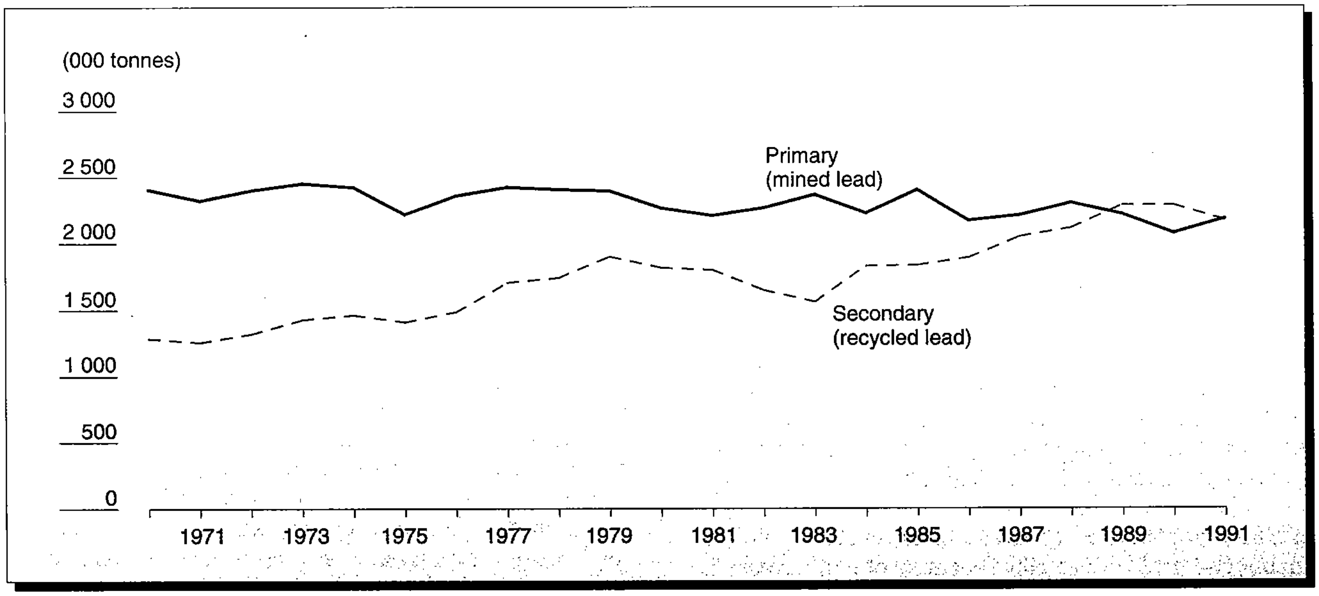
Lead is one of the most recycled nonferrous metals in the world. Secondary production (from recycled materials) has risen steadily and surpassed primary output for the first time in 1989 (Figure 1). This growth reflects the favourable economic conditions associated with lead recycling and the fact that lead retains its physical and chemical properties when recycled. As lead is used worldwide, scrap lead has become a readily renewable resource to which countries without lead mines have access.

In 1992, production cuts and closures were prevalent as low metal prices and competition for scrap batteries seriously reduced profit margins for secondary lead producers. Although there were cuts in production, it is expected that Western World secondary lead output continued to account for approximately 50% of total production.

In the United States, a Battery Council International (BCI) study indicated that, in 1990, the U.S. recycling rate for SLI (Starting, Lighting, Ignition) batteries had reached 97.8%, an increase of 2.5% from the previous year. The increase is, in part, attributed to recycling legislation that has been enacted in 37 states. Twenty-two states have adopted plans similar to the BCI's recycling model, which prohibits the disposal of used batteries in landfills or incinerators and requires wholesalers and retailers to take back old batteries. Other states have instituted a tax or cash deposit in lieu of trade when purchasing a new battery.

In February, Refined Metals Corp. temporarily closed its 18 000-t/y Memphis lead smelter due to a shortage of battery scrap and weak metal markets. Other smelters that were reported to have closed in February include: one of two 100-t/d blast furnaces at Schuyhill's Baton Rouge operation; a 100-t/d furnace at Saunders Lead's Troy, Alabama smelter; and a 20 000-t/y furnace at Gopher Metals' 55 000-t/y Egan, Minnesota operation.

Figure 1
World Lead Metal Production,[1] 1970-91



1 Excludes Eastern European and socialist countries.
SOURCE: International Lead and Zinc Study Group.

In July, PBX opened a 20 000-t/y secondary lead smelter in Norwalk, Ohio. However, the plant closed in October due to cash-flow problems as a result of weak metal prices and competition for scrap batteries.

Also in July, Ross Metals closed its Rossville 24 000-t/y secondary lead smelter in Tennessee due to poor market conditions.

In August, Master Metals' 20 000-t/y secondary lead smelter in Cleveland closed for a few months after the Ohio Environmental Protection Agency found that emissions of lead exceeded national air-quality standards.

In Georgia, GNB Inc. announced plans to close its 19 000-t/y secondary smelter at Columbus and build a new 82 000-t/y lead smelter in Waynesboro. The new plant is expected to start up in 1994.

RSR Corporation announced plans to build a new 108 000-t/y secondary lead smelter in North or South Carolina. Construction is expected to take three to five years at a cost of US$60 million.

In the Netherlands, Hollandse Metallurgische Industrie Billiton BV closed its 35 000-t/y Arnhem lead-tin smelter during the first half of 1992. The decision was made in response to low metal prices and rising environmental costs.

In an effort to curb air pollution, the Government of Taiwan announced in December 1991 that it will ban imports of scrap metal commencing in January 1993. Scrap metal imports were reported to be 234 094 t in 1990.

In Saudi Arabia, a 12 000-t/y secondary lead smelter near Riyadh is expected to come on stream in 1994. Feed availability is not anticipated to be a problem as it was reported, in 1991, that Saudi authorities have instituted a ban on scrap battery exports.

CONSUMPTION AND USES

Since 1970, the world demand for lead has increased by 25% to a record 5.627 Mt in 1990. In 1991, Europe accounted for 31% of world demand while North America (including Mexico) consumed 26%, Japan used 7%, and Eastern European and C.I.S. countries consumed 14%. Asia (excluding Japan) is the fourth largest and fastest-growing lead-consuming region. During the last two decades, Asian demand for lead has increased by a factor of 6 and now accounts for 10% of world demand. The increase largely reflects the rapid pace of economic growth in this region.

On the basis of preliminary statistics from the International Lead and Zinc Study Group (ILZSG), lead consumption decreased by 0.8% in 1992 to 4.43 Mt.

Lead is a dense, bluish white metal whose physical and chemical properties find application in a variety of uses in the manufacturing, construction and chemical industries.

Lead-acid batteries constitute the largest market for lead, representing over 60% of total usage in the non-socialist world. In the United States, battery manufacturing constitutes almost 80% of total lead demand. The largest market for batteries, representing about 80% of lead used in the industry, is the automotive sector. The average automobile battery contains about 10 kg of lead. A potential growth area for the lead-acid battery is in energy storage facilities for utilities. These are designed to supplement existing generators during the peak morning and evening hours without drawing on other sources or building new power plants.

Electric cars may provide the greatest future growth in demand for lead-acid batteries. In 1990, California approved stringent automobile emissions standards which will require, by 1998, 2% of new cars sold in the state to be zero emission or electric powered, with the figure increasing to 10% by the year 2003. It has been estimated that this would amount to about 40 000 electric vehicles (EV) for 1998. Similar requirements were adopted by 10 eastern states in 1991. It was reported that the 11 states account for one third of the total U.S. vehicle market. General Motors Corp.'s lead-acid battery-powered "Impact" electric car is expected to be available for this new market by the mid-1990s. However, this new demand for lead will also increase the incentive to develop a longer lasting, more efficient and cost-competitive substitute for the lead-acid battery.

In this regard, Nissan is developing a future electric vehicle (FEV) to be powered by a nickel-cadmium battery that is expected to achieve a full charge in 15 minutes. Isuzu Motors Ltd. and Fuji Electrochemical Co., Ltd. expect to market, by 1993, a new revolutionary battery made of activated carbon and diluted sulphuric acid that recharges faster and produces more power than conventional batteries. Also competing are Kansai Electric Power Co., Inc. and Japan Storage Battery Co., Ltd., who are developing a new nickel-zinc battery. Also in Japan, Matsushita Battery Industrial Co. Ltd. developed the world's first sealed nickel-metal hydride battery during 1992. Other candidates include a zinc-based slurry developed by Luz International that generates energy when combined with oxygen and can be recharged in minutes by adding fresh slurry. There is also the Australian-designed vanadium redox battery that is reported to be recyclable, more efficient, longer lasting and requires one eighth the time to recharge than a lead-acid cell. The Canada Centre for Mineral and Energy Technology (CANMET) of Energy, Mines and Resources Canada is participating with industry in the development of a lithium-aluminum-iron sulphide battery and a sodium-sulphur battery.

Some experts believe that the lead-acid battery is the only technology that can be counted on to meet new EV demand in the short to medium term. Compared to other battery systems, lead-acid batteries are easily recycled, relatively inexpensive and considered to be free from safety concerns.

In March 1992, an Advanced Lead-Acid Battery Consortium (ALABC) was formed to develop an improved lead-acid battery for the EV. The ALABC currently has 37 members representing lead producers, battery companies, and an automotive manufacturer from 11 countries. Canadian sponsors are Cominco and Noranda.

The second largest use of lead is in pigments and compounds. The principal uses are in PVC stabilizers, which prevent degradation during processing or from ultraviolet radiation; colour pigments; and the manufacture of glass, including crystal, light bulbs, insulators and television/computer screens. While lead is still used for some specific paint applications, its general use in this application has declined significantly due to the potential risk involved in exposure to weathered or flaked paint.

Until the mid-1970s, the production of lead additives for gasoline, including tetraethyl lead, constituted one of the most important markets for the metal. However, with the adoption of environmental regulations that have either prohibited or severely restricted the use of such additives, the demand for lead in this application has declined dramatically. In Canada, lead was eliminated, through legislation, as an additive in gasoline for general consumption at the end of 1990.

Lead is alloyed with tin in the production of solder used in both the electronics and plumbing sectors, although these markets have declined in recent years. In the plumbing industry, the demand for lead has fallen primarily as a result of the increasing use of plastic piping. Where metal systems are still used for potable water systems, new regulations, which have been adopted or are being considered, will reduce the amount of lead in solder. In the electronics field, the move to miniaturization, combined with the replacement of printed circuit boards, has also reduced the demand for lead in solder.

Lead is also used with tin in foil for wine bottle capsules. However, this practice is being phased out because of perceived environmental and health concerns. In mid-1991, the European Community announced that it would ban the use of tin-lead capsules as of January 1, 1993. Aluminum, plastics (PVC) and tin-based products have been used to replace lead foil.

Other important applications of both lead metal and lead alloys include: the production of free machining steel and brass, rolled sheet and strip for roofing applications, power and communication cable sheathing, especially for underground or submarine environments, and as a sound barrier material in construction.

Lead's high resistance to gamma radiation and X rays makes it the preferred metal for shielding around X-ray equipment and at nuclear installations.

Potential new uses for lead include: nuclear waste disposal applications; liquid metal (magnetohydrodynamics), a method of generating electricity by passing an electrically conducting fluid through a magnetic field; additives to extend the life of asphalt; barriers or shields against radon gas and electromagnetic fields; and as a damper to protect buildings from vibrations during earthquakes.

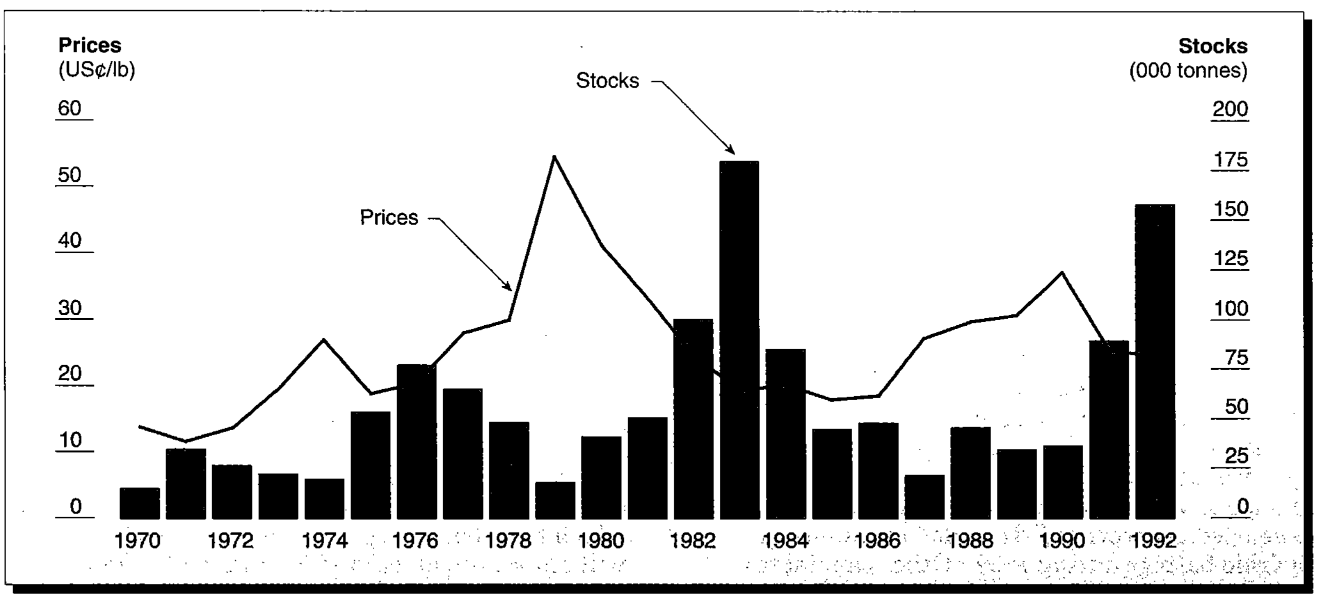
New uses for lead-acid batteries are also being developed. In Canada, Black & Decker Canada Inc. introduced a new cordless electric lawn-mower during 1992. The fluidless lead battery can operate for about one hour before running out of power; it also regains 80% of its power after three to four hours of recharging, and can be fully recharged overnight. The new mower will be marketed in the United States in 1993.

The latest high-tech use for lead was developed in 1992. U.S. and Russian scientists successfully focussed cold neutrons into a beam that can penetrate substances and show where contaminants lie in a silicon semi-conductor, or discern how quickly atoms diffuse through aerospace alloys. The focussed beam was created with a lense constructed of lead-silica glass. It was also reported that companies using advanced materials will benefit the most from cold-neutron focussing.

MARKETS, PRICES AND STOCKS

Lead prices on the London Metal Exchange (LME) declined steadily during 1992 as LME stocks rose. Prices rebounded slightly in the third quarter based on speculative support before falling to a six-year low of US20.2¢/lb in November. The price averaged US24.5¢/lb in 1992, compared to 25¢/lb in 1991. (Table 4 provides a detailed price history.)

Figure 2
Lead Prices[1] and Stocks,[2] 1970-92



1 Annual average London Metal Exchange (LME) prices.
2 Annual average of LME month-end stocks.
SOURCE: International Lead and Zinc Study Group.

In 1992, the LME decided to switch the floor trading currency of the Standard Lead contract from sterling to U.S. dollars. This action is consistent with earlier decisions to convert to dollars for zinc, copper and other metal contracts.

Final year-end stock figures are unavailable; however, it is expected that total lead stocks rose to record levels of about 640 000 t at the end of 1992 compared with 458 400 t at the end of 1991. According to the latest figures compiled by the ILZSG, producer stocks were up 21% to 200 000 t, while LME stocks rose by 80% to 227 200 t.

INTERNATIONAL ORGANIZATIONS

The International Lead and Zinc Study Group was formed in 1959 to improve market information and to provide opportunities for regular intergovernmental consultations on lead and zinc markets. Particular attention is given to providing regular and frequent information on supply and demand and their probable development.

The Study Group is headquartered in London, England. Its membership includes most major lead- and zinc-producing and consuming countries. While it has an extensive information-gathering and dissemination role, the Study Group has no market intervention powers. Member countries' delegations generally include a number of industry representatives as advisors. Canada has been an active member since its inception.

HEALTH, SAFETY AND THE ENVIRONMENT

In response to concern over the health effects of exposure to lead and lead compounds, and to an overall increase in environmental awareness, governments in the industrialized nations have moved to restrict or ban the use of lead additives in gasoline. In Canada, leaded gasoline was phased out during 1990, prior to the December 31 legislated deadline banning its use. In addition to the potential benefits associated with the removal of lead emissions, the use of unleaded fuel permits the removal of hydrocarbons, carbon monoxide and nitrous oxides from automobile exhaust gases.

The World Health Organization's (WHO) provisional tolerable weekly intake (PTWI) of lead in drinking water was set at 50 micrograms per litre in 1984. In 1992, the WHO recommended the PTWI guideline be reduced to 10 micrograms per litre.

The Organization for Economic Co-operation and Development (OECD) is preparing an international document on measures to reduce risks to health and the environment from exposure to lead. Initial drafts raised considerable concern as they focussed on sunsetting and substitution at the expense of other risk management measures. Canada, the United States, Germany and Australia jointly prepared a third revision of the document during 1992.

OUTLOOK

Lead inventories rose in 1992 as demand weakened and exports increased from China and C.I.S. countries. For the market to recover, it is expected that the large overhang of stocks will have to be reduced through closures or substantial cuts in production. A significant number of North American producers may be adversely affected as metal prices are considered to be below or near operating costs. Although demand is forecast to increase marginally in 1993, the high stock levels are expected to continue to place downward pressure on prices. The price in 1993 is predicted to range between 17¢ and 24¢/lb.

In the medium to long term, lead demand is expected to maintain an average growth rate of 1.0% to 1.5%/y during the 1990s. The battery sector will account for most of the growth with the newly industrialized nations of Southeast Asia expected to record the most rapid pace of growth. However, future growth in demand is expected to be met or offset by additional mine and smelter capacity in the Asia-Pacific region and increased recycling in Europe and North America.

In Canada, mine output is expected to increase in the medium to long term as new mines in British Columbia, the Yukon, and possibly the Northwest Territories, come on stream. Lead metal produced from both ores and concentrates, and recycled materials, is also set to rise when a new lead smelter is commissioned in Trail.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada[1]	EEC MFN	Japan[1] MFN
2607.00	Lead ores and concentrates	Free	Free	Free	1¢/kg on Pb	Free	Free
78.01	Unwrought lead						
7801.10	Refined lead						
7801.10.10	Pig and block	Free	Free	Free	1.8% on Pb	3.5%	8 yen/kg
7801.10.90	Other	10.2%	Free	5.1%	1.8% on Pb	3.5%	8 yen/kg
7801.91	Containing by weight antimony as the principal other element						
7801.91.10	Lead antimony-tin alloys	6.8%	Free	3.4%	1.8% on Pb	3.5%	6.5%
7801.91.90	Other	10.2%	Free	5.1%	1.8% on Pb	3.5%	6.5%
7801.99	Other						
7801.99.10	For refining, containing 0.02% or more by weight of silver (bullion lead)	10.2%	Free	5.1%	2.1% on Pb	Free	4.7%
7801.99.20	Lead alloys	10.2%	Free	5.1%	2.1% on Pb	3.5%	4.7%
7801.99.90	Other	10.2%	Free	5.1%	1.8% on Pb	3.5%	8 yen/kg
7802.00	Lead waste and scrap	Free	Free	Free	Free	Free	3.2%
7803.00	Lead bars, rods, profiles and wire						
7803.00.10	Bars and rods, not alloyed	4%	2.5%	2%	0.7%	8%	5.8%
7803.00.20	Bars and rods, of lead-antimony-tin alloys	6.8%	Free	3.4%	0.7%	8%	5.8%
7803.00.30	Bars and rods, of other alloys; profiles and wire	10.2%	Free	5.1%	0.7%	8%	5.8%
7804.20	Powders and flakes						
7804.20.10	Powders, not alloyed	4%	Free	2%	6.7%	2.2%	6.5%
7804.20.20	Alloyed powders; flakes	10.2%	Free	5.1%	6.7%	2.2%	6.5%

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States,1992; Official Journal of the European Communities, Vol. 35, No. L268, 1992, "Conventional" column; Customs Tariff Schedules of Japan, 1992.

[1] GATT rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. CANADA, LEAD PRODUCTION AND TRADE, 1991 AND 1992, AND CONSUMPTION, 1990 AND 1991

Item No.		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)
SHIPMENTS					
	All forms[1]				
	Newfoundland	–	–	–	–
	Prince Edward Island	–	–	–	–
	Nova Scotia	x	x	x	x
	New Brunswick	51 957	44 163	77 374	56 096
	Quebec	–	–	–	–
	Ontario	x	x	–	–
	Manitoba	2 286	1 943	x	x
	Saskatchewan	–	–	–	–
	Alberta	–	–	–	–
	British Columbia	63 385	53 878	73 991	53 644
	Yukon	93 912	79 825	125 924	91 295
	Northwest Territories	35 388	30 078	39 140	28 377
	Total	248 102	210 886	318 515	230 923
	Mine output[2]	276 528	. .	342 486	. .
	Refined production				
	Primary	106 420	. .	146 000	. .
	Secondary	105 946	. .	104 000	. .
	Total	212 366	. .	250 000	. .
EXPORTS				(Jan.-Sept.)	
2607.00	Lead ores and concentrates				
	Japan	69 822	20 674	31 454	14 642
	Italy	73 154	19 609	30 432	13 836
	United States	14 727	7 452	24 846	12 789
	India	–	–	16 990	9 669
	South Korea	12 025	3 224	18 368	8 486
	Germany	26 510	9 731	17 655	6 357
	Australia	14 687	4 788	8 834	3 481
	Other countries	22 350	5 681	7 982	3 189
	Total	233 276	71 159	156 561	72 449
2607.00.20	Lead content of lead ores and concentrates	162 559	54 057	153 686	53 930
2603.00	Copper ores and concentrates				
2603.00.20	Lead content	335	167	727	224
2608.00	Zinc ores and concentrates				
2608.00.20	Lead content	12 256	2 637	5 830	1 553
78.01	Unwrought lead				
7801.10	Refined lead				
	United States	59 961	42 446	63 615	44 911
	Belgium	3 647	2 631	601	6 121
	Germany	4 300	3 403	6 011	4 224
	Singapore	980	724	4 097	2 000
	Thailand	1 437	1 008	2 533	1 479
	Japan	6 148	4 051	1 874	1 148
	Taiwan	2 059	1 261	1 024	599
	South Korea	4 179	2 516	7 714	440
	Other countries	3 382	2 214	4 184	2 510
	Total	86 093	60 254	91 651	63 432
7801.91	Containing by weight antimony as the principal other element	9 910	7 372	6 287	4 493
7801.99	Other	18 788	13 810	27 069	19 475

TABLE 1 (cont'd)

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
7802.00	Lead waste and scrap				
	United States	2 228	1 048	3 699	1 377
	Ireland	878	540	21	11
	Germany	231	143	39	6
	India	325	166	11	2
	France	262	160	–	–
	Indonesia	450	141	–	–
	Other countries	855	474	295	125
	Total	5 229	2 672	4 066	1 521
7803.00	Lead bars, rods, profiles and wire				
	United States	271	421	328	388
	Other countries	–	–	46	47
	Total	271	421	374	435
78.04	Lead plates, sheets, strip and foil; lead powders and flakes				
	Plates, sheets, strip and foil				
7804.11	Sheets, strip and foil of a thickness (excluding any backing) <0.2 mm	243	292	181	241
7804.19	Other	21	27	60	61
7804.20	Powders and flakes	3	20	4	31
7805.00	Lead tubes, pipes and tube or pipe fittings (i.e., couplings, elbows, sleeves)	12	47	10	17
7806.00	Other articles of lead				
	United States	..	1 461	..	1 431
	Other countries	..	339	..	98
	Total	..	1 800	..	1 529
IMPORTS					
2607.00	Lead ores and concentrates				
	United States	5 167	2 682	2 517	2 283
	Greece	–	–	3 477	2 103
	Peru	29 550	5 761	1 660	1 461
	Belgium	1 540	530	–	–
	Total	36 256	8 973	7 654	5 848
2607.00.00.20	Lead content of lead ores and concentrates	4 480	2 815	7 642	4 867
2608.00	Zinc ores and concentrates				
2608.00.00.20	Lead content	10 370	8 685	5 162	4 879
78.01	Unwrought lead				
7801.10	Refined lead				
7801.10.10	Pig and block	6 745	5 032	4 417	3 543
7801.10.90	Other	..	100	..	71
7801.91	Containing by weight antimony as the principal other element	488	649	57	85
7801.99	Other	630	499	190	151
7802.00	Lead waste and scrap				
	United States	58 031	10 637	38 485	7 141
	Other countries	13	2	1	...
	Total	58 044	10 639	38 486	7 141
7803.00	Lead bars, rods, profiles and wire				
	United States	80	112	107	168
	Other countries	18	29	17	23
	Total	98	141	124	191

TABLE 1 (cont'd)

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)					
78.04	Lead plates, sheets, strip and foil; lead powders and flakes				
	Plates, sheets, strip and foil				
7804.11	Sheets, strip and foil of a thickness (excluding any backing) < 0.2 mm	136	251	88	149
7804.19	Other	324	406	283	348
7804.20	Powders and flakes	192	228	99	128
7805.00	Lead tubes, pipe and tube or pipe fittings (i.e., couplings, elbows, sleeves)	9	24	25	67
7806.00	Other articles of lead				
	United States	..	2 078	..	1 728
	Germany	..	66	..	34
	United Kingdom	..	24	..	57
	Other countries	..	31	..	55
	Total	..	2 199	..	1 874

	1990			1991		
	Primary	Secondary4	Total	Primary	Secondary4	Total
	(tonnes)					
CONSUMPTION3						
Lead used for, or in the production of:						
Antimonial lead	x	x	20 450	x	x	16 706
Batteries and battery oxides	22 350	5 467	27 817	20 871	7 267	28 138
Chemical uses; white lead, red lead, litharge, tetraethyl lead, etc.	x	x	10 494	x	x	9 618
Copper alloys; brass, bronze, etc.	113	19	132	128	17	145
Lead alloys:						
solders	485	1 020	1 505	491	584	1 075
others (including babbitt, type metals, etc.)	380	3 230	3 610	x	x	4 284
Semi-finished products:						
pipe, sheet, traps, bends, blocks for caulking, ammunition, etc.	2 081	1 275	3 356	1 754	1 256	3 010
Other lead products	3 563r	541r	4 104r	4 553	723	5 276
Total, all categories	40 598r	30 869r	71 468r	39 696	28 556	68 252

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; .. Not available; ... Amount too small to be expressed; p Preliminary; r Revised; x Confidential.
1 Production includes recoverable lead in ores and concentrates shipped, valued at the average Montréal price for the year. 2 Lead content of domestic ores and concentrates exported. 3 Available data, as reported by consumers. 4 Includes all remelt scrap lead used to make antimonial lead.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, LEAD PRODUCTION, TRADE[1] AND CONSUMPTION, 1975, 1980, AND 1985-92

	Production				Exports[1]			Imports	Consumption[3]
		Refined							
	All Forms[2]	Primary	Secondary	Total	In Ores and Concentrates	Refined	Total	Refined	
	(tonnes)								
1975	349 133	171 516	. .	171 516	211 909	110 882	322 791	1 962[a]	89 192
1980	251 627	162 463	72 117	234 580	147 008	126 539	273 547	2 602[a]	106 836
1985	268 291	173 220	66 791	240 011	93 657	113 993	207 650	5 675[a]	104 447
1986	334 342	169 934	87 746	257 680	118 373	111 831	230 204	4 247[a]	94 680
1987	373 215	139 475	91 186	230 661	207 936	100 204	308 140	12 558[a]	97 281
1988	351 148	179 461	88 615	268 076	200 822	179 946	380 768	15 132	88 041
1989	268 887	157 330	85 515	242 845	170 568	121 444	292 012	11 708	87 715
1990	233 372	87 180	96 465	183 645	221 565	84 007	305 572	11 756	71 468[r]
1991	248 102	106 420	105 946	212 366	175 150	86 631	261 781	7 495	68 252
1992[p]	318 515	146 000	104 000	250 000	160 243[b]	92 270[b]	252 513[b]	5 011[b]	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
. . Not available; [p] Preliminary; [r] Revised.
[a] Lead in pigs, blocks and shot. [b] January to September 1992.
[1] Beginning in 1988, Exports and Imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Ores and concentrates include HS classes 2603.00.20, 2607.00.20 and 2608.00.20. Refined exports include HS classes 7801.10, 7803.00, 7804.11, 7804.19 and 7804.20. Refined imports include HS classes 7801.10.10.00, 7801.10.90.00, 7803.00, 7804.11, 7804.19 and 7804.20. [2] Recoverable lead in ores and concentrates shipped. [3] Consumption of lead, primary and secondary in origin, as measured by survey of consumers.

TABLE 3. CANADA, PRIMARY LEAD REFINED METAL CAPACITY, 1992

Company and Location	Annual Rated Capacity
	(000 t of refined lead)
Brunswick Mining and Smelting Corporation Limited Belledune, New Brunswick	72
Cominco Ltd. Trail, British Columbia	135
Total Canada	207

TABLE 4. AVERAGE ANNUAL LEAD PRICES, 1975-92

Year	London Metal Exchange Settlement (£/t)	Settlement (US¢/lb)	Three Months (£/t)	Three Months (US¢/lb)	U.S. Domestic (US¢/lb)
1975	185.63	18.755	186.78	18.821	21.529
1976	250.70	20.480	259.79	21.275	23.102
1977	354.11	28.022	359.12	28.433	30.703
1978	342.79	29.886	342.94	29.895	33.653
1979	567.66	54.574	542.66	52.161	52.642
1980	391.29	41.237	392.08	41.343	42.455
1981	363.37	33.327	370.93	34.025	36.531
1982	310.72	24.679	321.55	25.516	25.547
1083	279.97	19.290	290.62	19.983	21.377
1984	332.49	20.156	333.20	20.196	25.548
1985	304.01	17.876	304.03	17.877	19.067
1986	277.36	18.456	277.61	18.473	22.047
1987	363.66	27.098	346.40	25.736	35.943
1988	368.40	29.748	358.35	28.834	37.140
1989	412.39	30.669	406.41	29.908	39.350
1990	458.21	37.097	443.06	35.871	47.069
1991	315.23	25.303	325.84	25.805	38.800
1992	306.12	24.496	317.26	25.109	38.500

Sources: London Metal Exchange; Metals Week; Reuters.

TABLE 5. AVERAGE MONTHLY LEAD PRICES, 1991 AND 1992

	London Metal Exchange Settlement (£/t)	Settlement (US¢/lb)	Three Months (£/t)	Three Months (US¢/lb)	U.S. Domestic (C¢/lb)	U.S. Domestic (US¢/lb)
1991						
January	309.99	27.2	324.20	28.0	45.5	39.3
February	301.89	26.9	312.61	27.4	44.4	38.5
March	330.69	27.3	342.94	27.9	44.5	38.5
April	343.02	27.2	351.78	27.5	44.4	38.5
May	321.72	25.2	333.34	25.7	44.3	38.5
June	332.72	24.9	339.03	25.0	44.0	38.5
July	331.64	24.8	340.42	25.2	44.3	38.5
August	320.54	24.5	332.49	25.1	44.1	38.5
September	312.41	24.5	322.98	25.0	43.9	38.7
October	302.88	23.7	313.70	24.2	44.5	39.5
November	284.24	22.9	295.51	23.5	44.8	39.7
December	290.98	24.1	301.07	24.6	45.3	39.5
1992						
January	284.39	23.34	295.47	23.91	39.5	45.7
February	283.79	22.89	295.18	23.45	39.5	46.7
March	302.14	23.60	312.86	24.44	40.4	48.2
April	303.09	24.15	315.24	24.72	40.3	47.9
May	287.28	23.58	299.63	24.21	39.5	47.4
June	295.19	24.84	306.54	25.41	39.5	47.2
July	326.08	28.36	337.09	28.89	39.6	47.2
August	336.48	29.66	345.56	29.90	38.5	45.8
September	336.06	28.15	345.67	28.77	38.5	47.1
October	324.82	24.35	336.78	25.29	38.5	47.9
November	301.28	20.85	313.16	21.71	35.0	44.3
December	306.12	24.50	317.26	25.11	33.5	42.6

Sources: Metals Week; Reuters.

TABLE 6. NON-SOCIALIST WORLD LEAD CONSUMPTION, 1988-91

	1988		1989		1990		1991	
	(000 t)	(%)	(000 t)	(%)	(000 t)	(%)	(000 t)	(%)
Batteries	2 394.3	61.0	2 492.4	61.5	2 543.3	63.2	2 559.5	63.9
Cable sheathing	183.2	4.7	196.0	4.8	182.1	4.5	164.0	4.1
Rolled and extruded products	320.4	8.2	320.6	7.9	310.1	7.7	282.6	7.1
Shot/ammunition	85.4	2.2	95.5	2.4	100.5	2.5	108.1	2.7
Alloys	147.1	3.7	139.6	3.5	132.7	3.3	122.5	3.1
Pigments and other compounds	526.6	13.4	556.9	13.8	517.0	12.8	538.9	13.4
Gasoline additives	103.0	2.6	98.2	2.4	86.9	2.2	74.0	1.8
Miscellaneous	164.8	4.2	151.3	3.7	153.2	3.8	157.3	3.9
Total	3 924.8	100.0	4 050.5	100.0	4 025.8	100.0	4 006.9	100.0

Source: International Lead and Zinc Study Group.
Statistics are for: Australia, Austria, Belgium, Brazil, Canada, Finland, France, Germany, India, Italy, Japan, the Republic of Korea, Mexico, the Netherlands, New Zealand, Scandinavia, South Africa, Southeast Asia, Spain and Switzerland.

TABLE 7. REFINED LEAD CONSUMPTION BY COUNTRY, 1988-92

	1988	1989	1990	1991	1992p
			(000 t)		
AMERICAS					
Canada	108	94	83	77	62
United States	1 236	1 346	1 312	1 247	1 141
Mexico	133	146	119	133	144
Brazil	96	100	75	66	62
Other Americas	84	70	58	72	99
Total Americas	1 657	1 756	1 647	1 595	1 508
EUROPE					
United Kingdom	303	302	301	264	261
Germany[1]	374	375	392	413	378
Italy	252	259	258	259	240
France	216	244	255	252	224
Spain	123	119	134	135	123
Other EEC	222	242	230	212	167
Other Europe	218	196	175	188	143
Total Europe	1 708	1 736	1 746	1 723	1 536
ASIA					
Japan	406	406	416	422	371
Republic of Korea	146	155	149	161	147
Taiwan	75	65	75	87	77
India	75	80	75	75	77
Other Asia	182	200	196	224	212
Total Asia	884	906	911	969	884
OCEANIA					
Australia	60	61	54	56	54
Other Oceania	9	9	7	5	6
Total Oceania	69	70	61	61	60
AFRICA					
South Africa	56	63	66	56	51
Egypt	17	8	13	17	16
Algeria	21	17	15	19	17
Other Africa	25	23	17	27	20
Total Africa	119	111	115	119	104
Subtotal	4 437	4 579	4 480	4 467	4 092
Other countries	1 422	1 318	1 198	1 012	..
Total world	5 859	5 897	5 678	5 479	..

Source: International Lead and Zinc Study Group.
.. Not available; p Preliminary (January-November).
[1] Data prior to 1991 include the former Federal Republic only.

TABLE 8. LEAD MINE PRODUCTION BY COUNTRY, 1988-92

	1988	1989	1990	1991	1992p
			(000 t)		
AMERICAS					
Canada	367	276	241	276	342
United States	394	420	497	477	404
Mexico	178	163	187	168	180
Peru	149	193	188	199	193
Other Americas	70	63	58	60	60
Total Americas	1 158	1 115	1 171	1 180	1 179
EUROPE					
Yugoslavia	88	86	83	85	49
Sweden	85	83	85	87	106
Spain	74	64	62	50	32
Ireland	32	32	35	40	43
Germany[1]	18	9	8	7	2
Other EEC	69	66	61	49	53
Other Europe	7	8	6	6	6
Total Europe	373	348	340	324	291
ASIA					
Japan	23	19	19	18	18
Iran	17	10	11	13	12
Thailand	29	24	22	17	19
India	23	25	26	25	36
Other Asia	31	36	33	33	35
Total Asia	123	114	111	106	120
Australia	457	499	556	574	
AFRICA					
South Africa	90	78	69	76	76
Morocco	69	63	65	70	72
Zambia	14	12	12	10	6
Other Africa	33	28	23	18	17
Total Africa	206	181	169	174	171
Subtotal	2 317	2 256	2 347	2 363	2 336
Other countries	1 055	1 063	993	968	..
Total world	3 372	3 319	3 340	3 331	..

Source: International Lead and Zinc Study Group.
.. Not available; p Preliminary.
[1] Data prior to 1991 include the former Federal Republic only.

TABLE 9. REFINED LEAD PRODUCTION BY COUNTRY, 1988-92

	1988	1989	1990	1991	1992p
			(000 t)		
AMERICAS					
Canada	268	243	184	212	255
United States	1 091	1 253	1 291	1 195	1 159
Mexico	249	249	238	236	271
Peru	54	74	69	76	80
Brazil	98	86	76	64	68
Other Americas	48	46	41	44	55
Total Americas	1 808	1 951	1 899	1 827	1 888
EUROPE					
United Kingdom	374	350	329	311	329
Germany[1]	345	350	349	362	355
Italy	178	181	171	208	211
France	256	268	260	283	284
Spain	122	122	130	112	67
Yugoslavia	131	119	94	95	46
Other EEC	200	185	172	169	163
Other Europe	87	77	81	93	97
Total Europe	1 693	1 652	1 586	1 633	1 552
ASIA					
Japan	340	344	327	332	330
Republic of Korea	90	87	75	62	88
Taiwan	67	58	27	20	24
India	32	37	41	43	55
Other Asia	78	85	87	97	97
Total Asia	607	600	557	554	594
OCEANIA					
Australia	204	210	224	239	232
Other Oceania	5	5	5	5	5
Total Oceania	209	215	229	244	237
AFRICA					
South Africa	36	37	31	32	31
Morocco	71	66	68	73	69
Namibia	44	44	35	34	32
Other Africa	18	15	18	16	17
Total Africa	169	162	152	155	149
Subtotal	4 486	4 580	4 423	4 413	4 420
Other countries	1 403	1 404	1 306	5 588	..
Total world	5 889	5 984	5 729	5 588	..

Sources: Energy, Mines and Resources Canada; International Lead and Zinc Study Group.
.. Not available; p Preliminary.
1 Data prior to 1991 include the former Federal Republic only.

Lime

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"Lime" is a general term referring to burned or calcined limestone (burnt lime or quicklime) and its secondary products, including slaked lime and hydrated lime (or calcium hydroxide). In the calcining process, quicklime (CaO or CaO•MgO), begins to form when the dissociation temperature of the limestone occurs. (This occurs from 402°C for the $MgCO_3$ component to 898°C for the $CaCO_3$ portion.) Temperatures are maintained sufficiently long until there is a complete breakdown of the limestone and a release of the carbon dioxide content.

In 1992, shipments of all lime amounted to 2.4 Mt valued at $182.8 million, based on preliminary data. Quicklime accounted for 92% of the total volume, which remained essentially the same as in 1991; however, the total value of shipments decreased 5.5% in 1992. Production figures do not include some captive production from pulp and paper plants which burn sludge to recover lime for re-use in the causticization process.

The Canadian Industry

In 1992, the lime industry in Canada comprised 13 active companies operating 19 plants, of which 13 plants were in eastern Canada (Table 3). Total employment in the industry was approximately 850. Calcining capacity to produce quicklime has not changed following expansions in the 1989-91 period in New Brunswick, Quebec, Ontario and western Canada. Capacity utilization was approximately 60% in 1992.

Lime is a high-bulk, comparatively low-cost commodity; however, it may be sold within a wide radius depending on transportation costs and supply and demand. Preferred locations are within close proximity to major lime markets and sources of high-quality limestones, with convenient access to low-priced energy.

High-calcium quicklime is commercially available in six forms: lump, crushed, pebble, ground, pulverized lime, and as briquettes or pellets. Slaked lime is produced from mixing quicklime and water, and may be purchased as a putty, dry powder, or slurry. Hydrated lime is produced from slaked lime after drying and regrinding. The resulting hydrated lime products, which are categorized by their chemistry, include the following types: high-calcium lime, dolomitic lime, and magnesian or hydraulic lime. (The latter type contains siliceous, aluminous or ferrous compounds.) Aglime, or agricultural lime, refers to pulverized limestone used for soil neutralization, primarily during the fall and spring spreading seasons.

The lime industry underwent several changes in ownership in 1992. BeachviLime Limited, of Ingersoll, Ontario, and owned by Dofasco Inc., was sold to Calcitherm Nederland BV of the Netherlands. The Chemical Lime Works, also of Ingersoll and owned by Stelco Inc., was sold to Global Stone Corp. of Vancouver, British Columbia. These divestitures by Canada's leading steel producers apparently were based on company strategies to place more emphasis on core business activities; however, both Dofasco and Stelco will continue to source their lime requirements from the respective plants. Calcitherm is a holding company for several major limestone- and lime-producing subsidiaries in Europe and the United States. Global Stone Corp. is a privately owned company that has a management group linked with the production of construction materials and lime in the United Kingdom.

Texada Lime (BP Resources Canada Limited, Mining Division) of Fort Langley, British Columbia, was sold to Chemstar Lime Co., a member of the Chemical Lime Group (CLG), which is the largest lime producer in the United States. CLG, in turn, is controlled by business interests in the Netherlands and Belgium. At Spragge, Ontario, the operations of Reiss Lime Company of Canada were purchased by Koch Minerals of Canada Limited.

Consumption

The consumption of lime produced in Canada consists of two basic categories: the captive market, which mainly includes lime produced internally by chemical plants, one steel producer and two sugar refineries; and the merchant market, which is served by the mainstream lime producers. In 1991, captive consumption, estimated to be 826 000 t, accounted for 49% of total domestic sales. (Domestic sales are defined as output for captive use, plus all sales in the merchant market.)

Consumption of quicklime, based on sales in the merchant market, amounted to 1 552 727 t in 1991. The major end uses were steelmaking (50%), environmental control (20%), pulp and paper (14%), chemicals (7.5%), and other industrial uses, including metal concentration (7.5%). Hydrated lime shipments in the merchant market amounted to 147 185 t in 1991, and were sold mainly for environmental control (50%), industrial uses (24%), agricultural uses (6%), masonry (4%), metallurgy (6%), pulp and paper (2%), and other miscellaneous uses related mainly to construction (8%). Eastern Canada, comprising Ontario eastward, accounted for about three quarters of total merchant sales of quicklime in 1991.

Lime is used widely in the metallurgical, industrial (including environment), agricultural and construction sectors. In the metallurgical industry, consumption is mainly as a basic flux in steel furnaces allowing impurities, including silica, alumina, phosphorus and sulphur, to form a slag. Other fluxing agents may include limestone, dolomite and fluorspar. Limestone and dolomite (or dolostone) are used mainly in blast furnaces for making pig iron and in sinter plants at steel mills; limestone, lime and dolime are used in both basic oxygen and electric-arc steel furnaces. Electric-arc furnaces account for one third of steel production capacity in Canada, with basic oxygen furnaces accounting for the remainder.

Industrial markets mainly include the pulp and paper industry, the mining industry, chemicals manufacturing, and environmental control. The pulp and paper industry is the second largest consumer of lime, mainly for the preparation of digesting liquor for manufacturing kraft or sulphate paper, and for pulp bleaching during a primary stage of production. Most of the input lime is recovered by calcining dewatered calcium carbonate sludges; however, an important volume of lime is required as "make-up." The increasing use of precipitated calcium cabonate in coated and uncoated printing and writing papers in North America has led to major growth in the demand for lime.

In the mining sector, acidic effluents are treated with alkalis or related industrial products. These include lime, limestone, soda ash, and ammonium and magnesium hydroxide to raise pH levels (for neutralization) and to precipitate metals. In the uranium industry, lime controls hydrogen-ion concentration in the extraction process as well as in the recovery of sodium carbonate and the neutralization of waste sludges. Lime is also used for cyanidation and the neutralization in recovering gold and silver by flotation. Chemical manufacturers require lime to produce sodium carbonate (soda ash) and bicarbonate of soda, and also to produce chloralkali, calcium carbide and calcium cyanimide.

Lime is increasingly needed for environmental control with the introduction of more stringent regulations. Major uses include the treatment of liquid wastes and industrial effluents; lime is also used in the clarification and softening of potable water. In addition, the neutralization of lakes has attracted much attention over the last two decades. In certain areas, these bodies of water have been acidified by precipitation of sulphur dioxide and nitrogen dioxide emissions. Effective interim actions include liming with limestone, calcite, quicklime, hydrated lime, dolomite, sodium bicarbonate, fly ash and industrial slags. However, research conducted mainly in Ontario has shown that pure limestone (or calcite) was the most cost-effective method.

Air pollution control is a major developing market for lime and limestone in North America. Major coal-fired power stations are taking measures to reduce emissions from the burning of high-sulphur coal, oil and lignite. Several methods apply, including the use of Flue Gas Desulphurization (FGD) units, or scrubbers. There are several options for scrubbing, including the following: wet scrubbing with limestone or lime; dry scrubbing with lime; dry injection using sodium reagents (sodium bicarbonate and sodium sesquicarbonate), trona, or nahcolite; dry injection with limestone integrated with calcium oxide activation; and dry injection of hydrated lime. Wet scrubbing processes using limestone or lime now appear to be gaining importance. The choice of processes depends on many factors such as resource availability, solid waste disposal programs, equipment costs, maintenance and operational costs, flue gas characteristics, utility type and size, and the type of fuel consumed by the power station.

Agricultural uses apply mainly to neutralizing soil acidity. The current practice principally involves the use of pulverized limestone (or aglime). In the case of some sandy soils, dolomitic liming is carried out to help balance magnesium deficiencies.

Miscellaneous uses for lime relate to sugar refining (removal of acids from the crude sugar liquids), the control of storage conditions for fruit and vegetables, and petroleum refining (neutralization of sulphur compounds and sulphur dioxide emissions). Lime is also used in making plaster, mortar, leather and rubber, paint, glass, dolomitic refractories, and calcium-silicate bricks.

Energy and Technology

Energy costs to produce quicklime account for nearly 40% of total production costs, one of the highest ratios in the manufacturing sector. Calcining takes place mainly in vertical (shaft-type) or rotary-type kilns, the latter technology being most common in North America. Preheater systems and computerized process control systems are now commonplace.

About 80% of the kilns in service use natural gas, 12% use coal, and less than 6% use electricity. Long rotary kiln systems consume an average of about 6.4 gigajoules per tonne (GJ/t) of calcined lime. New rotary kilns, with preheaters, consume less than 5.0 GJ/t, and short-shaft kilns consume about 4.2 GJ/t of calcined lime. Other types of kilns, of comparatively recent design, are the rotary hearth, travelling grate, fluo-solid, and the inclined vibratory kiln. Dust-collecting equipment to meet current environmental control regulations is required for all systems.

Prices

Published prices for lime represent only a broad range. Actual prices vary according to marketing strategies and supply and demand. Average prices for high-calcium quicklime and high-calcium hydrated lime, f.o.b. plant, in Ontario, in bulk, were quoted at $70.80/t and $80.40/t, respectively.

International Developments

In 1992, world lime production was an estimated 133.1 Mt, compared to 132.8 Mt in 1991, based on revised figures. The former Soviet Union, the largest producing area, accounted for 19%, followed by China (14%), the United States (12.3%), Germany (7.2%), and Japan (6.7%). Canada ranked fourteenth with a 2% share.

The United States produced 16.33 Mt of lime in 1992, compared to 15.67 Mt in 1991, according to preliminary figures. Apparent consumption in 1992 amounted to 16.4 Mt, compared to 15.8 Mt in 1991. During the period of economic expansion in the industry since 1986, higher consumption was mainly attributable to growing sales to the chemical and industrial sectors, accounting for about 90% of the market.

Outlook

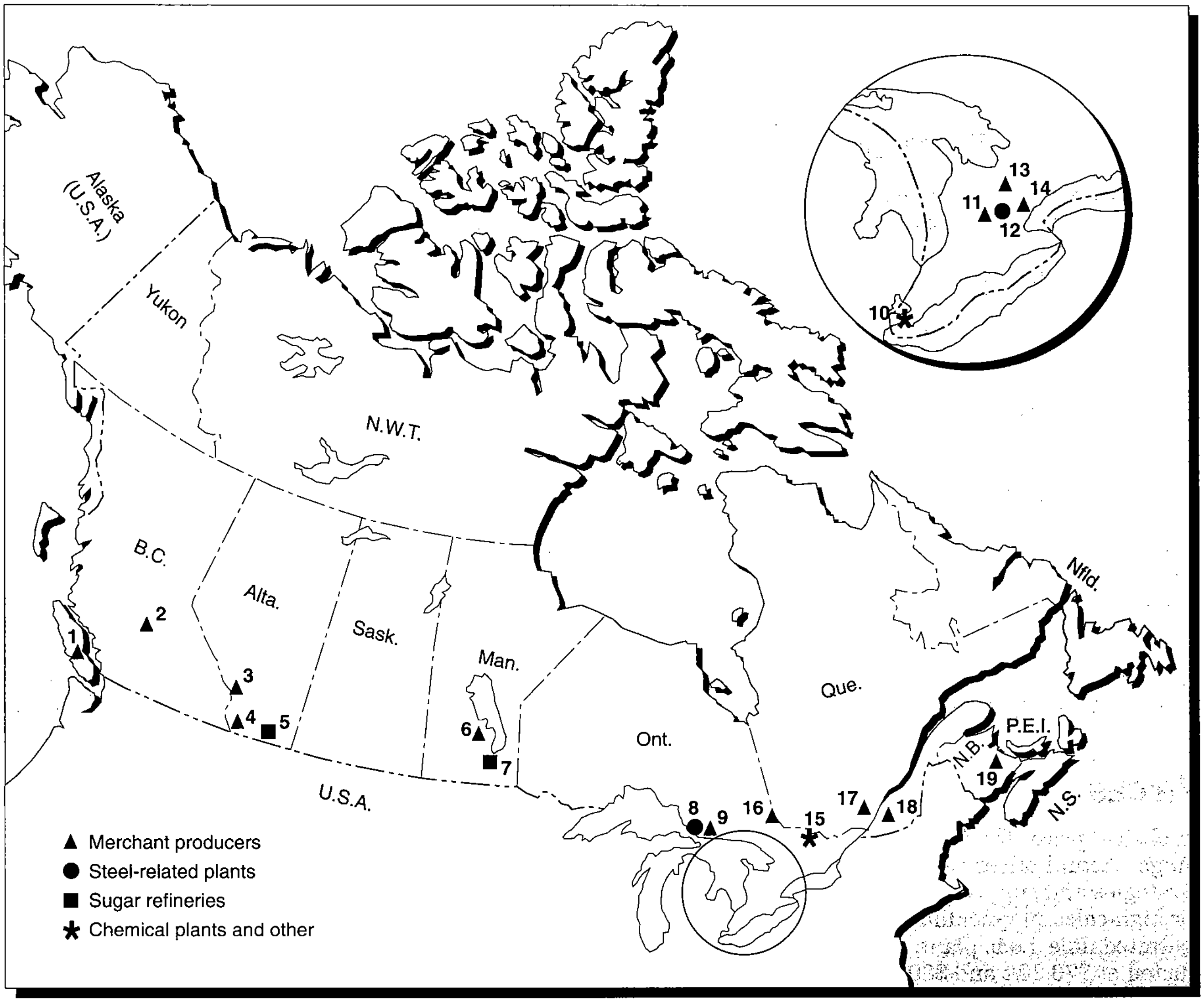
The production of lime in Canada in 1993 is expected to remain about the same as in 1992. Sales to the steel industry, characterized by low demand and weak prices, are expected to remain weak with demand in Ontario influenced greatly by the success of a long-term restructuring plan by Algoma Steel Inc. Over the medium-to-long term, demand for lime as a flux in steelmaking is forecast to decline because of several factors. These include: more use of continuous casting, growing energy efficiency, the use of larger amounts of scrap in basic oxygen furnaces, improved ore grades having a lower silica content, and the use of mini-mills that make steel from scrap iron in electric furnaces.

Demand for lime in the pulp and paper and chemical sectors will continue to be affected by low operating rates. Consumption in the environmental sector is expected to expand in the short term, with increased treatment of effluents in the industrial and mining sectors. Ontario Hydro is installing wet scrubbers using limestone at Lambton and Nanticoke. Similarly, limestone technology is planned for controlling sulphur dioxide emissions at major power installations in Nova Scotia and New Brunswick. In the United States, the extent of the choice between lime and limestone for wet scrubbing technology remains uncertain.

After some consolidation, restructuring and recent plant improvements, the lime industry has become more concentrated as fewer companies control more operations. These companies, or corporate groups (often diversified geographically and in product line), will be in a better position to meet future economic downturns. However, the current low rate of capacity utilization, along with ongoing plant modernization, will allow the lime industry to be well positioned in response to any major increases in demand.

Note: Information in this review was current as of Feburary 1, 1993.

Figure 1
Lime Producers in Canada, 1992



Numbers refer to locations on map above.

MERCHANT PRODUCERS

1. Texada Lime (BP Resources Canada Mining Division), Fort Langley
2. Continental Lime Ltd., Pavilion Lake
3. Continental Lime Ltd., Exshaw
4. Summit Lime Works Limited, Hazell
6. Continental Lime Ltd., Faulkner
9. Koch Minerals of Canada Limited
11. Guelph DoLime Limited, Guelph
13. Steetley Quarry Products Inc., Dundas
14. BeachviLime Limited, Ingersoll
16. Dymond Clay Products Limited, Haileybury
17. Graybec Calc Inc., Joliette
18. Graybec Calc Inc., Marbleton
19. Havelock Lime, a division of Dickenson Mines Limited, Havelock

STEEL-RELATED PRODUCERS

8. The Algoma Steel Corporation, Limited, Sault Ste. Marie
12. Global Stone (Ingersoll) Ltd.

SUGAR REFINERIES

5. The British Columbia Sugar Refining Company, Limited, Taber
7. The British Columbia Sugar Refining Company, Limited, Fort Garry

CHEMICAL PLANTS AND OTHER

10. General Chemical Canada Ltd., Amherstburg
15. Timminco Limited, Haley

PRICES

Canada lime prices quoted in "Camford Chemical Report"	December 1991	December 1992
	($ per tonne)	
Lime, carload and truckload f.o.b. Ontario plant		
High calcium quicklime, bulk	70.80	70.80
High calcium hydrated lime, bulk	80.40	80.40

f.o.b. Free on board.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2522.10	Quicklime	Free	Free	Free	Free
2522.20	Slaked lime	Free	Free	Free	Free
2522.30	Hydraulic lime	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992.

TABLE 1. CANADA, LIME PRODUCTION AND TRADE, 1990-92

Item No.		1990		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
PRODUCTION[1]							
	By type						
	Quicklime	2 137 996	168 854	2 184 836	175 183	2 199 562	166 228
	Hydrated lime	202 741	19 429	190 424	18 358	183 774	16 606
	Total	2 340 737	188 283	2 375 260	193 541	2 383 336	182 834
	By province						
	New Brunswick	x	x	x	x	x	x
	Quebec	x	x	x	x	x	x
	Ontario	1 366 082	102 338	1 439 341	107 790	1 455 099	103 205
	Manitoba	x	6 850	x	9 382	x	11 285
	Alberta	240 254	22 336	217 946	20 407	186 425	16 388
	British Columbia	x	x	x	x	x	x
	Total	24 307 377	188 283	2 375 260	193 541	2 383 336	182 834
IMPORTS						(Jan.-Sept.)	
2522.10	Quicklime						
	United States	29 876	2 673	34 425	3 160	33 942	2 892
	India	3	1	–	–	–	–
	Total	29 879	2 674	34 425	3 160	33 942	2 892
2522.20	Slaked lime						
	United States	4 611	668	1 913	343	2 021	366
	Belgium	–	–	17	7	64	28
	United Kingdom	–	–	–	–	6	2
	Total	4 611	668	1 930	350	2 091	397
2522.30	Hydraulic lime						
	United States	7 597	1 185	7 902	1 153	5 848	995
	Germany	–	–	755	390	1 500	334
	United Kingdom	1 628	358	–	–	–	–
	Total	9 225	1 543	8 657	1 543	7 348	1 330
EXPORTS							
2522.10	Quicklime						
	United States	90 938	7 711	94 445	8 512	100 953	9 066
	South Korea	–	–	–	–	–	–
	Bermuda	–	–	16	2	–	–
	Total	90 938	7 711	94 461	8 514	100 953	9 066
2522.20	Slaked lime						
	United States	24 879	2 611	20 408	2 117	16 044	1 821
	Bermuda	17	2	–	–	–	–
	Total	24 896	2 613	20 408	2 117	16 044	1 821
2522.30	Hydraulic lime						
	United States	22 561	2 014	19 520	1 781	13 287	1 220
	Bermuda	–	–	16	2	32	4
	Other countries	15	6	–	–	1	1
	Total	22 575	2 020	19 536	1 783	13 319	1 225

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; p Preliminary; x Confidential.
[1] Producers' shipments and quantities used by producers.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, LIME PRODUCTION, TRADE AND APPARENT CONSUMPTION, 1970, 1975, 1980, AND 1985-92

	Production[1]					Apparent
	Quick	Hydrated	Total	Imports	Exports	Consumption[2]
			(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
1980	2 364 000	190 000	2 554 000	40 901	403 166	2 191 735
1985	2 054 294	157 286	2 211 580	23 056	194 097	2 040 539
1986	2 069 043	173 534	2 242 577	46 917	189 512	2 099 982
1987	2 140 793	189 278	2 330 071	44 290	163 767	2 210 594
1988a	2 306 831	211 151	2 517 982	28 861	111 177	2 435 666
1989	2 349 312	202 622	2 551 934	37 520	76 852	2 512 602
1990	2 137 996	202 741	2 340 737	39 104	113 513	2 266 328
1991	2 184 836	190 424	2 375 260	43 082	113 997	2 304 345
1992p	2 199 562	183 774	2 383 336	52 909	154 425	2 281 820

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary.
a Beginning in 1988, Exports and Imports are based on the new Harmonized System and may not be in complete accord with previous method of reporting. Imports and Exports include HS classes 2522.10 and 2522.30.
1 Producers' shipments and quantities used by producers. 2 Production plus imports, less exports.

TABLE 3. CANADIAN LIME INDUSTRY, 1992

Company	Plant Location	Calcining Capacity	Market	Type of Quicklime and Other Products
		(000 t/y)		
NEW BRUNSWICK				
Havelock Lime, a division of Dickenson Mines Limited	Havelock	175	Merchant	High calcium[1]
QUEBEC				
Graybec Calc Inc.	Marbleton	300	Merchant	High calcium[1]
Graybec Calc Inc.	Joliette	282	Merchant/captive	High calcium[1]
ONTARIO				
Algoma Steel Inc.	Sault Ste. Marie	200	Captive	High calcium and dolomitic
BeachviLime Limited	Ingersoll	922	Merchant	High calcium[1]
Dymond Clay Products Limited	Haileybury	40	Merchant	High calcium
General Chemical Canada Ltd.	Amherstburg	292	Captive	High calcium
Guelph DoLime Limited	Guelph	122	Merchant	Dolomitic[1]
Koch Minerals of Canada Limited	Spragge	200	Merchant	High calcium
Steetley Quarry Products Inc.	Dundas	345	Merchant	Dolomitic
Global Stone (Ingersoll) Ltd.	Ingersoll	215	Merchant/captive	High calcium
Timminco Limited	Haley	53	Captive	Dolomitic
MANITOBA				
The British Columbia Sugar Refining Company, Limited	Fort Garry	16	Captive	High calcium
Continental Lime Ltd.	Faulkner	117	Merchant	High calcium
ALBERTA				
The British Columbia Sugar Refining Company, Limited	Taber	66	Captive	High calcium
Continental Lime Ltd.	Exshaw	130	Merchant	High calcium[1]
Summit Lime Works Limited	Hazell	50	Merchant	High calcium and dolomitic[1]
BRITISH COLUMBIA				
Continental Lime Ltd.	Pavilion Lake	235	Merchant	High calcium
Texada Lime (BP Resources Canada Limited, Mining Division)	Fort Langley	135	Merchant	High calcium[1]

Source: Mineral Policy Sector, Energy, Mines and Resources Canada.
1 Production of hydrated lime.

TABLE 4. CANADA, CONSUMPTION[1] OF DOMESTIC LIME, QUICK AND HYDRATED, 1990 AND 1991

End Uses	1990	1991
	(tonnes)	
CHEMICAL AND METALLURGICAL		
Steelmaking	438 000	780 978
Water and sewage treatment	412 710	292 346
Water purification	42 329	71 212
Gas scrubbing	13 922	17 088
Metal concentration	59 248	70 856
Pulp and paper mills	234 917	220 735
Chemicals	119 587	116 939
Other industrial uses	88 531	90 401
CONSTRUCTION		
Road and soil stabilization	14 329	12 723
Mason and finishing lime	7 095	5 971
Other	21 230	11 079
AGRICULTURE	10 519	9 584
Total	1 462 417	1 699 912

Sources: Energy, Mines and Resources Canada; producing companies' surveys, 1990-91.
[1] Includes merchant market; excludes companies that are completely captive producer/consumers.

TABLE 5. WORLD PRODUCTION OF QUICKLIME AND HYDRATED LIME, INCLUDING DEAD-BURNED DOLOMITE SOLD AND USED, 1987-92

	1987	1988	1989	1990	1991	1992e
			(000 tonnes)			
U.S.S.R.	30 115	30 110	30 020	27 996	26 036	25 400
China	10 975	12 970	15 960	16 964	18 507	19 050
United States	14 290	15 490	15 580	15 832	15 667	16 350
Japan[1]	6 740	7 725	7 890	8 528	8 954	9 000
Germany	9 485	10 680	10 745	10 197	9 317	9 600
Brazil	5 300	5 495	5 495	5 697	5 498	5 450
Poland	4 260	4 100	4 100	4 400	3 103	3 100
Mexico	6 250	6 000	5 995	5 996	6 505	6 550
Romania	3 630	3 535	3 265	3 202	3 003	3 000
Czechoslovakia	3 235	3 300	3 200	3 348	2 994	3 000
France	2 990	3 090	3 080	2 994	2 994	3 000
United Kingdom	2 810	2 810	2 810	2 604	2 604	2 550
Yugoslavia	2 495	1 990	1 995	1 996	1 597	1 200
Italy	3 890	3 900	3 900	3 846	3 602	3 650
Canada	2 330	2 520	2 550	2 341	2 375	2 400
Belgium	1 760	1 890	1 905	1 796	2 005	2 000
South Africa	1 580	1 915	1 940	1 831	1 765	1 800
Other countries	14 395	15 195	14 980	22 455	16 043	15 984
Total	126 530	132 705	135 310	142 023	132 569	133 084

Sources: Energy, Mines and Resources Canada; Statistics Canada; U.S. Bureau of Mines, Mineral Commodity Summaries, 1993.
e Estimated.
1 Quicklime only.

Magnesium

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Shipments of magnesium increased to a record 257 300 t in 1992 compared to 243 500 t in 1991. In response to weak markets, Western World production fell in 1992 to about 230 100 t from 254 800 t in 1991. According to the International Magnesium Association (IMA), primary magnesium stocks also fell sharply in 1992. By the end of December, primary magnesium stocks reached 29 500 t, down from 55 100 t in December 1991.

CANADIAN DEVELOPMENTS

The Canadian magnesium industry faced a difficult year in 1992. The world recession and trade action by the United States led to a decrease in Canada's total refinery magnesium production in 1992. Canadian magnesium consumption in 1991 increased by 123 t to 15 248 t. While consumption of magnesium for castings and wrought products declined by 20% to 4604 t, demand for magnesium for aluminum alloys increased 17% to 9215 t. The increase in alloy aluminum demand was due in part to the completion of several aluminum smelter expansions in Canada.

The Magnesium Corporation of America (Magcorp) filed an anti-dumping and countervailing petition in 1991 requesting the imposition of anti-dumping and countervailing duties on the imports of pure and alloy magnesium from Canada. In 1992, following an investigation by the U.S. Department of Commerce, a final determination in the case was delivered and countervailing duties were imposed against magnesium produced by Norsk Hydro Canada Inc. In its final determination, the Department of Commerce fixed the rate for Norsk Hydro at 21.61% on an ad valorem basis. The high rate was attributed to programs found to provide benefits, specifically the electricity contracts between Norsk Hydro and Hydro-Québec, as well as to assistance provided by the Province of Quebec under its Société de développement industriel (SDI) program. Timminco Limited, the only other Canadian producer, was not subject to duties.

On February 12, 1992, in addition to the countervailing duties, the United States issued its anti-dumping preliminary determination that placed a 32.7% dumping margin against Norsk Hydro Canada Inc. The dumping margin for Timminco was zero. On August 10, the U.S. International Trade Commission (ITC) voted unanimously to make an affirmative final injury determination with respect to the investigations against magnesium imports from Canada, thereby confirming the application of countervailing (22%) and anti-dumping (33%) duties against magnesium exports to the United States by Norsk Hydro.

In October, the U.S. Department of Commerce issued a changed circumstances review, which concluded that the amended electricity contract between Hydro-Québec and Norsk Hydro does not confer a subsidy. The countervailing duties were reduced from 22% to 8%. Norsk Hydro and the Government of Quebec filed requests for a panel review under the dispute settlement provisions of the Canada-U.S. Free Trade Agreement with respect to both the dumping and subsidy determinations. The panel report is expected sometime during the second quarter of 1993.

Norsk Hydro's magnesium plant at Bécancour, Quebec, started production in December 1989 and produced at roughly 50% of the plant's capacity of 45 000 t/y. The plant receives its raw magnesite material supply from China. At the 1992 rate of magnesium production, magnesite consumption at Bécancour is estimated to be 80 000 t/y. The process technology used at the Bécancour plant involves leaching the magnesite with hydrochloric acid to produce a brine of magnesium chloride ($MgCl_2$), and then reducing the $MgCl_2$ granules in electrolytic cells to produce metallic magnesium.

Norsk Hydro commissioned a $7 million refining facility in Bécancour to convert magnesium scrap into high-purity alloys. The facility processes internally generated scrap and customer die-cast scrap.

Timminco Metals, a division of Timminco Limited, produces high-purity metal (up to 99.99% pure) for specialized market applications at its 4000-t/y magnesium plant in Haley Station, Ontario. Timminco Limited produces magnesium for a variety of applications such as an alloying agent for aluminum and calcium, Grignard reagents for the pharmaceutical industry, and electronic products. Timminco announced an agreement to sell its adhesive business to H.B. Fuller Canada Inc., a wholly owned unit of H.B. Fuller Co. of St. Paul, Minnesota, for $11 million. The company will refocus its future activities on nonferrous metals, including the production of strontium and calcium metals and their alloys.

Timminco uses the Pidgeon magnesium process in which calcined dolomite is reduced by ferrosilicon in a vacuum retort. Timminco mines the dolomite at the plant site but purchases the ferrosilicon feed on the open market.

Noranda Minerals Inc. announced this year that it was taking over sole ownership of the Magnola magnesium project near Thetford Mines, Quebec. The project had been previously operated as a joint venture between Noranda and Lavalintech, until Lavalin was acquired by Benvest Capital in 1991. Noranda and Lavalin formed a joint venture in 1987 to conduct a feasibility study for the construction of a magnesium plant using a unique process based on the tailings from a local asbestos mine to serve as the plant's feedstock.

Prior to Benvest's acquisition of Lavalin, the Noranda-Lavalin joint venture had successfully completed a technical feasibility study concluding that the production of magnesium metal from asbestos tailings is economically feasible. The study called for the construction of a $600 million plant to be constructed that could produce 50 000 t/y of magnesium metal. Noranda is actively searching for a major magnesium consumer in the automotive industry to become a partner in the project.

The Institute of Magnesium Technology Inc. (IMT) was established in 1990 as a private non-profit research organization to promote the development of a downstream magnesium-processing industry in Canada, and to contribute to a greater use of the metal. The IMT is expected to become an international centre of excellence for magnesium technology for developing magnesium alloys and processing technologies.

Currently, more than 80% of the IMT's research projects are commissioned by companies outside Canada. The Institute's membership has grown to 34 members, which include producers, converters and end users. In October, the Institute increased its membership to include Germany's BMW AG. The Institute now has six automotive manufactures among its members including BMW, General Motors Corp., Honda Motors Co. Ltd., Mazda Motor Co. Ltd., Nissan Motor Co. Ltd., and Yamaha Motor Co. Ltd.

Meridian Technologies Inc. of Toronto is currently the largest magnesium die-cast manufacturer in North America and is 20% owned by Norsk Hydro. The company signed a licensing agreement with Japan's Kobe Steel permitting Kobe to exclusively market Meridian's die-cast products in Japan and Southeast Asia. Meridian will also supply its magnesium die-cast manufacturing technology for Kobe's new magnesium die-casting plant to be built in Japan.

Magnesium Products Limited (MPL) of Strathoy, Ontario, announced a $3.2 million plan to expand its current magnesium die-cast facility. The expansion includes a new 2200-t die-cast machine and is expected to be completed by June 1993. MPL is a wholly owned subsidiary of Meridian Technologies.

WORLD DEVELOPMENTS

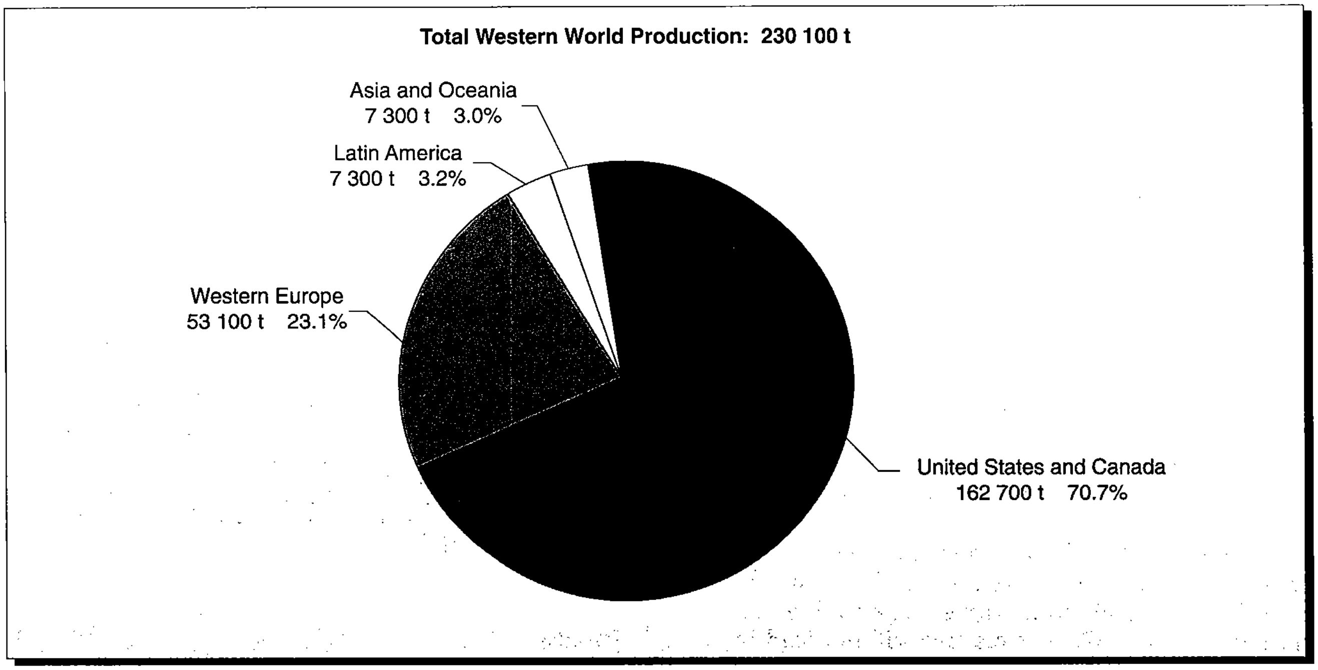
In response to weak economic conditions and weak prices, Western World production of magnesium declined to its lowest level since 1986. Primary world production totalled 230 100 t in 1992 compared to 254 800 t in 1991. The greatest decline in primary production was in Europe, where production fell 23% to 15 600 t. North American production declined 2.5% to 162 700 t.

United States

The United States, the world's largest magnesium producer, has three primary magnesium plants. Dow Chemical Company, the largest U.S. producer, operates a 95 000-t/y electrolytic magnesium plant at Freeport, Texas. Magnesium chloride feedstock for the plant is derived from a seawater-dolomite process. The company recently completed the construction of a new 25 million-kg/y vertical direct-chill caster. As a result of a modernization program undertaken in the 1970s and productivity improvements in the 1980s, Dow is generally considered as one of the world's lowest-cost producers of magnesium.

Magcorp operates a 33 000-t/y electrolytic plant employing more than 500 workers in Rowley, Utah. Magnesium chloride feedstock for the

Figure 1
Percentage of Magnesium Metal Production by World Zone, 1992



SOURCE: International Magnesium Association.

Magcorp plant is normally derived from the natural brines of Great Salt Lake. However, high water levels on the lake in 1986 caused US$20 million in damage to the solar ponding system. In 1989, the company began drawing brine from a new pond system in the west desert. MagCorp estimates that the new ponds have a 10- to 15-year supply of brine.

Magcorp announced that since its chlorine reduction burner came on stream in June 1990, the company has reduced its chlorine emissions by 50%, while total emissions have decreased by 40%. In 1993, Magcorp is planning a further 40% reduction in chlorine emissions. These programs to reduce air pollution followed information published in 1989 by the U.S. Environmental Protection Agency (EPA) that stated that Magcorp was the country's biggest air polluter.

Northwest Alloys Inc., a subsidiary of the Aluminum Company of America (Alcoa), operates a 33 000-t/y magnesium plant in Addy, Washington. The plant uses the Magnetherm process in which magnesium is produced by reducing dolomite with ferrosilicon. In January, the company announced that it would cut production by 50% because of low prices and an oversupply of magnesium in both domestic and foreign markets. The company now produces magnesium exclusively for its parent company, Alcoa.

Toronto-based Meridian Technologies announced in August that it will build a new $35 million magnesium pressure die-cast facility at Eaton Rapids, Michigan. The new facility will include fully automated die-cast equipment and machining capabilities. With the completion of the new facility, Meridian's North American magnesium die-casting division will have the ability to process 18 000 t/y of magnesium.

Brazil

Brazil's Companhia Brasileira de Magnesio (Brasmag) operates a 12 000-t/y magnesium metal plant. Production was temporarily reduced to 8000 t/y because of difficult market conditions. Future expansion plans at the plant have been put on hold due to weak markets and the financial situation of Brasmag.

Europe

Norsk Hydro AS operates a 55 000-t/y primary magnesium plant at Porsgrunn, Norway. The plant produces magnesium by the electrolysis of magnesium chloride derived from a seawater-dolomite process and from magnesium chloride brine imported from Germany. Norsk Hydro AS was also challenged by U.S. trade actions on countervailing and anti-dumping. Although the U.S. Department of Commerce dropped the countervailing charges against magnesium from Norway, the dumping charges were maintained. The Department issued its anti-dumping preliminary determination placing an 8.3% dumping margin against Norway.

Pechiney Électrométallurgie operates a 17 000-t/y smelter in Marignac, France. In 1990, the company continued the rationalization of its magnesium division. Pechiney anticipated reducing its production costs by 15% and increasing capacity by 2000 t/y through a reduction in the workforce, lower overhead costs, technological improvements, and energy savings. Pechiney also developed a new dolomite quarry at Bois des Teuses, 25 km from the Marignac plant, at a cost of 31 million francs. Pechiney uses its proprietary Magnetherm process.

In September, Pechiney announced that it will close its Marignac magnesium plant in January and February 1993 under an energy-saving plan announced in 1992. The closure will not lead to any significant production losses. Annual magnesium output is expected to remain at 15 000 t. Recent technological developments at the Marigny magnesium plant will allow the company to produce more in the summer when electricity costs are lower.

The Societa Italmagnesio temporarily stopped production at its 8000-t/y Bolzano plant in northern Italy in 1992. According to company officials, the plant shut-down was in response to an increase in magnesium metal from the C.I.S. and weak market conditions. The magnesium alloy and anode production sections of the plant continued to operate using stockpiled material.

Magnahorn operates a 9000-t/y magnesium smelter in Bela Stena, Serbia. In response to the prevailing market conditions, Magnahorn announced its intention to cut production by 20% for two years.

Australia

In Australia, Queensland Metal Corp., MIM Holdings Ltd., UBE Industries Ltd., and the Commonwealth Scientific Industrial and Research Organization (CSIRO) created a joint venture to invest A$50 million to develop a magnesium production process. The three private companies will fund half the cost of the Magmetal project, while the Australian government will provide A$20 million and the Queensland government will provide A$5 million. The partners plan to build a 60 000-t/y magnesium metal plant next to Queensland Metal Corp.'s magnesite deposit in Kunwarara. Initially, the company expects to commission a 1000-t/y pilot plant by 1994 or 1995. The five-year program includes 18 months of laboratory work followed by testing at a plant to be built in Gladstone, 150 km south of Kunwarara. The joint-venture partners plan to start production in 1997 to meet the expected increase in Japanese magnesium demand.

Japan

Japan's Kobe Steel announced plans to build a new aluminum and magnesium alloy casting and forging plant. Kobe will spend about US$155 million on the new plant in anticipation of increased consumption of aluminum and magnesium castings and forgings over the next three to four years in the automotive, railway, aerospace and electronic industries. The plant is scheduled to be in full operation by 1995.

Israel

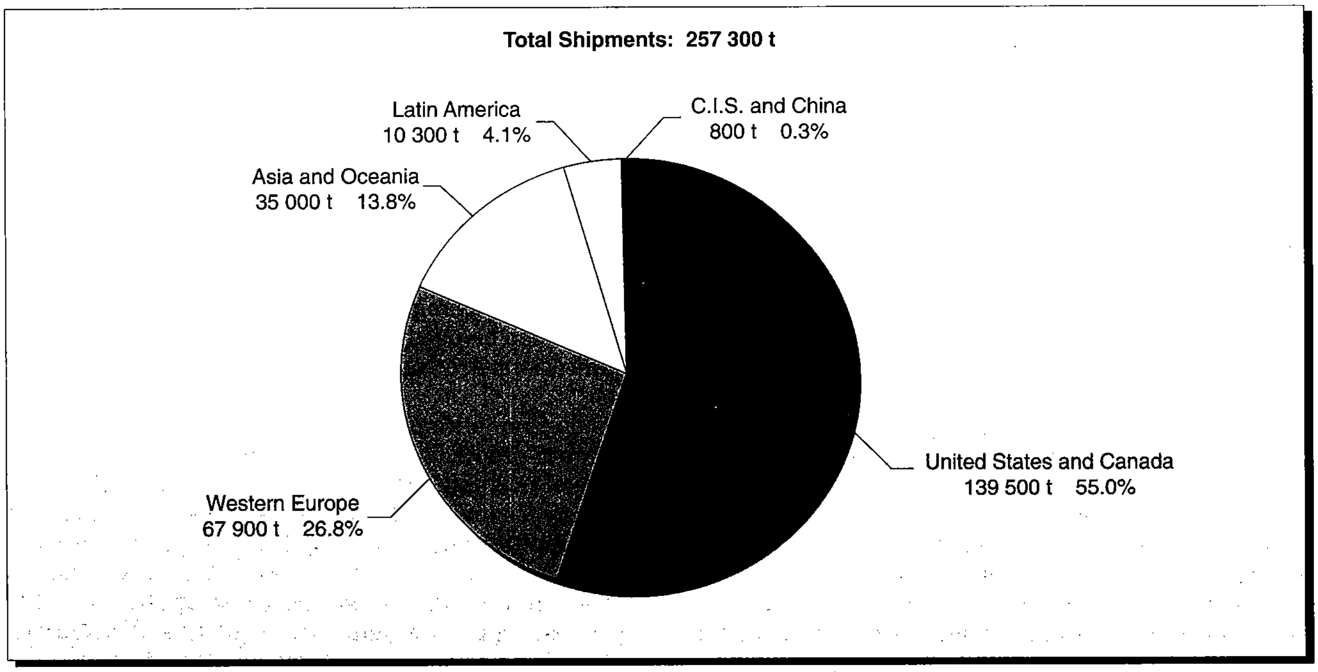
The Dead Sea Works Ltd., a subsidiary of the Israeli Chemical Company Ltd., announced plans to construct a 50 000-t/y magnesium and magnesium alloy plant. The plant will reportedly use Russian magnesium production technology using carnallite ($MgCl_2 \cdot KCL \cdot 6H_2O$) as the raw material. The plant is to be built in two 25 000-t/y stages. The first stage is to be commissioned by 1995 and the second stage by 1998.

USES AND MARKETS

The main application of magnesium is as an alloying agent for aluminum, accounting for close to 57% of non-socialist consumption in 1992. World magnesium consumption for this application decreased by 3%, or 4100 t, in 1992 despite an 8%, or 4900-t, increase in North America. Magnesium consumption for this application is forecast to increase by 3%/y, despite the increased recycling of cans and a reduction in their thickness.

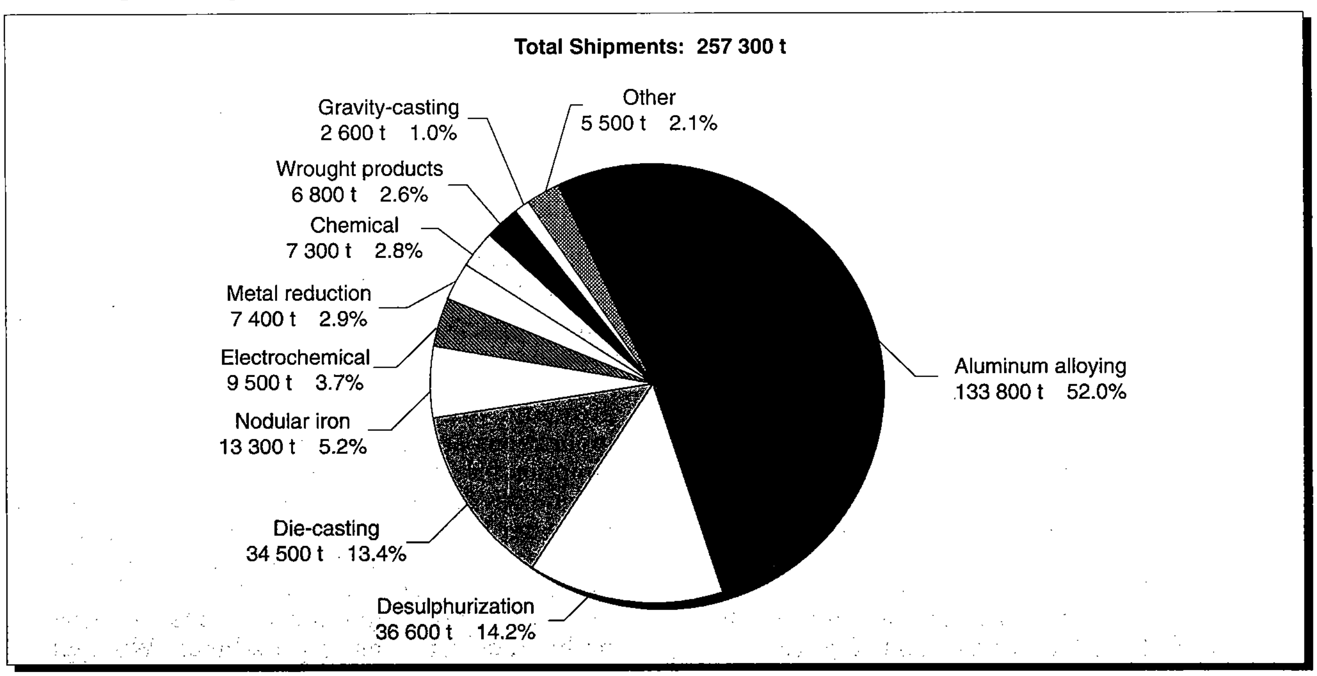
The second largest use of magnesium is in structural applications, in which pressure die-cast products is the most important use. Consumption has increased from 21 000 t in 1982 to 34 500 t in 1992, and is expected to exceed 55 000 t/y within five years. During the next decade, pressure die-casting is expected to be the fastest growing sector, particularly in the United States and Japan.

Figure 2
Percentage of Magnesium Metal Shipments by World Zone, 1992



SOURCE: International Magnesium Association.

Figure 3
Percentage of Magnesium Shipments by Use, 1992



SOURCE: International Magnesium Association.

The increased interest in magnesium metal in the automotive market is largely due to a weight savings of about 33% compared to aluminum. Magnesium also has good vibration dampening characteristics. Its lower heat of solidification, which increases die-casting production capacity by 25%, results in major process energy savings. In addition, magnesium dies are reported to have twice the life of aluminum dies. Parts requiring several castings when made from aluminum can be produced with a single casting when produced from magnesium. Furthermore, die-casters note that even at a magnesium-aluminum price ratio of 1.7 to 1, some magnesium metal parts can be fabricated at the same cost as those made from aluminum.

The enforcement of stricter fuel efficiency and emissions standards is encouraging many auto manufacturers to reduce their vehicles' weight. Increased consumer demand for cars with added luxury items is also driving manufacturers to find ways to reduce automobile curb-weight. Many automobile manufactures in both the United States and Japan are looking to magnesium to help reduce total vehicle weight without sacrificing the consumer demand for larger vehicles.

In an attempt to reduce air pollution, the Japanese government has introduced nitrous oxide regulations requiring the average automobile weight to decrease by 35% over the next 10 years. The principal aim of the Japanese legislation, as with the U.S. Corporate Average Fuel Economy (CAFE) requirement, is to reduce both fuel consumption and automobile emissions of carbon dioxide, sulphur dioxide and nitrous oxide. The Japanese Automotive Manufacturers Association (JAMA) expects magnesium use per Japanese car to grow from 1 kg in 1989 to 5 kg in 1995 and 40 kg by the year 2000. In anticipation of this market growth, Norsk Hydro has established a market development centre in Japan. Norsk Hydro and Dow currently operate such centres in the United States and Europe.

Several automobile manufacturers have announced plans to increase magnesium use beyond the average of 2-3 kg per American car in 1991. Chrysler Corp.'s Dodge Viper high-performance sports car, introduced in 1992, incorporates about 5 kg of magnesium components in its engine as well as magnesium castings in its valve covers and accessory brackets. General Motors' North-Star V-8 Cadillac engine contains about 7 kg of magnesium. The GM Cadillac model will use magnesium in the induction system, valve covers, and oil filter adapters. The 1994 edition of the Ford Aerostar front-wheel-drive minivan should contain 7 kg of magnesium parts, including seat stanchions and steering systems.

New applications in European luxury cars should also translate into further applications for magnesium. Mercedez Benz started to use an 8.5-kg magnesium one-piece seat frame on some of its models. Audi uses a 4.2-kg magnesium component in the dashboard bulkhead on its V-8 sedan. The company anticipates using this part on other models. Volvo is currently evaluating magnesium and aluminum doors for one of its models. Magnesium and aluminum doors can provide a weight reduction of approximately 13 kg. Such an application could also be used for electric cars in which weight limitations are very important.

Aside from automotive applications, die-cast magnesium products are widely used in the manufacture of portable tools and sporting goods. The use of magnesium in electronics equipment, particularly in computer housings and components, has grown substantially. This trend is expected to continue. Magnesium's advantages for these applications are good strength-to-weight ratio, good heat dissipation, electro-magnetic field containment, and radio frequency interference dissipation.

The third largest use of magnesium is as a deoxidizing and desulphurizing agent in the ferrous industry. Magnesium used for desulphurization increased 30% to a record 36 600 t in 1992. This sector, which has grown at an average rate of 15%/y in the late 1980s, should see a more moderate growth rate because of a major rationalization taking place in the steel industry. An increase in steel scrap recovery is also expected to create more markets for magnesium in this application.

Nodular iron production, primarily for ductile iron pipes and die-cast parts for use in automobiles and farm equipment, accounts for about 13 300 t, or 5% of Western World magnesium consumption. This application is not expected to grow as plastics increasingly penetrate the water pipe market. Magnesium is also used as a reducing agent (7400 t or 2.9%) in the production of titanium, beryllium, zirconium, hafnium and uranium. Electrochemical applications account for 3.6% of magnesium consumption for use in the manufacture of batteries and anodes for cathodic protection of gas pipelines and water heaters. As with nodular iron, plastics in the gas pipeline market continue to penetrate this market. Chemical applications (7300 t or 2.8%) include the manufacture of pharmaceutical products, perfumes and pyrotechnics. Wrought products (2.6%) mainly include extruded products except anodes, sheets and plates; gravity casting

(1.0%) includes the production of complex or large parts by sand casting or with other materials. Other applications together account for 2.1% of magnesium consumption.

RECYCLING

An anticipated growth of magnesium die-cast parts in the automotive sector should provide greater opportunities for magnesium recycling. Norsk Hydro Canada Inc. and the Dow Chemical Company will both collect magnesium scrap from their clients. This trend should continue as magnesium metal further penetrates the automobile market.

The International Magnesium Association unveiled its new magnesium recycling logo in 1992. The new logo comprises the chemical symbol for magnesium (Mg) surrounded by a hexagonal-shaped mobius loop. It was designed to educate end users about a magnesium component's metal content and ability to be recycled. Like aluminum, recycled magnesium only requires about 5% of the energy required to manufacture primary magnesium. Currently, the magnesium present in aluminum alloys, primarily beverage cans, accounts for approximately 75% of the magnesium recycled throughout the world. The recycling of magnesium is expected to increase with the expected growth in the use of magnesium die-cast automobile parts.

PRICES

According to the International Magnesium Association, total magnesium stocks decreased from 55 100 t in December 1991 to 29 500 t at the end of 1992. The September inventory figure of 25 700 t represented the lowest level recorded since June of 1989. Current stocks levels represent about 42 days' demand.

As stocks fell and the market tightened, North American producers began increasing prices for both primary and alloy magnesium. Transaction prices for the main die-cast alloy, AZ91D, were listed at US$1.32/lb until November, when prices increased to about $1.46/lb. Prices for pure magnesium also increased when Dow announced a new producer price of $1.53/lb, up from $1.43/lb.

Norsk Hydro AS began publishing quarterly European magnesium prices in 1992. The decision to publish a European price was partly in response to increased sales of lower-grade magnesium by C.I.S. countries. The quoted price for 99.8% magnesium purchased from January 1, 1992, was established at DM3.85/kg (approximately US$1.10/lb). Elsewhere in Europe, traders reported that prices drifted slightly lower at year-end to about US$1.18/lb ($2600/t). The increased availability of C.I.S. material, including oxidized metal offered at a discount, and the general weakness in the European economy were cited as the main reasons for the lower prices.

OUTLOOK

The economic recovery in the second half of 1993 is expected to have some positive impacts on magnesium consumption, particularly in the aluminum alloying and die-casting end uses. The effects of the rationalization and a decrease in exports from the former U.S.S.R. should also improve prices.

Within five years, Western World magnesium consumption should rise to more than 325 000 t/y, primarily because of the substantial increase expected in the die-casting of automobile parts. Magnesium die-casting consumption should well exceed 55 000 t/y by 1997.

Increased production capacity and the slow economic recovery are expected to keep magnesium prices low. These low prices will force older high-cost producers to curtail production or to close.

If growth in consumption is to be sustained, magnesium must remain competitively priced while facing stiff competition from aluminum and plastics in the automobile parts sector. A long-term magnesium-aluminum price ratio of 1.5 to 1 could lead to important breakthroughs for new applications. Canada's comparative advantages, such as low-cost energy and raw materials, a skilled workforce, and its proximity to major world markets, should make it an important player in this promising market.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada			United States	EEC	Japan[1]
		MFN	GPT	USA	Canada	MFN	MFN
8104.11	Magnesium unwrought, containing by weight at least 99.8% of magnesium	4%	2.5%	2%	4.8%	5.3%	6.5%
8104.19	Magnesium unwrought, n.e.s.	4%	Free	2%	3.9%	5.3%	6.5%
8104.20	Magnesium waste and scrap	Free	Free	Free	Free	Free	3.2%
8104.30	Magnesium raspings, turnings and granules, graded according to size; powders						
8104.30.10.00	Raspings, turnings and granules; powders, alloyed	10.2%	6.5%	5.1%	3.9%	5.3%	7.2%
8104.30.20.00	Powders, not alloyed	4%	2.5%	2%	3.9%	5.3%	7.2%
8104.90	Other magnesium						
8104.90.10	Bars, rods, plates, sheets, strip, foil, tubes and pipes, alloyed	4%	Free	2%	a	5.3%	7.2%
8104.90.90	Other	10.2%	6.5%	5.1%	a	5.3%	7.2%

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States 1992; Official Journal of the European Communities, Vol. 35, No. L268, 1992, "Conventional" column; Customs Tariff Schedules of Japan, 1992.
n.e.s. Not elsewhere specified.
[a] 8.8¢/kg on magnesium content plus 2.1%.
[1] GATT rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. CANADA, MAGNESIUM EXPORTS AND IMPORTS BY COMMODITIES AND COUNTRIES, 1991 AND 1992

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS					
8104.11	Magnesium unwrought, containing by weight at least 99.8% of magnesium				
	Netherlands	171	682	1 248	3 075
	United Kingdom	194	967	606	2 686
	Germany	1	4	910	2 388
	Japan	316	1 018	814	2 324
	Norway	. . .	2	449	1 349
	Switzerland	166	545	298	973
	United States	21 234	59 139	223	729
	Other countries	679	2 213	505	1 444
	Total	22 761	64 570	5 053	14 968
8104.19	Magnesium unwrought, n.e.s.				
	United States	3 399	11 315	2 708	9 686
	Australia	90	582	168	945
	Germany	4	34	20	180
	Netherlands	133	680	24	129
	Venezuela	19	48	46	119
	Mexico	–	–	20	106
	Other countries	198	808	74	255
	Total	3 843	13 467	3 060	11 420
8104.20	Magnesium waste and scrap				
	United States	3 035	4 050	617	623
	Venezuela	–	–	18	43
	Total	3 035	4 050	636	666
8104.30	Magnesium raspings, turnings or granules, graded according to size and powders				
	United States	654	3 552	496	2 723
	Ireland	160	1 015	120	725
	South Korea	40	189	40	174
	Switzerland	–	–	12	69
	Other countries	5	29	18	16
	Total	859	4 787	686	3 707
8104.90	Magnesium and articles thereof, n.e.s.				
	United States	186	571	344	1 027
	Australia	51	294	52	298
	Japan	–	–	70	186
	Austria	–	–	19	110
	Other countries	5	37	69	245
	Total	242	902	554	1 866
	Total exports	30 740	87 776	9 989	32 627
IMPORTS					
8104.11	Magnesium unwrought, containing by weight at least 99.8% of magnesium				
	United States	4 652	14 256	3 253	9 117
	Norway	495	1 512	487	1 628
	Former U.S.S.R.	. . .	1	129	329
	United Kingdom	2	7	. . .	1
	France	71	238	–	–
	Germany	1	3	–	–
	Total	5 221	16 019	3 869	11 076
8104.19	Magnesium unwrought, n.e.s.				
	United States	2 823	7 870	895	2 616
	United Kingdom	56	758	29	389
	Other countries	44	130	19	65
	Total	2 923	8 759	943	3 071
8104.20	Magnesium waste and scrap				
	United States	260	688	1 525	3 968
	Total	260	688	1 525	3 968
8104.30	Magnesium raspings, turnings or granules, graded according to size and powders				
	United States	87	323	114	402
	Other countries	4	13	33	95
	Total	91	336	147	498
8104.90	Magnesium and articles thereof, n.e.s.				
	United States	634	3 935	660	3 650
	United Kingdom	1	6	. . .	2
	Other countries	. . .	. . .	–	–
	Total	635	3 942	660	3 653
	Total imports	9 130	29 744	7 144	22 266

Source: Statistics Canada.
– Nil; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified; p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, CONSUMPTION[1] OF MAGNESIUM, 1985-91

	1985[a]	1986[a]	1987	1988[a]	1989[a]	1990	1991[p,a]
				(tonnes)			
Castings and wrought products[2]	1 814	2 628	3 837	5 067	5 661	5 849	4 604
Aluminum alloys	4 813	4 907	4 508	7 810	7 761	7 672	9 215
Other uses[3]	1 316	1 191	1 124	1 189	1 985	1 604	1 429
Total	7 943	8 726	9 469	14 066	15 407	15 125	15 248

Source: Energy, Mines and Resources Canada.
[p] Preliminary.
[a] Increase in number of companies being surveyed.
[1] Available data as reported by consumers. [2] Die, permanent mould and sand castings, structural shapes, tubings, forgings, sheet and plate. [3] Cathodic protection, reducing agents, deoxidizers and other alloys.

TABLE 3. WORLD PRIMARY MAGNESIUM PRODUCTION, 1987-91

	1987	1988	1989	1990	1991
			(tonnes)		
Brazil	5 488	5 865	6 200	6 500[r]	7 800[e]
Canada	8 800	7 600	7 200	26 726	34 480
China	3 000	3 200	3 600[r]	5 800[r]	6 000[e]
France	13 601	13 800	14 600	14 600[r]	14 000[r]
Italy	7 626	5 436	5 469	5 700[r]	4 800[e]
Japan	8 180	9 012	8 381	12 843	11 559
Norway	56 907	50 300	49 827	48 222	44 322
C.I.S. (formerly U.S.S.R.)	90 000	91 000	91 000	88 000	80 000[e]
United States	124 396	141 983	152 066	139 333	131 288
Yugoslavia	5 932	6 176	6 105[r]	5 788[r]	4 000[e]
Total	323 930	334 372	344 372	353 512[r]	338 249

Sources: Energy, Mines and Resources; U.S. Bureau of Mines.
[e] Estimated; [r] Revised.

TABLE 4. PRIMARY MAGNESIUM PRODUCTION BY WORLD ZONE,[1] 1981-92

Period	Area 1 United States and Canada	Area 2 Latin America	Area 3 Western Europe	Area 5 Asia and Oceania	Total
			(000 tonnes)		
1981	138.4	–	64.4	5.7	208.5
1982	97.8	–	52.8	5.8	156.4
1983	109.0	–	51.0	6.0	166.0
1984	152.8	1.0	71.6	6.7	232.1
1985	142.9	2.0	80.8	8.2	233.9
1986	130.7	3.7	81.4	8.1	233.9
1987	133.2	5.2	84.0	7.9	230.3
1988	149.6	5.8	76.2	9.6	241.2
1989	159.3	6.2	76.5	11.4	253.4
1990	164.6	8.7	74.6	12.9	260.8
1991	166.8	7.8	68.7	11.5	254.8
1992	162.7	7.3	53.1	7.0	230.1

Source: International Magnesium Association.
– Nil.
[1] There is no production in Area 4 (Africa and the Middle East).

TABLE 5. PRIMARY MAGNESIUM SHIPMENTS BY WORLD ZONE, 1982-92

Period	Area 1 United States and Canada	Area 2 Latin America	Area 3 Western Europe	Area 4 Africa and Middle East	Area 5 Asia and Oceania	Area 6 COMECON C.I.S. & PRC	Total
				(000 tonnes)			
1982	85.5	8.3	60.6	1.3	17.7	–	173.7
1983	98.6	9.6	60.4	2.4	33.4	–	204.4
1984	110.1	8.0	66.8	1.6	29.5	–	216.0
1985	102.4	9.4	72.2	2.4	38.4	–	224.8
1986	103.3	11.3	73.6	3.2	35.0	–	226.4
1987	113.7	8.3	66.9	5.2	28.7	13.2	236.0
1988	125.0	11.7	70.6	3.8	33.8	6.2	251.2
1989	127.9	9.4	69.5	2.6	33.7	4.1	246.2
1990	127.3	11.6	68.7	4.0	37.6	2.8	252.0
1991	121.3	10.3	66.6	4.5	40.1	0.7	243.5
1992	139.5	10.3	67.9	3.8	35.0	0.8	257.3

Source: International Magnesium Association.
– Nil.

TABLE 6. PRIMARY MAGNESIUM SHIPMENTS BY WORLD ZONE AND CATEGORY, 1992

Use	Area 1 United States and Canada	Area 2 Latin America	Area 3 Western Europe	Area 4 Africa and Middle East	Area 5 Asia and Oceania	Area 6 Other	Total
				(000 tonnes)			
Aluminum alloying	66.2	2.9	33.8	3.6	27.3	–	133.8
Desulphurization	24.6	–	12.0	–	–	–	36.6
Die casting	21.2	5.4	6.5	–	1.4	–	34.5
Nodular iron	6.2	0.5	4.4	0.1	2.1	–	13.3
Electrochemical applications	6.2	1.0	1.4	–	0.9	–	9.5
Metal reduction	5.5	0.3	1.5	–	0.1	–	7.4
Chemical applications	1.4	–	4.0	–	1.9	–	7.3
Wrought products	5.8	–	0.9	–	0.1	–	6.8
Gravity casting	0.7	–	1.9	–	–	–	2.6
Other	1.7	0.2	1.5	0.1	1.2	0.8	5.5
Total	139.5	10.3	67.9	3.8	35.0	0.8	257.3

Source: International Magnesium Association.
– Nil.

TABLE 7. PRIMARY MAGNESIUM SHIPMENTS BY CATEGORY, 1984-92

	1984	1985	1986	1987	1988	1989	1990	1991	1992
					(000 tonnes)				
Aluminum alloying	113.5	121.0	122.1	122.1	134.3	130.8	130.6	137.9	133.8
Desulphurization	17.4	19.1	20.3	21.9	28.6	32.3	28.0	28.1	36.6
Die casting	30.4	29.7	26.8	26.6	28.5	28.6	36.3	30.7	34.5
Nodular iron	9.8	11.3	12.3	14.2	15.8	16.9	14.4	13.7	13.3
Electrochemical applications	7.7	9.1	8.3	8.0	8.0	8.1	9.6	9.2	9.5
Metal reduction	12.2	10.3	9.6	8.8	10.2	9.4	8.8	5.6	7.4
Chemical applications	7.8	8.0	8.0	7.2	8.1	5.5	7.1	7.1	7.3
Wrought products	6.6	4.8	5.4	8.4	7.4	6.2	6.7	5.7	6.8
Gravity casting	1.3	1.2	1.6	1.8	2.1	2.5	3.3	2.2	2.6
Other	9.3	10.3	10.0	17.0	8.2	6.9	7.2	3.3	5.5
Total	216.0	224.8	226.4	236.0	251.2	247.2	252.0	243.5	257.3

Source: International Magnesium Association.

Manganese

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Approximately 90% of the manganese consumed in the world is used in metallurgical applications. Manganese ferroalloys and manganese metal are used in the production of iron and steel; manganese metal is also used in the production of nonferrous products such as aluminum alloys. The non-metallurgical applications include the use of ore to produce manganese chemicals for use in fertilizers, bricks, paint, and for water purification.

Because of the relatively low grade of domestic deposits, Canada has never produced manganese ore on a commercial basis. However, the recent price increase for manganese ore has resulted in renewed interest in three projects: the Hollinger-La Fosse and Wabush mine projects located in the Labrador Trough, and the Woodstock project in New Brunswick.

The recent closure of Canada's only manganese alloy manufacturer had a very strong impact on the country's manganese trade. It resulted in a loss of production valued at about $67 million per year.

The world's production of manganese ore in 1992 declined by about 15% compared to 1991 because of reduced demand in the steel industry. This did not impede the development of new manganese ore production capacity which had been encouraged by the relatively high price for the commodity since 1989. Brazil, Burkina Faso, Ghana, Australia, the Ukraine and the Philippines are some of the host countries for these developments.

These developments affected the traditional producers, mostly in South Africa, who were forced to cut their production to stabilize the manganese ore price. Also affected by poor demand, the high price for raw materials, and the low price for its products, the world's manganese alloy manufacturers were forced to cut production drastically to weather the downturn.

The outlook for 1993 does not show much promise. Consumption of manganese products is forecast to increase very slowly as the world economies recover from the recession. However, the realignment of the market will result in a further redistribution of production capacity. In fact, the price for manganese ore is expected to fall by up to 15% while the price for manganese alloys should stabilize at current levels.

CANADIAN DEVELOPMENTS

In 1992, Canada remained dependent on imports for all of its manganese product requirements for the domestic production of steel, ferroalloys and non-metallurgical products. However, changing market conditions, such as the manganese ore price hike in 1989, have encouraged the re-evaluation of known Canadian resources to supply the domestic market.

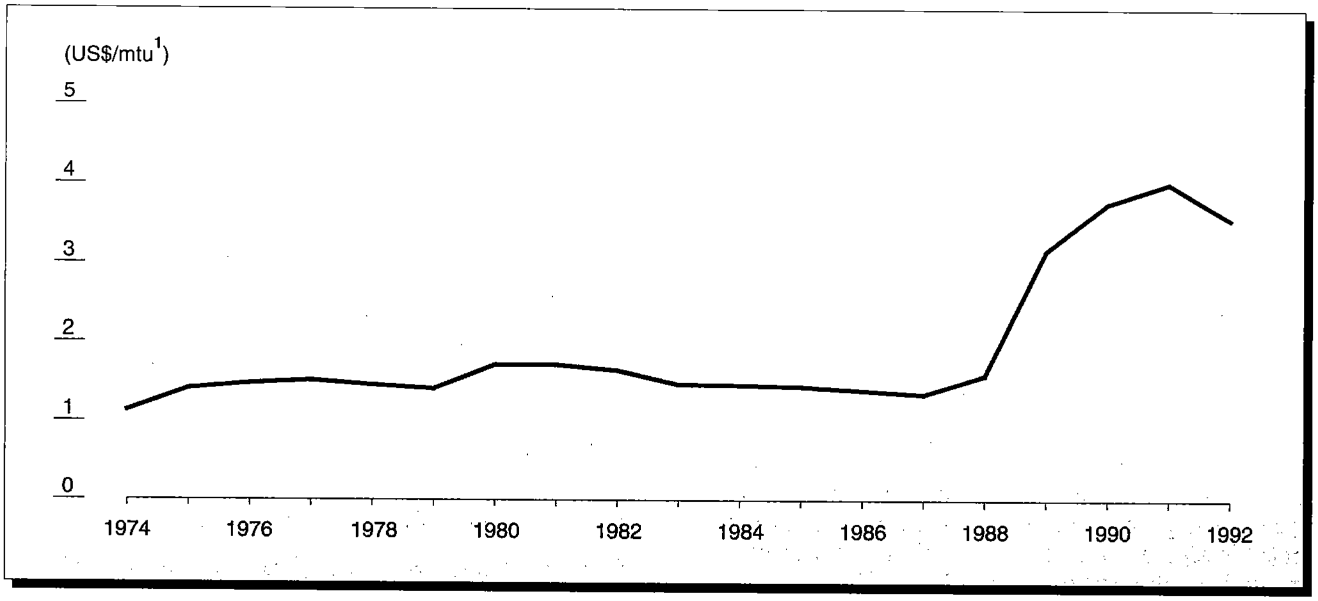
In Canada, manganese occurrences of importance are found in the Labrador Trough of Quebec and Labrador, in New Brunswick near Woodstock, in Nova Scotia, and in the Northwest Territories. Lately, renewed interest has focused on some of the deposits in Quebec/Labrador and New Brunswick.

Occurrences of manganese in the Labrador Trough are associated with iron ore deposits. Two manganese projects located in this area are under study.

Near Schefferville, Quebec, Hollinger North Shore Exploration, a subsidiary of La Fosse Platinum Group Inc., is planning on producing from several small manganese deposits concurrently with the production of iron ore. Ore reserves of more than 1.66 Mt grading an average of 23.9% manganese were outlined by diamond drilling or the surface sampling of 15 deposits. These deposits range in size from 15 000 to 600 000 t grading between 17.0% and 48.5% manganese. Beneficiation of the ore up to 43% manganese by crushing and screening, followed by heavy media separation, will be done locally to produce two lumpy products grading 40% plus and 35% manganese.

Initial production is planned at around 68 000 t/y, growing to 135 000 t/y after four years. Adequate

Figure 1
U.S. Price of Metallurgical Manganese Ore, 1974-92



mtu = metric tonne unit.
1 Minimum 48% manganese, low impurities.
Source: Metals Week.

financing has not yet been found to go ahead with the project.

Wabush Mines, an iron ore producer located in Wabush, Quebec, is involved in research concerning the production of a manganese concentrate as a by-product of the beneficiation of its iron ore. If tests are successful, a secondary benefit would be manganese metal production representing 15% of the North American import market for manganese in all forms.

In New Brunswick, manganese deposits located near Woodstock host reserves estimated at 175 Mt grading 9% manganese. The Plymouth property holds the largest of these deposits, with reserves of 46 Mt grading 10.9% manganese. Various studies made in the past to develop these resources failed to outline an economic way to concentrate the ore. However, these deposits are the subject of renewed interest for the production of manganese dioxide or electrolytic manganese dioxide.

The Canadian consumption of manganese ore in 1991 (the most recent year for which all data are compiled) was down 57% compared with the 1990 figure of 253 002 t. This dramatic fall in consumption is a result of the May 15, 1991, closure of the Elkem Métal Canada Inc. ferroalloy plant located in Beauharnois, Quebec. This smelter was the only producer of manganese ferroalloys in Canada. Its closure takes a production capacity of 130 000 t/y out of the market.

Canada's consumption of ferromanganese and ferro-silicomanganese in 1991 was 4.3% more than in 1990, but 18% less than the average consumption in the 1987-89 three-year period. This reduction follows the softening of the demand for steel products (the main use for manganese ferroalloys).

TRADE

Canada's trade in manganese products is relatively small. However, it is vital to the country since manganese is essential to the activities of the steel industry.

In 1991, the most recent year for which all data are compiled, total imports of manganese products were valued at $72 million while exports amounted to about $16 million.

As a result of the Elkem plant closure, imports of manganese ores and concentrates in 1992 remained low at less than 15% of the 1990 figure. Despite the cut in the domestic supply of ferromanganese and silicomanganese due to the plant closure, imports of these ferroalloys in 1992 were down 1.3% compared to 1991. The supply cut may have been reduced by sales from stockpiles at Elkem and compensated for by a further decrease in demand for ferroalloys compared to 1991.

Imports of manganese metal increased by 8% in 1992, compared to 1991, but were 5.6% lower than the 1990 figure. The increase is due to greater consumption at Quebec-based aluminum plants. In 1991, these plants expanded their production capacity of aluminum alloys containing manganese, which are used in the packaging industry.

Exports of ferroalloys in 1992 plummeted as a result of the cut in domestic production and were probably drawn from Elkem's stockpile. The plant closure resulted in a production loss valued at about $67 million per year.

WORLD DEVELOPMENTS

World production of manganese ores and concentrates in 1992, as estimated by the U.S. Bureau of Mines (USBM), was 18.8 Mt gross weight, down 15% from 1991. It averaged 23.8 Mt gross weight, or close to 8 Mt/y manganese metal content, between 1987 and 1990.

The drop in production is a result of declining demand from the steel industry. This was brought on by the recession and a reduced demand from the global defence sector following the collapse of the U.S.S.R. and the end of the Cold War.

The Commonwealth of Independent States (C.I.S.), South Africa, China, Gabon, Brazil and Australia are the leading producers of manganese ores and concentrates. The export market for manganese ores and concentrates totals an average 3.75 Mt/y gross weight. Gabon, South Africa, Australia, Brazil and Ghana are the major exporting countries. The damage from the C.I.S.'s exports, as observed in other ferroalloy markets in 1992, did not impact on the manganese market as much because of the relatively low quality of C.I.S. material.

Relatively high but decreasing ore prices and the realignment of the markets encouraged the development of new manganese production capacity in some areas of the world, while traditional producers like South Africa were forced to cut capacity. By country, the projects now being developed are described below.

Urucum Mineracao SA, who owns the rights to Brazil's largest manganese reserves, planned to raise output at its Urucum mine by 30% to 400 000 t/y starting in 1992. This mine, an underground operation located close to Brazil's border with Bolivia, has estimated reserves of 60 Mt.

In addition, Prometal Productos Metalurgicos in Brazil is planning to open the Busitirama mine located in the state of Para by mid-1993. It plans to export 250 000 t of manganese ore in 1993, and to escalate that level to 500 000 t/y by 1995. The products marketed will be of two types: lump ore grading 44%-46% manganese, and sinter feed fines grading 42%-44% manganese. Additional plans to open a 200 000-t/y ferroalloy plant in the Carajas area have been dropped.

The Tambao deposit, located in Burkina Faso, contains proven reserves evaluated at 12.1 Mt grading 51.75% manganese and a relatively high 0.15% phosphorus content. Trial shipments to European and Japanese steelmaking and ferroalloy plants from this deposit are slated to begin in January 1993. It is expected that commercial production will start in the second quarter of 1993 at a rate of 30 000 t/y and increase to 80 000 t/y in 1994.

In western Ghana, Brem Wilson Mining is expected to start producing from the Kwesikrom deposit. Planned production is 330 000 t/y of manganese ore.

Portman Mining of Australia is expected to increase its production of high-grade (48.8% manganese) manganese ore by 30% in 1992 to 400 000 t/y at its Woodie deposits in the Pilbara area. Since it started production two years ago, Portman Mining has captured 20% of the Japanese market and 30% of the imports of Taiwan and Korea. The production increase is targeted at the European market.

A third Australian manganese ore producer started operating, this time in the Peak Hill area of central Western Australia. Joint-venture partners Valiant Consolidated Ltd. and Sabminco N.L. started shipments to Japan of lump ore grading better than 45% manganese. Proven mineable ore reserves in the area are 250 000 t in the Millidie deposit and more than 500 000 t in the nearby Horseshoe deposit. The joint venture is now planning to develop the more sizeable Mount Sydney deposit located in the East Pilbara area.

As a major expansion move, Portman Mining of Australia announced in July 1992 that it had reached an agreement with the Ukrainian government on a joint venture to develop the Stepnogorks manganese mine located in the southern part of the country. Portman Mining believes that the deposit's ore reserves exceed 1000 Mt. The company will take a 55% interest in the joint venture in exchange for quadrupling ore production to 1 Mt/y, providing management and marketing input, and injecting some capital.

Also active in the Philippines, Portman Mining expects to begin production early in 1993 from the Panunan district deposits near Aparri in northern Luzon. Production at this site is 50 000-100 000 t/y of lumpy ore. Development programs were also carried out in the nearby Mamit and Sanchez Mira districts where important reserves of high-grade ore have been indicated.

The realignment of the market also encouraged the vertical integration of the industry and the reorganization of some of its members. Joint ventures between ore producers and ferroalloy manufacturers, and company acquisitions, were common in 1992 and followed a trend started in 1991.

The most important of these was the joint-venture agreement between the Norwegian ferroalloy producer, Elkem S.A., and the Australian manganese ore producer, Broken Hill Proprietary Co. Ltd. (BHP). Elkem took a 49% stake in a subsidiary of Groote Eylandt Mining Co. (GEMCO) who is operating the Groote Eylandt manganese mine, which will supply ore to Elkem's two Norwegian ferroalloy plants and the Marietta plant in the United States. BHP, in exchange, receives a 49% interest in some of Elkem's plants.

Another important transaction in 1992 was the 35% acquisition of Société Européenne d'Alliages pour la Sidérurgie (SEAS), a manganese alloy producer in Dunkirk, France, by Brazilian manganese ore producer Companhia Vale do Rio Doce (CVRD). SEAS, owned by Usinor Salicor S.A., has a capacity to produce 100 000 t/y of ferromanganese and silicomanganese. According to the agreement, CVRD will supply two thirds of SEAS's ore requirements.

The world's manganese alloy production in 1991, the most recent year for which data were compiled by the USBM, was 6.905 Mt, down 9% from 1990 and 10% from 1989, when production peaked in recent years.

Another sign of the restructuring of the manganese industry was the alloy manufacturers' obligation in 1992 to cut capacity further. In response to relatively high raw material costs and low product price, ferroalloy producers, such as Elkem S.A., Thyssen Stahl AG of Germany, and Japan Metals & Chemicals Co. Ltd., were forced to lower production at some of their plants while some others, such as Mexican producer Ferromex, were forced into liquidation.

In addition, in an effort to rationalize its operations, Elkem S.A.'s three business groups, ferroalloys, materials and aluminum, will be replaced by four product-oriented divisions, namely: manganese/chrome, silicon metal, ferrosilicon and aluminum. Moreover, Elkem is planning to make a $103 million rights issue guaranteed in part by the Norwegian government, which is also considering additional demands for assistance from the company to help restructure it.

As a result of increased market competition, and to defend its industry, Japan has imposed anti-dumping duties ranging between 4.5% and 27.2% on silicomanganese imports from China. Norway and South Africa, also initially accused, were cleared of the charges.

In other developments, the U.S. Defense Logistics Agency (DLA) awarded a manganese upgrading contract to Elkem Metals Corp. of Pittsburgh. Elkem's plant in Marrietta, Ohio, will upgrade 75 678 t of manganese ore from the DLA stockpile to high-carbon ferromanganese in exchange for US$43.7 million worth of material. This contract will complete the upgrading program started in 1983.

A Defense Authorization Bill approved by Congress in 1992 called for the sale, over a 10-year period, of part of the material contained in the National Defense Stockpile. The DLA will make available for sale 1 467 937 t of metallurgical-grade manganese ore, 61 540 t of battery-grade natural ore manganese, 2716 t of synthetic dioxide battery-grade manganese, and 846 333 t of ferromanganese.

PRICES

The decrease in demand for manganese products started in early 1991, and increasing production capacity resulted in lower prices in 1992. From its high of US$4.00 per metric tonne unit (mtu) of manganese (48% ore) in December 1990, the price stabilized in the middle of 1992 and finished the year at US$3.50/mtu of manganese.[1]

Similarly, the price for medium carbon ferromanganese decreased by 6% during 1992 to finish the year at US50.6¢/lb. The silicomanganese price remained fairly stable during the year, hovering in the US23.4-24.4¢/lb range.

The price for U.S. manganese metal of regular grade remained stable throughout 1992 at US$1.04/lb.

[1] Price is reported in dollars, U.S. currency, for each percentage point of manganese in a tonne of ore; e.g., at $3.00/mtu of manganese, ore grading 48% manganese would bear a price of 48 x $3.00 = US$144.00/t.

OUTLOOK

Experts agree that the steel industry is at a mature stage. Average world steel production is not expected to increase significantly before the next decade. With that viewpoint, the consumption of manganese products will not expand. It is actually expected to decrease since improvements in production efficiency enable steel producers to use less manganese in the steelmaking process for an equal quality product. The restructuring in Eastern Bloc countries and a revamping of their antiquated steel industry using new technologies should also result in lower average manganese consumption. In the short term, however, consumption of manganese products should increase by the end of 1993 as the world economies improve.

The manganese market imbalance, which started in the second half of 1990 when supply exceeded demand, is expected to continue in 1993 and maybe even worsen as more ore production capacity is developed. For this reason, the price for manganese ore is expected to fall significantly and could touch the US$3.00/mtu mark in 1993.

Ferroalloy prices appear to have reached the low end. They are expected to stabilize at this level for the short term, until demand increases substantially.

The decrease in ore price observed in 1991 and 1992, and expected in 1993, as well as difficult market conditions for ferroalloys, could result in the elimination of the higher-cost producers serving the international market.

Already, some producers are trying to protect themselves by vertical integration, obtaining equity positions or arranging partnerships with firms located both upstream and downstream from them in the processing of manganese. Through vertical integration, they are protecting their source of supply and their market while becoming more competitive.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2530.90.50	Natural manganese oxides	Free	Free	Free	Free
2602.00	Manganese ores and concentrates, including manganiferous iron ores and concentrates with a manganese content of 20% or more, calculated on the dry weight	Free	Free	Free	Free
2820.10	Manganese dioxide	Free	Free	Free	0.9%
72.02	Ferromanganese				
7202.11	Containing by weight more than 2% of carbon				
7202.11.10	Containing by weight not more than 1% of silicon	0.88¢/kg or fraction thereof on the manganese content	Free	Free	
7202.11.10.10	Containing by weight more than 2% but not more than 3% of carbon				Free
7202.11.10.20	Containing by weight more than 3% of carbon				
7202.11.20	Containing by weight more than 1% of silicon	1.54¢/kg or fraction thereof on the manganese content	Free	Free	
7202.11.50	Containing by weight more than 4% of carbon				Free
7202.19	Other ferromanganese				
7202.19.10	Containing by weight not more than 1% of silicon	0.88¢/kg on the manganese content	Free	Free	Free
7202.19.20	Containing by weight more than 1% of silicon	1.54¢/kg on the manganese content	Free	Free	Free
7202.30	Ferro-silicomanganese	1.54¢/kg or fraction thereof on the manganese content	Free	Free	Free
8111.00.10.10	Unwrought manganese, not alloyed	Free	Free	Free	
8111.00.10.20	Manganese powders, not alloyed	Free	Free	Free	
8111.00.20	Unwrought manganese, alloyed; waste and scrap; powders, alloyed; articles of manganese	10.2%	6.5%	5.1%	
8111.00.30	Manganese waste and scrap				Free
8111.00.45	Unwrought manganese				8.4%
8111.00.60	Articles of manganese				3.3%

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992.

TABLE 1. CANADA, MANGANESE TRADE, 1990-92 AND CONSUMPTION, 1989-91

Item No.		1990		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
IMPORTS							
2530.90.50	Natural manganese oxides						
	United States	–	–	1	4	3	12
	Total	–	–	1	4	3	12
2602.00	Manganese ores and concentrates, including manganiferous iron ores and concentrates with a manganese content of 20% or more, calculated on the dry weight						
	United States	6 897	1 618	7 142	1 869	6 876	1 895
	Brazil	–	–	183	45	–	–
	South Africa	22 885	5 358	–	–	–	–
	Australia	15 829	4 801	–	–	–	–
	Other countries	17 198	5 949	–	–	–	–
	Total	62 809	17 726	7 324	1 915	6 876	1 895
2820.10	Manganese dioxide						
	United States	2 744	1 129	2 927	1 999	2 279	1 792
	Japan	1 368	1 906	851	1 340	654	1 152
	South Africa	–	–	72	108	90	130
	Total	4 112	3 036	3 850	3 447	3 023	3 075
72.02	Ferromanganese						
7202.11	Containing by weight more than 2% of carbon						
7202.11.10	Containing by weight not more than 1% of silicon						
7202.11.10.10	Containing by weight more than 2% but not more than 3% of carbon						
	United States	55	50	455	267	–	–
	Total	55	50	455	267	–	–
7202.11.10.20	Containing by weight more than 3% of carbon						
	Norway	–	–	660	359	8 645	5 035
	South Africa	9 055	7 251	8 000	5 632	3 873	2 278
	France	–	–	2 209	1 417	1 215	951
	United States	3 065	2 275	1 515	1 106	1 013	847
	Other countries	–	–	2 098	1 297	19	11
	Total	12 120r	9 526r	14 482	9 811	14 766	9 124
7202.11.20	Containing by weight more than 1% of silicon						
7202.11.20.10	Containing by weight more than 2% but not more than 3% of carbon						
	United States	13	7	–	–	–	–
	Total	13	7	–	–	–	–
7202.11.20.20	Containing by weight more than 3% of carbon						
	United States	261	161	2 257	1 588	193	116
	South Africa	–	–	–	–	173	82
	Other countries	–	–	2 310	1 453	–	–
	Total	261	161	4 567	3 041	366	198
7202.19	Other ferromanganese						
7202.19.10	Containing by weight not more than 1% of silicon						
7202.19.10.10	Containing by weight not more than 0.75% of carbon						
	Norway	681	973	4 841	6 480	3 047	3 511
	France	30	45	168	323	227	386
	United States	871	791	749	813	435	383
	Spain	–	–	1 211	2 284	–	–
	Mexico	13	10	275	374	–	–
	Brazil	32	48	47	70	–	–
	Yugoslavia	200	421	–	–	–	–
	Total	1 827	2 288r	7 290	10 345	3 709	4 281

TABLE 1 (cont'd)

Item No.		1990		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)							
7202.19.10.20	Containing by weight more than 0.75% but not more than 2% of carbon						
	South Africa	4 021	4 674	5 552	5 882	4 717	4 759
	United States	500	841	5 623	7 203	4 116	4 707
	Norway	2 817	3 090	92	120	1 243	1 422
	Germany	4 747	6 004	2 133	2 499	756	770
	Brazil	–	–	39	52	501	502
	Other countries	179	285	620	690	107	129
	Total	12 264	14 894	14 059	16 446	11 440	12 291
7202.19.20	Containing by weight more than 1% of silicon						
7202.19.20.10	Containing by weight not more than 0.75% of carbon						
	Italy	1 397	2 873	2 162	3 901	724	1 165
	France	–	–	141	284	42	88
	United States	89	209	328	650	15	31
	Norway	173	310	–	–	–	–
	Total	1 659r	3 393r	2 631	4 835	781	1 285
7202.19.20.20	Containing by weight more than 0.75% but not more than 2% of carbon						
	United States	351	435	1 073	1 097	54	88
	Brazil	–	–	1 504	892	–	–
	Norway	680	771	26	36	–	–
	Total	1 031r	1 207r	2 603	2 026	54	88
7202.30	Ferro-silicomanganese						
	United States	1 032	1 173	1 945	2 080	4 643	3 793
	Brazil	9 777	7 039	8 006	4 505	5 504	2 948
	Norway	–	–	897	1 048	1 298	1 425
	South Africa	6 000	4 215	4 000	2 208	1 988	1 029
	Other countries	–	–	678	458	1 042	663
	Total	16 808r	12 428	15 526	10 299	14 475	9 860
8111.00.10.10	Unwrought manganese, not alloyed						
	United States	172	436	343	851	209	575
	South Africa	40	102	338	816	–	–
	Brazil	60	105	–	–	–	–
	Total	272	644	681	1 668	209	575
8111.00.10.20	Manganese powders, not alloyed						
	South Africa	2 099	4 776	1 440	3 226	1 593	3 644
	United States	147	443	48	132	87	206
	Other countries	150	229	160	328	–	–
	Total	2 396	5 449	1 647	3 687	1 680	3 851
8111.00.20.10	Unwrought manganese, alloyed						
	United States	1 356	4 021	1 261	3 427	900	2 623
	Belgium	–	–	37	101	–	–
	Netherlands	57	195	38	94	–	–
	United Kingdom	20	54	–	–	–	–
	Total	1 433r	4 271	1 336	3 624	900	2 623
8111.00.20.20	Articles of manganese, n.e.s.[1]						
	United States	..	..	..	252	..	747
	Total	..	..	..	252	..	747
8111.00.20.90	Manganese powders, alloyed, including waste and scrap[2]						
	United States	..	..	..	149	..	231
	United Kingdom	..	..	..	148	..	172
	Total	..	..	..	297	..	403
EXPORTS							
2820.10	Manganese dioxide						
	United States	–	–	21	22	–	–
	Total	–	–	21	22	–	–

TABLE 1 (cont'd)

Item No.		1990 (tonnes)	1990 ($000)	1991 (tonnes)	1991 ($000)	Jan.-Sept. 1992p (tonnes)	Jan.-Sept. 1992p ($000)
EXPORTS (cont'd)							
7202.11	Ferromanganese, containing by weight more than 2% of carbon						
	United States	14 608	8 547	11 092	5 504	75	25
	France	–	–	–	–	19	17
	Total	14 608	8 547	11 092	5 504	95	42
7202.19	Ferromanganese, n.e.s.						
	France	–	–	–	–	52	43
	Philippines	–	–	...	4	2	15
	Norway	–	–	2 526	891	–	–
	Other countries	3	13	40	42	–	–
	Total	3	13	2 566	937	54	59
7202.30	Ferro-silicomanganese						
	United States	7 446	4 790	15 612	8 877	141	86
	France	–	–	–	–	6	4
	Norway	–	–	1 919	742	–	–
	Total	7 446	4 790	17 531	9 619	147	90
8111.00	Manganese and articles thereof, including waste and scrap						
	United States	67	234	152	125	258	249
	Netherlands	–	–	–	–	24	68
	Other countries	23	46	28	84	...	3
	Total	90	280	180	209	282	320

	1989	1990	1991p
	(gross weight, tonnes)		
CONSUMPTION[3]			
Manganese ore	203 574	253 002	109 028

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; .. Not available or not applicable; ... Amount too small to be expressed; n.e.s. Not elsewhere specified; p Preliminary; r Revised.
1 The definition of this item changed to "articles of manganese" from "manganese waste and scrap" as of July 1991. 2 This is a new code as of July 1991.
3 Available data as reported by consumers.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, MANGANESE IMPORTS, EXPORTS AND CONSUMPTION, 1970, 1975, 1980, AND 1985-91

	Imports			Exports	Consumption[1]	
	Manganese Ore	Ferro-manganese	Ferro-silico-manganese	Ferro-manganese	Ore	Ferromanganese and Silicomanganese
	(metal content)	(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
1980	95 161	26 704	20 901	11 278	157 680	95 796
1985	102 199	27 481	6 601	43 408	160 241	93 994
1986	94 914	20 283	6 773	45 090	199 699	86 687
1987	80 957	39 606	13 301	23 103	220 053	112 868
1988	108 255	35 071	17 140	25 790	160 146	112 678r
1989	70 033	44 616	13 097	21 894	203 574	113 188
1990	62 809	29 230r	16 808r	14 611	253 002	88 841
1991	7 324	46 087	15 526	13 658	109 028p	92 630p

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; r Revised.
1 Available data as reported by consumers.

Mineral Aggregates

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Total shipments of mineral aggregates (mainly crushed stone and sand and gravel), decreased 7% to about 280 Mt in 1992, the lowest level since 1982. In contrast, total annual shipments were in excess of 350 Mt/y during the pre-recessionary period from 1987 to 1990.

Related unit values have generally increased in pace with average annual inflation rates, with selling prices varying considerably depending on proximity to consumers. Housing starts, a broad indicator of demand for most primary construction materials, were 182 000 in 1990, 156 000 in 1991, and 168 000 in 1992. Total construction expenditures in 1992 were about 7% lower than intended (Table 13).

Canadian Developments

In the context of land-use planning and the environment, there is considerably more awareness of the importance of this large sector of the mining industry. Ontario's new *Aggregate Resources Act*, probably the most comprehensive act of its kind in Canada, requires that producers file detailed site plans describing present uses and planned rehabilitation as resources are extracted.

Numerous constraints to increasing the reserves of aggregates persist because property owners generally oppose the opening of nearby quarries or pits. The Ontario Ministry of Natural Resources, however, is involved with a number of economic assessment studies relating to supply/demand, costs, recycling and re-use, with the goal of ensuring that decision-makers are aware of alternatives, the non-renewable resource aspects of the issues, and the socio-economic impacts of longer haul distances. Several other provinces are involved with related, but less comprehensive, studies.

Demand for mineral aggregates is mainly local or regional, reflecting trends in domestic construction. International bulk shipping, however, is becoming more important in some areas.

Sand and Gravel

Sand and gravel deposits are widespread and large producers have established plants as conveniently as possible to major consuming centres. These large aggregate operations are usually associated with other activities such as ready-mix or asphalt plants and are complemented by many small producers who serve local markets seasonally or only on demand. Also, some relatively large operations may operate intermittently serving, when required, as suppliers to heavy construction companies. Provincial highways departments operate regional or divisional quarries supplying roadbed material for new and repair work. This activity by a wide range of groups has been an obstacle to capturing complete production and consumption data. In the case of Ontario, the largest producing province, estimates indicate that the total production of aggregates from all sources is 25%-30% higher than official surveys indicate. Included in the all-source estimates are designated areas, wayside sources, Ministry of Transportation sites, Crown lands and private lands.

Crushed Stone

Many operations producing crushed stone are part-time or seasonal; others are operated as subsidiaries of construction or manufacturing establishments not classified with the stone industry. In addition, some are operated by municipal or provincial government departments producing stone only for their own use. Quarries removing rock by drilling, blasting and crushing are generally associated with work by large construction companies, and not with the smaller, more local needs often associated with gravel pits. 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-base aggregates (road metal). In these applications, it is subject to the same physical and chemical-testing procedures as the gravel and sand aggregates are.

In **Atlantic Canada**, The Newfoundland Resources and Mining Company (NRMC) initiated steps to develop a high-purity limestone deposit near its established operation. Plans are to produce special products in conjunction with the new aggregates operation at Lower Cove, on the Port au Port Peninsula, in **Newfoundland**. The new $30 million plant and handling facility is designed mainly for shipping bulk quantities; approximately 500 000 t can be stockpiled, and about 4.3 Mt/y can be produced.

Aguathuna Mining Inc. plans a limestone and dolomite quarry at Aguathuna on the Port au Port Peninsula. Efforts have been directed toward securing sales contracts for the planned output of high-calcium limestone and high-purity dolomite.

Granite aggregate from the Porcupine Mountain quarry at Auld's Cove, near Port Hawkesbury, **Nova Scotia**, has been transported to markets throughout the region. In recent years, 50 000-60 000-t loads have been shipped as far as Houston, Texas.

Plans by Kelly Rock Limited and an associate to develop a major coastal marine quarry for construction aggregates remained on hold pending an environmental review. Intentions are to develop a site on deep water at Kelly's Mountain, about 40 km north of Sydney.

In **Quebec**, Marconi Quarries Ltd., situated on the north shore of the St. Lawrence River at Pointe Noire, near Sept-Îles, continued to produce a wide range of construction aggregates for widespread distribution. Reserves of anorthositic gabbro are said to be very large.

In **Ontario**, Dufferin Aggregates (a subsidiary of St. Lawrence Cement Inc.), operating near Milton and producing about 7 Mt/y, remains the largest quarrier in Canada. Following a growing pattern in the industry, the progressive and ongoing rehabilitation of the company's sites has become a major priority in recent years.

Manitoulin Dolomite, owned by Standard Aggregates Inc., is situated on Manitoulin Island in Lake Huron. Approximately 2.2 Mt/y of white-to-grey, fine-grained dolomite is shipped for construction, chemical and metallurgical markets in Canada and the United States.

3M Canada Inc. completed a three-year, $6.5 million modernization program at its Havelock, Ontario, basalt quarry. Capital expenditures were mainly related to increasing the output of crushed aggregates, particularly a fine-grained, dense rock having superior physical properties for use in asphalt surfacing.

In **British Columbia**, large-volume ocean transportation facilities have been used to supply high-quality aggregates or high-calcium limestone for many years. For example, limestone producers on Texada Island, situated about 100 km northwest of Vancouver in the Strait of Georgia, supply raw material to cement and lime producers on the lower mainland and in the state of Washington. Holnam West Materials Ltd., formerly Ideal Basic Industries Limited, has been shipping from Texada since 1957. Road-base material and riprap for use in the lower mainland are also important products; occasionally, orders are from as far away as Alaska.

RECYCLING

Recycling has become more important, particularly as it relates to hot-mix asphalt. In Ontario, more than 90 of the province's 144 asphalt plants are now producing some recycled hot-mix material, according to a recent study. In the future, more recycling of old pavements is expected as a result of limitations on the use of landfill sites and as technical and other problems are better understood.

WORLD DEVELOPMENTS

The Occupational Safety and Health Administration (OSHA) in the United States announced in June that it will exclude from its asbestos regulations the non-asbestiform varieties of the minerals actinolite, tremolite and anthophyllite (AT&A). The ruling culminated six years of discussions headed mainly by the National Stone Association and the National Aggregates Association, but also supported by other mining groups. The non-asbestiform varieties of AT&A will now be regulated as a particulate (in essence, as a nuisance dust). The decision bodes well for established and prospective producers of granitic or gabbroic aggregates which, under the former regulatory approach, may have faced limits to sales in the United States.

Large-scale coastal marine quarrying of aggregates for international markets continues to attract considerable attention. A new coastal marine quarry known as the Wimpey Fleming Adrigole Quarry started production in the southwest of Ireland. (This is a joint venuture between John Fleming Construction of County Cork, and the Minerals Division of the U.K.-based Wimpey Group.) Annual production is expected to rise from 500 000 t in 1992/93 to 1.2 Mt in 1995 and 2.0 Mt by the end of the decade. The rock, situated in a remote area, is described as a superior-quality quartzitic sandstone expected to meet new European standards for aggregates. The project is only the second large-scale operation of its kind in Europe, and it is expected that markets in the United Kingdom and continental Europe will present ideal backhaul cargo. This scale of aggregates operation was pioneered in 1986 by Foster Yeoman Ltd. at its Glensanda quarry on the west coast of Scotland. This was followed later by the Vulcan Materials Co. joint venture on Mexico's Yucatan Peninsula, as well as NRMC's large project, as described earlier.

Also in the United Kingdom, Redland Aggregates proposes to develop a 1-Mt/y quarry off the coast of Scotland on the Isle of Harris. The initial cost of the project is expected to be about $US36 million. Plans are being considered for production of up to 9 Mt/y over 70 years of operation, and leaving the site open for a new tidal inlet.

International investments in North American aggregates production slowed down during 1991 and 1992. Relatively fewer opportunities, as well as growing interest in other areas, including Eastern Europe, may have been factors influencing corporate strategies. Major companies involved in recent years include Tarmac plc, RMC Group plc, Redland plc, C.H. Beazer, English China Clays plc, Alfred McAlpine, Blue Circle Industries Ltd., BTR Ltd., Hanson PLC, Consolidated Gold Fields PLC, and Wimpey Construction Ltd.

Offshore dredging projects for unconsolidated aggregates have become more important because of growing demand and the impact of more on-land environmental and zoning constraints. This is particularly true in the United States, but also applies to Japan where seabed sands account for about 40% of the total domestic production of fine aggregates needed for concrete.

LIGHTWEIGHT AGGREGATES

The classification of lightweight aggregates is based on source, processing methods, and end uses. Source rocks include pumice, scoria, volcanic cinders, and tuff. Manufactured lightweight aggregates are bloated or expanded products commonly obtained by heating certain clays, shales and slates. Ultra-lightweights, produced mainly from perlite and vermiculite, are expanded or exfoliated by heating. Fly ash, resulting from the combustion of coal and coke, and slag from metallurgical processes are classified as by-product aggregates.

Perlite

Perlite is a glassy volcanic rock containing 2%-5% of combined water and, after crushing and heating rapidly to 760°-1100°C, the volume expansion is from 4 to 20 times. With attention to pre-blending of kiln feed and retention time in the kiln, expanded material can be manufactured to weigh as little as 30-60 kg/m^3.

Imported perlite is expanded at numerous locations for use mainly in horticultural peat mixes and lightweight and fire-resistant construction products. Other uses relate to loose insulation and insulating media in concrete products. Imports of crude perlite are mainly from New Mexico and Colorado, with production from companies such as Grefco, Inc., Manville Corporation, USG Corporation, and United Perlite Corp.

Perlite has not been produced in Canada since Aurun Mines Ltd. closed its processing plant in Surrey, British Columbia, in 1990. With improved markets over a wider range of grades, there is a possibility that local occurrences may be used in the future.

Pumice

Numerous concrete product manufacturers, mainly including block producers, use pumice imported from Greece or the northwestern United States. In Canada, a major potential use for this durable and angular material is in highway asphalt overlay as a highly skid-resistant ingredient.

Vermiculite

Vermiculite refers to a small group of minerals, physically resembling the lamellar structure of the micas, that expand or exfoliate greatly when heated rapidly. Canadian consumption is mainly for horticultural uses, with lesser amounts for insulation and other products.

The United States is the world's leading producer of vermiculite, with W.R. Grace and Company being the major supplier from the Enoree region of South Carolina. Canada also imports crude vermiculite from the Republic of South Africa, where Palabora Mining Co. Ltd. (PMC) is the major producer. Vermiculite occurrences have been reported in British Columbia, and deposits near both Perth and Peterborough, in Ontario, have attracted attention in the past.

Clay, Shale and Slag

Common clays and shale are used throughout Canada for manufacturing lightweight aggregates. Although the Canadian industry began in the 1920s in Ontario, it did not evolve significantly until the 1950s. Raw clay materials, usually quarried adjacent to plant sites, receive little beneficiation other than drying before going to the kiln where they are expanded. Shales are crushed and screened before burning. Slag, a porous, glassy, nonmetallic by-product resulting from controlled cooling conditions at the end of the steel-making process, may be crushed and sized for many construction-related applications.

Ongoing research sponsored through the Canada Centre for Mineral and Energy Technology (CANMET), relating to supplementary cementing materials, led to the successful use of ground granulated blast furnace slag for use as a cementitious material in concrete. Koch Minerals of Canada Limited (formerly Reiss Lime Company of Canada, Limited) produces this material commonly referred to as "slag cement" at a grinding plant at Spragge, Ontario. The granulated slag is from a plant owned by Algoma Steel Inc. at Sault Ste. Marie. Plant capacity is 200 000 t/y of slag cement for complete or partial replacement of Portland cement, depending on requirements. The primary use at present is in mine backfill; however, construction-related uses are also being investigated.

PRICES

In addition to supply/demand factors, prices of the various aggregates are determined locally or regionally on the basis of production and transportation costs, the degree of processing prior to final use, and by site-specific volume requirements.

USES

The principal uses for sand and gravel are for highway construction and concrete and asphalt aggregates. Based on a recent study by the Ontario Ministry of Natural Resources, the construction of single-family homes triggers an overall demand of about 300 t of aggregate per unit, while apartment construction requires about 50 t per unit.

More than 90% of the total stone output used by the construction industry is for crushed material as an aggregate in concrete and asphalt for highway and railway construction, and as heavy riprap for facing wharves and breakwaters.

Specifications vary greatly depending on intended uses, and many tests are required to determine the acceptability of aggregates for certain applications. Particle size distribution – as assessed by grading tests or sieve analysis – affects the uniformity and workability of concrete, the strength of the final product, the density and strength of an asphalt material, and the durability, strength and stability of aggregates compacted as fill or base-course material. Also of importance are tests concerning organic impurities or other deleterious material, resistance of the aggregate to abrasion and to freeze-thaw cycles, the effects of thermal expansion, porosity and absorption, reactivity with associated materials, and surface texture.

Lightweight concrete used in commercial and institutional projects has facilitated the construction of taller buildings and the use of longer clear spans in bridges and buildings. Other advantages of using lightweight aggregates relate to their thermal and acoustical properties, fire resistance, freeze-thaw properties, and low water-absorption characteristics.

As yet, there are no Canadian Standards Association (CSA) specifications for lightweight aggregates. Production and application are based on the American Society for Testing and Materials (ASTM) designations as follows: ASTM C 332-87, Lightweight Aggregates for Insulating Concrete; C 330-89, Lightweight Aggregates for Structural Concrete; and C 331-89, Lightweight Aggregates for Concrete Masonry Units.

OUTLOOK

Shipments of aggregates in 1993 are expected to increase, mainly based on a moderate recovery in residential construction. However, a recovery in non-residential building construction is expected to be slower, given relatively high office and industrial vacancy rates. Federal and provincial government plans to increase 1993/94 expenditures by $500 million to $1.0 billion on selected infrastructure are expected to help boost locally the $36 billion/y engineering construction sector.

The construction sector in the United States is expected to improve in 1993 based on growth in single-family housing and additional expenditures on public works, in particular, highways, roads and bridges. Commercial building is expected to remain weak.

Urban expansion has greatly increased the demand for aggregates in support of major construction. Paradoxically, urban spread has not only tended to overrun operating pits and quarries, but it has also extended into areas containing potentially valuable reserves and resources. Clearly, municipal and regional zoning – given advancements in land rehabilitation, reclamation and redevelopment – is expected to become more regulation-oriented to help ensure optimal sequential land use.

Sand and gravel will continue to be competitive with crushed stone in many areas and, in some applications, with lightweight aggregates. New reserves are expected to be located and assessed as part of the community planning or regional zoning process. Prices for aggregates will continue to rise with increasing land values, more sophisticated operating techniques and equipment, the depletion expenditures.

Estimates have indicated that available sand and gravel supplies in some regions will be depleted during the 1990s, resulting in a need for outlying deposits. Predicted shortages could encourage the exploitation of offshore deposits and even underground mining in some regions.

Note: Information in this review was current as of February 1, 1993.

TABLE 1. CANADA, TOTAL PRODUCTION OF STONE, 1990-92

	1990		1991		1992p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
BY PROVINCE[1]						
Newfoundland	1 501	9 952	1 270	7 691	930	4 947
Nova Scotia	7 271	39 459	4 632	24 810	4 210	19 799
New Brunswick	2 711	18 098	2 591	15 851	2 234	13 404
Quebec	40 634	243 573	34 801	208 805	31 634	205 775
Ontario	50 418	300 561	38 704	238 446	36 075	218 572
Manitoba	3 737	15 193	1 725	11 023	1 728	8 705
Alberta	317r	3 111r	321	3 556	347	4 309
British Columbia	3 271	24 327	2 779	24 685	3 724	28 766
Northwest Territories and Yukon	1 495	9 079	1 003	4 788	757	3 368
Total	111 355r	663 354r	87 826	539 654	81 639	507 645
BY USE[2]						
Dimensional stone			..	..	..	..
Rough	274	27 508	..	..	..	..
Monumental and ornamental stone (n.f.)	60	14 007	..	..	..	..
Other (flagstone, curbstone, paving blocks, etc.)	56	3 093	..	..	..	..
Chemical and metallurgical						
Cement plants, Canada	12 991	28 646	..	..	..	..
Cement plants, foreign	1 126	4 332	..	..	..	..
Lining, open-hearth furnaces	...	2	..	..	..	..
Flux in iron and steel furnaces	656	3 673	..	..	..	..
Flux in nonferrous smelters	16	390	..	..	..	..
Glass factories	171	2 975	..	..	..	..
Lime plants, Canada	2 367	18 602	..	..	..	..
Lime plants, foreign	236	1 532	..	..	..	..
Pulp and paper mills	214	1 850	..	..	..	..
Sugar refineries	37	274	..	..	..	..
Other chemical uses	846	5 332	..	..	..	..
Pulverized stone						
Whiting (substitute)	54	3 593	..	..	..	..
Asphalt filler	139	715	..	..	..	..
Dusting, coal mines	8	549	..	..	..	..
Agricultural purposes and fertilizer plants	914	13 195	..	..	..	..
Other uses	420	14 094	..	..	..	..
Crushed stone for						
Manufacture of artificial stone	37	718	..	..	..	..
Roofing granules	310	6 480	..	..	..	..
Poultry grit	56	1 201	..	..	..	..
Stucco dash	15	1 979	..	..	..	..
Terrazzo chips	4	514	..	..	..	..
Rock wool	...	34	..	..	..	..
Rubble and riprap	1 301	9 041	..	..	..	..
Concrete aggregate	11 363	66 615	..	..	..	..
Asphalt aggregate	9 151	55 031	..	..	..	..
Road metal	47 596	230 030	..	..	..	..
Railroad ballast	2 842	19 272	..	..	..	..
Other uses	33 452	175 325	..	..	..	..
Total	126 713	710 602	..	..	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
.. Not available; ... Amount too small to be expressed; n.f. Not finished or dressed; p Preliminary; r Revised.
[1] Data exclude stone used in the Canadian cement and lime industries. [2] Data include stone used in the Canadian cement and lime industries.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, PRODUCTION OF SAND AND GRAVEL[1] BY PROVINCE, 1990-92

	1990		1991		1992p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
Newfoundland	3 016	14 456	2 535	11 396	2 859	11 583
Prince Edward Island	1 311	3 271	1 123	3 261	1 144	3 414
Nova Scotia	6 890	22 945	5 526	21 667	5 402	20 443
New Brunswick	8 285	16 405	7 400	13 483	7 045	14 616
Quebec	29 895	89 533	32 804	113 299	30 721	93 255
Ontario	79 970	286 391	65 317	233 239	62 329	206 465
Manitoba	12 355	38 384	8 000	28 355	7 475	28 241
Saskatchewan	12 022	23 462	9 871	41 513	5 627	21 018
Alberta	43 905	158 198	38 401	127 307	35 689	101 364
British Columbia	41 278	140 585	42 023	135 852	39 883	128 024
Yukon and Northwest Territories	5 387	23 689	3 265	11 953	2 908	8 613
Total	244 316	817 317	216 264	741 326	201 082	637 035

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary.
1 Production values for silica have been included in sand and gravel.
Note: Numbers may not add to totals due to rounding.

TABLE 3. AVAILABLE DATA ON CONSUMPTION OF SAND AND GRAVEL,[1] BY PROVINCE, 1989 AND 1990

		Atlantic Provinces	Quebec	Ontario	Western Provinces[2]	Canada
				(000 tonnes)		
Road bed, surface	1989	13 947	19 052	45 959	85 554	164 513
	1990	13 897	14 964	40 899	77 431	147 193
Roads, ice control	1989	780	1 256	2 442	586	5 063
	1990	798	975	2 248	961	4 981
Concrete aggregate	1989	1 802	5 192	15 974	13 913	36 881
	1990	1 591	4 812	13 580	12 670	32 652
Asphalt aggregate	1989	1 795	3 735	7 270	8 697	21 498
	1990	1 673	3 109	4 960	7 339	17 080
Railroad ballast	1989	129	285	423	1 125	1 961
	1990	20	57	599	817	1 493
Mortar sand	1989	103	540	1 726	309	2 680
	1990	83	554	1 403	282	2 321
Backfill for mines	1989	15	119	557	116	806
	1990	9	53	524	682	1 268
Fill	1989	1 407	3 023	12 714	8 640	25 783
	1990	925	2 797	11 049	8 016	22 787
Other special uses[3]	1989	53	880	519	573	2 023
	1990	52	705	404	543	1 704
Other purposes	1989	870	1 998	4 680	6 147	13 693
	1990	456	1 932	4 306	6 239	12 932
Total	1989	20 901	36 079	92 264	125 658	274 901
	1990	19 502	29 959	79 970	114 978	244 410

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Data include natural silica sand, silica sand manufactured from quartz or silica rock, and silica used in Canadian cement plants. [2] The western provinces include the Yukon and Northwest Territories. [3] Includes glass manufacture, ferrosilicon carbide manufacture, silica brick manufacture, chemical manufacture, smelter flux, sand blasting, and moulding and core sands.
Note: Numbers may not add to totals due to rounding.

TABLE 4. CANADA, EXPORTS AND IMPORTS OF SAND AND GRAVEL AND CRUSHED STONE, 1990-92

Item No.		1990		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
EXPORTS							
2505.90	Natural sands n.e.s., excluding metal-bearing sands						
	United States	48 907	323	35 614	342	82 814	669
	St. Vincent Grenada	–	–	–	–	11 688	250
	Bermuda	–	–	7 026	70	18 141	166
	Bahamas	42 696	723	34 923	652	7 628	143
	Saint Lucia	–	–	67 959	1 331	6 621	124
	France	50	10	16	3	97	22
	United Kingdom	–	–	–	–	66	18
	Mexico	–	–	–	–	3	. .
	Other countries	104	34	4 051	87	–	–
	Total	91 757	1 093	149 589	2 485	127 058	1 396
2517.10	Pebbles, gravel, broken or crushed stone used for aggregates, etc.						
	United States	1 274 312	7 777	1 315 763	7 527	1 448 401	8 234
	St. Vincent Grenada	–	–	–	–	25 867	512
	Bahamas	34 945	624r	20 575	383	27 312	397
	Saint Lucia	–	–	58 718	1 136	12 814	265
	Bermuda	11 002	102	21 534	197	15 982	134
	United Kingdom	–	–	–	–	184	48
	Other countries	35 899	722	26 394	504	–	–
	Total	1 356 158r	9 225r	1 442 984	9 749	1 530 560	9 592
2517.41	Marble granules, chippings and powder of 25.14 or 25.16 heat-treated or not						
	United States	220	36	325	61	4 590	575
	Total	220	36	325	61	4 590	575
2517.49	Granules, chippings and powder, n.e.s., of 25.15 or 25.16 heat-treated or not						
	United States	62	8	706	21	20	4
	Costa Rica	13	3	8	1	31	4
	Saint Lucia	–	–	9 000	167	–	–
	Belgium	–	–	35	5	–	–
	Bahamas	19 922	354	–	–	–	–
	Bermuda	7	. .	–	–	–	–
	Taiwan	193	21	–	–	–	–
	Total	20 197	388	9 749	195	51	8
2518.10	Dolomite, not calcined						
	United States	858 327	4 208	219 832	970	55 785	261
	Total	858 327	4 208	219 832	970	55 785	261
2518.20	Calcined dolomite						
	United States	38 074	4 615	27 261	4 233	16 961	3 022
	United Kingdom	175	40	–	–	–	–
	Total	38 249	4 655	27 261	4 233	16 961	3 022
2518.30	Agglomerated dolomite (including tarred dolomite)						
	United States	149	11	–	–	–	–
	Total	149	11	–	–	–	–
2521.00	Limestone flux; limestone and other calcareous stone used for lime or cement						
	United States	1 364 506	6 802	1 134 223	6 120	1 072 645	5 846
	United Kingdom	3 114	21	–	–	–	–
	Total	1 367 620	6 824	1 134 223	6 120	1 072 645	5 846
IMPORTS							
2505.90	Natural sands n.e.s., excluding metal-bearing sands						
	United States	288 179r	4 312r	125 018	2 868	177 838	2 623
	Japan	113	7	375	55	258	35
	United Kingdom	18	2	84	15	55	10
	Germany	–	–	22	4	37	7
	Italy	26	5	25	4	28	5
	France	8	1	282	56	4	. .
	Other countries	23	2	396	62	–	–
	Total	288 367r	4 332r	126 202	3 067	178 220	2 682

TABLE 4 (cont'd)

Item No.		1990		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)							
2517.10	Pebbles, gravel, broken or crushed stone used for aggregates, etc.						
	United States	993 623r	5 473r	1 019 089	6 113	719 234	5 059
	Indonesia	–	–	–	–	880	13
	Germany	771	11	386	5	379	5
	France	855	12r	1 026	14	301	4
	Belgium	777	11	422	4	238	3
	Hong Kong	25	..	127	..	62	..
	South Africa	–	–	–	–	23	..
	Italy	–	–	361	5	–	–
	Total	996 051	5 509	1 021 411	6 144	721 117	5 087
2517.20	Macadam of slag, dross or similar industrial waste, etc.						
	United States	3 810	44	24 791	65	332	4
	Total	3 810	44	24 791	65	332	4
2517.30	Tarred macadam						
	United States	80	6	51	3	80	5
	Total	80	6	51	3	80	5
2517.41	Marble granules, chippings and powder of 25.15 or 25.16 heat-treated or not						
	United States	45 369r	5 505r	51 806	6 290	50 718	6 161
	Italy	51r	9	384	65	381	66
	France	450	88	673	109	272	53
	Total	45 870r	5 604r	52 863	6 464	51 371	6 282
2517.49	Granules, chippings and powder, n.e.s., of 25.15 or 25.16 heat-treated or not						
	United States	132 285r	1 432r	108 858	1 237	84 474	1 273
	France	231	19	–	–	18	2
	South Africa	–	–	3	..	6	..
	New Zealand	–	–	2	..	3	..
	Total	132 516r	1 452r	108 863	1 237	84 501	1 275
2518.10	Dolomite, not calcined						
	United States	1 630	364	2 752	536	3 672	703
	United Kingdom	12	3	5	1	5	1
	Total	1 642	367	2 757	538	3 677	705
2518.20	Calcined dolomite						
	United States	3 022	332	4 876	489	5 337	447
	Total	3 022	332	4 876	489	5 337	447
2518.30	Agglomerated dolomite (including tarred dolomite)						
	United States	57	30	624	184	167	65
	Total	57	30	624	184	167	65
2521.00	Limestone flux; limestone and other calcareous stone used for lime or cement						
	United States	3 816 995r	14 704r	2 696 021	11 119	2 044 185	8 638
	Thailand	230	1r	919	5	305	1
	Total	3 817 225	14 705	2 696 940	11 124	2 044 490	8 640

Source: Statistics Canada.
– Nil; .. Not available; n.e.s. Not elsewhere specified; p Preliminary; r Revised.
Note: Numbers may not add to totals due to rounding.

TABLE 5. LIGHTWEIGHT AGGREGATE PRODUCERS IN CANADA, 1991

Company	Location	Commodity	Remarks
ATLANTIC PROVINCES			
Annapolis Valley Peat Moss Company Limited	Berwick, N.S.	Vermiculite	Processed for use in horticulture.
Avon Aggregates Ltd.	Minto, N.B.	Expanded shale	Processed for concrete products industry.
Fafard Peat Moss Company Ltd.	Shippagan, N.B.	Perlite	Processed for use in horticulture.
Fisons Horticulture Inc.	Maisonnette, N.B.	Perlite	Processed for use in horticulture.
QUEBEC			
Armstrong World Industries Canada Ltd.	Gatineau	Perlite	Processed for use in ceiling tile manufacture.
Miron Inc.	Ville St-Laurent	Pumice	Purchased for concrete block manufacture.
Premier Peat Moss Ltd.	Rivière du Loup	Perlite, vermiculite	Processed for use in horticulture.
Vermi-lite Inc.	Baie-du-Febvre	Perlite	Processed for use in horticulture, insulation and concrete products.
ONTARIO			
CGC Inc.	Hagersville	Perlite	Processed for use in gypsum plaster.
National Slag Limited	Hamilton	Slag	Used in concrete products industry and as slag cement.
V.I.L. Vermiculite Inc.	Woodbridge	Vermiculite	Processed for use in loose insulation, horticulture and concrete products.
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, horticulture, refractories, as loose insulation, in friction materials and in fire-proofing.
PRAIRIE PROVINCES			
Cindercrete Products Limited	Saskatoon, Sask.	Expanded clay	Processed for concrete block manufacture.
	Regina, Sask.	Expanded clay	Processed for concrete block manufacture.
Consolidated Concrete Limited	Calgary, Alta.	Expanded shale	Processed for concrete products industry and for loose insulation.
CBR Cement Canada Limited	St. Albert, Alta.	Expanded clay	Processed for concrete products industry and for loose insulation.
Fisons Horticulture Inc.	Elma, Man.	Perlite	Processed for use in horticulture.
Fisons Horticulture Inc.	Seba Beach, Alta.	Perlite	Processed for use in horticulture.
Kildonan Concrete 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 products industry.
W.R. Grace & Co. of Canada Ltd.	Vancouver	Vermiculite, perlite	Mainly for horticulture.

Source: Energy, Mines and Resources Canada, reported from EMR survey "Production of Lightweight Aggregates in Canada."

TABLE 6. CANADA, IMPORTS OF VERMICULITE, PERLITE AND PUMICE, 1990-92

Item No.		1990		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
2513.11	Pumice stone, crude or in irregular pieces, including crushed pumice						
	United States	10 830	830	4 891	712	4 044	488
	Turkey	1 985	300	3 886	1 124	1 907	359
	United Kingdom	1	. .	110	38	6	1
	Other countries	4 698	291	9	3	–	–
	Total	17 514	1 423	8 896	1 878	5 957	849
2513.19	Pumice stone, other						
	United States	3 656	756	5 592	796	2 665	525
	Germany	253	92	102	35	152	53
	Ecuador	174	58	180	52	155	50
	Taiwan	31	10	30	10	40	13
	United Kingdom	26	9	27	9	25	8
	Italy	–	–	39	13	. . .	. .
	Hong Kong	5	1	–	–	1	. .
	Other countries	63	25	7	2	–	–
	Total	4 209	951	5 977	920	3 037	652
2530.10.10.10	Vermiculite, unexpanded						
	South Africa	3 000	460	5 971	835	7 801	1 398
	United States	15 211	2 371	10 410	1 551	6 560	968
	China, People's Republic of	–	–	400	42	–	–
	Total	18 211	2 832	16 781	2 429	14 361	2 367
2530.10.10.20	Perlite, unexpanded						
	United States	21 894	2 801	28 018	3 288	19 171	2 302
	Greece	8 388	598	6 331	454	5 159	396
	Total	30 281	3 399	34 348	3 743	24 329	2 699
3802.90.20	Activated perlite, excluding expanded perlite ground to be employed in filtering						
	United States	210	92	1 779	788	73	31
	Total	210	92	1 779	788	73	31
6806.20.00.10	Exfoliated (expanded) vermiculite						
	United States	459r	1 351	313	755	239	514
	Total	459r	1 351	313	755	239	514
6806.20.00.20	Expanded perlite						
	United States	3 366r	1 806r	3 353	1 555	3 399	1 653
	Mexico	–	–	42	35	–	–
	Total	3 366r	1 806r	3 395	1 590	3 399	1 653

Source: Statistics Canada.
– Nil; . . Not available; . . . Amount too small to be expressed; p Preliminary; r Revised.
Note: Numbers may not add to totals due to rounding.

TABLE 7. CANADA, LIGHTWEIGHT AGGREGATES PRODUCED, SOLD AND USED, 1990 AND 1991

	1990				1991			
	Produced		Sold and Used		Produced		Sold and Used	
	(m^3)	($)	(m^3)	($)	(m^3)	($)	(m^3)	($)
From domestic and/or imported raw materials								
Expanded clay, shale and slag[1]	298 178	7 771 761	292 064	7 548 100	350 685	9 006 372	340 848	8 688 139
From imported crude materials								
Expanded perlite and exfoliated vermiculite[1]	462 652	25 501 609	462 652	25 501 609	450 209	24 008 711	473 544	25 358 011
Total	760 830	33 273 370	754 716	33 049 709	800 894	33 015 083	814 392	34 046 150

Source: Energy, Mines and Resources Canada, reported from EMR survey "Production of Lightweight Aggregates in Canada." See Table 5 for list of establishments surveyed.
1 Combined to avoid disclosing confidential company data.

TABLE 8. CANADA, SALES OF EXPANDED SLAG, PERCENTAGE BY END USE, 1989-91

Use	1989	1990	1991
Concrete block manufacture	85.9	90.0	60.0
Ready-mix concrete	8.5	10.0	20.0
Precast concrete manufacture	5.6	–	–
Miscellaneous uses	–	–	20.0

Source: Energy, Mines and Resources Canada, reported from EMR survey "Production of Lightweight Aggregates in Canada."
– Nil.
Notes: See Table 5 for list of establishments surveyed. Sales also imply quantities consumed for own use.

TABLE 9. CANADA, SALES OF EXPANDED CLAY AND SHALE, PERCENTAGE BY END USE, 1989-91

Use	1989	1990	1991
Concrete block manufacture	75.0	67.7	49.4
Loose insulation	12.5	25.5	33.1
Precast concrete manufacture	7.5	2.8	13.9
Ready-mix concrete	3.1	3.1	3.0
Horticulture and miscellaneous uses	1.9	0.9	0.6

Source: Energy, Mines and Resources Canada, reported from EMR survey "Production of Lightweight Aggregates in Canada."
Notes: See Table 5 for list of establishments surveyed. Sales also imply quantities consumed for own use.

TABLE 10. CANADA, SALES OF EXPANDED PERLITE, PERCENTAGE BY END USE, 1989-91

Use	1989	1990	1991
Insulation			
in gypsum products	1.7	0.8	8.2
in other construction materials	28.7	24.0	23.0
Horticulture and agriculture	58.9	67.0	62.3
Loose insulation and miscellaneous uses	10.7	8.2	6.5

Source: Energy, Mines and Resources Canada, reported from EMR survey "Production of Lightweight Aggregates in Canada."
Notes: See Table 5 for list of establishments surveyed. Sales also imply quantities consumed for own use.

TABLE 11. CANADA, SALES OF EXPANDED VERMICULITE, PERCENTAGE BY END USE, 1989-91

Use	1989	1990	1991
Horticulture	56.1	68.1	72.8
Loose insulation	14.2	9.9	9.0
Miscellaneous uses	29.7	22.0	18.2

Source: Energy, Mines and Resources Canada, reported from EMR survey "Production of Lightweight Aggregates in Canada."
Notes: See Table 5 for list of establishments surveyed. Sales also imply quantities consumed for own use.

TABLE 12. CANADA, VALUE OF CONSTRUCTION BY TYPE,[1] 1990-92

	1990	1991	1992
		($ millions)	
BUILDING CONSTRUCTION[2]			
Residential	41 012	36 776	41 115
Industrial	4 344	3 416	2 840
Commercial	16 574	14 009	12 637
Institutional	5 536	5 630	6 189
Other building	2 581	2 550	2 527
Subtotal	70 047	62 382	65 307
ENGINEERING CONSTRUCTION[2]			
Marine	586	627	681
Highways, airport runways	6 463	6 308	6 478
Waterworks, sewage systems	2 925	2 742	2 972
Dams, irrigation	456	459	445
Electric power	6 132	7 285	7 557
Railway, telephones	3 612	3 040	3 296
Gas and oil facilities	8 325	9 914	9 219
Other engineering	3 820	3 370	3 303
Subtotal	32 320	33 743	33 952
Total construction	102 367	96 125	99 259

Source: Statistics Canada.
[1] Actual expenditures 1990, preliminary 1991, intentions 1992. [2] Includes total value of new and repair work purchased.
Note: Numbers may not add to totals due to rounding.

TABLE 13. CANADA, VALUE OF CONSTRUCTION BY PROVINCE,[1] 1990-92

	1990			1991			1992		
	Building Construction[2]	Engineering Construction[2]	Total	Building Construction[2]	Engineering Construction[2]	Total	Building Construction[2]	Engineering Construction[2]	Total
					($ millions)				
Newfoundland	1 040	679	1 718	1 011	898	1 909	1 060	1 168	2 228
Nova Scotia	1 816	846	2 662	1 541	1 033	2 574	1 560	850	2 409
New Brunswick	1 314	719	2 033	1 147	1 061	2 208	1 166	1 039	2 205
Prince Edward Island	242	89	332	246	104	350	251	122	373
Quebec	16 394	6 552	22 946	14 996	6 592	21 588	14 077	7 027	21 104
Ontario	29 526	8 404	37 930	25 443	8 800	34 244	27 493	9 546	37 039
Manitoba	1 811	1 348	3 159	1 580	1 367	2 947	1 662	1 381	3 044
Saskatchewan	1 737	1 932	3 670	1 534	2 043	3 577	1 531	1 861	3 392
Alberta	6 283	7 494	13 777	5 391	7 191	12 582	5 689	6 754	12 443
British Columbia, Yukon and Northwest Territories	9 884	4 258	14 142	9 493	4 654	14 147	10 816	4 204	15 021
Total Canada	70 047	32 320	102 367	62 382	33 743	96 125	65 307	33 952	99 259

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Actual expenditures 1990, preliminary 1991, intentions 1992. [2] Includes total value of new and repair work purchased.
Note: Numbers may not add to totals due to rounding.

Molybdenum

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Canada is the third largest producer of molybdenum in the world. In 1992, Canadian companies produced 9540 t (estimate) of contained molybdenum in the form of molybdenum oxide. Production was down appreciably from the 11 330 t produced in 1991. The value of production in these two years was $63 million and $66 million, respectively.

World molybdenum production, including imports from Eastern countries, was estimated at 82 200 t in 1992, down significantly from 89 400 t in 1991. These changes illustrate the continuing decline in demand resulting from the recession. Most of this decline came from the temporary shut-down or permanent closure of primary molybdenum mines, a reduction totalling approximately 23 000 t. Primary producers took the brunt of the necessary reduction because by-product molybdenum production remained high. Some secondary producers even increased production because world demand for copper, their primary product, was relatively high over the past three years.

The United States remained the world leader in molybdenum production in 1992 with total production estimated at 47 300 t, followed by Chile at 14 800 t.

World consumption of molybdenum in 1992 is estimated at 78 000 t, down 7% from the 1991 level. A major factor in this drop was declining steel production. Towards year-end 1992, North American demand for steel increased slightly, which should mean a somewhat higher molybdenum consumption in the coming year. In the longer term, higher consumption is expected because, at current prices, molybdenum is a bargain-priced alloying element. The likely persistence of relatively low prices for molybdenum, in combination with its versatile performance, should result in an increase in its use per tonne of steel produced.

Molybdenum prices declined during the past three years because of a glut of the material. Surplus supplies of the element will persist and prices are unlikely to increase significantly in the near future. Much of this excess supply is due to the existence of large quantities of demand-insensitive by-product molybdenum from copper producers who take whatever price the market offers.

THE CANADIAN INDUSTRY

Canada has four operating molybdenum mines: one is a primary producer and three are by-product or co-product producers.

The Endako mine, 100% owned by Placer Dome Inc., is the primary producer. Endako, located at Fraser Lake, British Columbia, is the world's lowest cost primary producer at a production cost of less than $5.00/kg. Operations started in 1962, but the mine closed in June 1986. It re-opened in 1988 and capacity operation was achieved in October of that year. The mine has reserves of about 70 Mt of ore grading 0.082% molybdenum. Placer Dome has two roasters, with a total capacity of 10 800 t/y. In 1988, the company invested $2.2 million to double its mine-site ultrapure lubricant-grade molybdenum disulphide capacity to 450 t/y. The company also produces chemical and catalyst-grade molybdenum products on a toll basis in a leaching plant at Equity Silver Mines Limited, a Placer Dome subsidiary, located in British Columbia.

The following mines produce by-product molybdenum:

- Gibraltar Mines, at McLeese Lake, British Columbia, is owned 68.1% by Placer Dome. Reserves are about 160 Mt of ore grading 0.31% copper and 0.009% molybdenum. In recent years, production of molybdenum has fallen because the ore being mined is harder with lower molybdenum grades. The harder ore results in lower molybdenum recovery rates.

- Highland Valley Copper, at Highland Valley, British Columbia, is a joint venture with the following ownership: Cominco Ltd., 50%; Rio Algom, 33.6%; Teck Corp., 13.9%; and Highmont Mining Company, 2.5%. Reserves are 750 Mt grading 0.41% copper and 0.008% molybdenum. In 1991, Highland produced 900 t of molybdenum concentrate.

- BHP Minerals Canada Ltd. is the sole owner of the Island Copper mine located at Port Hardy, British Columbia. The open-pit copper mine has ore grading 0.4% copper and 0.02% molybdenum. It is a significant producer of molybdenum with annual production levels of about 2500 t of contained molybdenum. Proven ore reserves stand at about 140 Mt.

CANADIAN DEVELOPMENTS

Canadian molybdenum production decreased in both 1991 and 1992 to 11 330 t and 9540 t, respectively. This decrease is explained by the following factors. The Brenda mine, which had an annual production of about 3400 t, closed in June 1990. Production at the Island Copper mine declined from 2600 t to 400 t in 1992 because the ore being processed was very low in molybdenum and the recovery circuit was shut down for much of the year.

This by-product production decline was offset by higher output at the Endako mine of Placer Dome, where a higher-grade portion of the orebody was being mined. The Endako operation has also obtained profitable results from its molybdenum upgrading facilities. These facilities have been especially valuable since the Molycorp roaster in the state of Washington was closed in 1991.

The production levels at the other producers' operations were similar to 1991 levels.

U.S. DEVELOPMENTS

In the United States, three primary mines were temporarily closed in 1991 and 1992. Molycorp Inc.'s Questa mine in New Mexico and Cyprus Minerals Co.'s Tonapah mine in Nevada were closed in 1991. The temporary shut-down of Cyprus's Thompson Creek mine in Idaho was announced in November 1992. Since January 1991, U.S. primary molybdenum production has dropped by over 9000 t/y, or about 20% of Western World production.

USES

Molybdenum and its compounds have a number of diverse uses. It is used as a pure metal, as an alloy additive, as a lubricant, and in a number of chemical compounds. In order of market share, these uses are discussed below.

The Alloying Element

Molybdenum is a very versatile and cost-effective alloying element. It is added to steel and ferrous castings as molybdic oxide (MoO_3) or as ferromolybdenum. Ferromolybdenum is an alloy of iron and molybdenum. In this form, molybdenum is readily dissolved in molten steel with very little loss; therefore, ferromolybdenum is often used in making fine adjustments to the chemistry of batches of steel.

The Metal

Molybdenum metal is the product of a rather sophisticated refining process. The metal oxide is refined to high levels of purity by precipitation from solution. The oxide powder is then reduced in hydrogen and the metal powder is compressed into billets prior to required forming operations. Molybdenum metal has a number of valuable properties. Specifically, it has a low coefficient of thermal expansion, the refractory property of a high melting temperature, corrosion resistance, low levels of erosion from molten metal, low density, relatively high thermal conductivity, low specific heat, a high modulus of elasticity, and relatively high electrical conductivity and good electrical contact properties.

The Chemical

Molybdenum is an element that is an important component of a wide variety of chemicals. These chemicals are used as lubricants, reagents, dyeing compounds, pigments, vitreous glazes and enamels, electroplating compounds, catalysts, fertilizers, flame retardants, and paints and inks.

Other Uses

Molybdenum is valued for its properties as a catalyst in the petroleum refining and chemical-processing industries. Pure molybdenum disulphide is an excellent dry lubricant because it has a lamellar structure with a low coefficient of friction between the laminations and the property of bonding to other materials. Molybdenum can also be used in the production of rechargeable dry batteries. These lithium-molybdenum batteries have more power per cell volume than conventional nickel-cadmium or alkaline batteries.

PRICES

The Canadian price for contained molybdenum in concentrate averaged $5.76/kg in 1991 and was estimated at $6.55/kg in 1992.

On the world market, the spot price for molybdenum oxide averaged US$6.28/kg in 1990, US$5.24/kg in 1991, and US$4.87/kg in 1992.

OUTLOOK

There is unlikely to be a significant increase in molybdenum prices in 1993. High inventories and excess capacity will continue to be the main factors preventing a major market recovery in the short term. This oversupply will be exacerbated by a weakness in the major markets for metal. World demand for steel, the production of which accounts for about 75% of molybdenum consumption, is expected to grow at only 1%-2%/y over the next five years. Another important market for molybdenum is in the production of superalloys, a high percentage of which are used in the aerospace industry. Demand for these products has declined and is expected to remain weak in the short term.

In the longer term, over the next five to ten years, the demand for molybdenum should increase moderately. This expectation of higher consumption is reinforced by the fact that, even at considerably higher prices, molybdenum is a bargain alloying element. The current and anticipated long-term relatively low price for molybdenum, in combination with its versatile performance, should result in an increase in its use per tonne of steel produced.

The production of molybdenum in Canada in 1993 is forecast to increase slightly. In the longer term, prices should stabilize at somewhat higher levels as supply and demand become more balanced. Canadian molybdenum producers have taken steps in recent years to improve their competitiveness. This was accomplished mainly through cost-cutting measures such as lower labour costs, higher productivity, and negotiations resulting in lower hydro rates. These changes have placed Canadian producers among the lowest-cost operations in the Western World, which has helped them survive in the depressed market that has characterized the recent past.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
2613.10	Molybdenum ores and concentrates, roasted	Free	Free	Free	7.9¢/kg on molybdenum content + 1.1%	Free	Free
2613.90	Molybdenum ores and concentrates, n.e.s.	Free	Free	Free	3.9¢/kg on molybdenum content	Free	Free
2825.70.10	Molybdenum oxides	12.5%	8%	Free	0.6%	5.3%	3.7%
2825.70.20	Molybdenum hydroxides	Free	Free	Free	0.6%	5.3%	3.7%
2841.70	Metallic molybdates	9.2%	6%	Free	0.7%-0.8%	6.6%	4.9%
7202.70	Ferromolybdenum	10.2%	6.5%	Free	0.9%	4.9%	4.9%
8102.10.10	Molybdenum powders, not alloyed	4%	Free	Free	2.7¢/kg on molybdenum content + 0.3%	–	3.7%
8102.10.20	Molybdenum powders, alloyed	10.2%	6.5%	Free	2.7¢/kg on molybdenum content + 0.3%	–	3.7%
8102.91.10	Unwrought molybdenum, not alloyed	4%	Free	Free	2.7¢/kg on molybdenum content + 0.3%	5%	3.7%
8102.91.20	Unwrought molybdenum, alloyed; waste and scrap	10.2%	6.5%	Free	Free-2.7¢/kg on molybdenum content + 0.3%	5%	3.7%
8102.92	Molybdenum profiles, plate, sheet, strip or foil, including bars and rods not simply sintered	10.2%	6.5%	Free	1.3%	8%	4.9%
8102.93.10	Molybdenum wire, not coated or covered	8%	5%	Free	1.3%	8%	4.9%
8102.93.20	Molybdenum wire, coated or covered	10.2%	6.5%	Free	1.3%	8%	4.9%
8102.99	Molybdenum and articles thereof, n.e.s.	10.2%	6.5%	Free	1.1%	10%	4.9%

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992; Official Journal of the European Communities, Vol. 35, No. L268, 1992, "Conventional" column; Custom Tariff Schedules of Japan, 1992.
– Nil; n.e.s. Not elsewhere specified.
1 GATT rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. CANADA, MOLYBDENUM PRODUCTION AND TRADE, 1990-92, AND CONSUMPTION, 1990 AND 1991

Item No.		1990		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
PRODUCTION	(Shipments)[1]						
	British Columbia	12 188	84 721	11 437	65 928	9 602	62 866
	Total	12 188	84 721	11 437	65 928	9 602	62 866
EXPORTS						**(Jan.-Sept.)**	
2613.10	Molybdenum ores and concentrates, roasted						
	Japan	4 442	34 739	4 148	26 063	2 505	14 894
	Netherlands	404	3 255	816	4 597	1 059	7 753
	South Korea	419	3 155	806	5 161	447	2 647
	Belgium	688	5 507	68	588	242	2 040
	Other countries	734	5 304	1 262	7 971	262	1 379
	Total	6 687	51 960	7 100	44 380	4 515	28 713
2613.90	Molybdenum ores and concentrates, n.e.s.						
	Chile	1 281	11 496	2 361	15 262	256	1 267
	United States	–	–	36	129	339	1 265
	Belgium	1 992	15 316	436	3 672	56	408
	Other countries	1 102	8 227	266	2 252	–	–
	Total	4 375	35 039	3 099	21 315	651	2 941
2825.70	Molybdenum oxides and hydroxides						
	United States	7	58	102	655	39	236
	Other countries	18	86	5	80	–	–
	Total	25	145	107	736	39	236
2841.70	Metallic molybdates	–	–	–	–	–	–
7202.70	Ferromolybdenum						
	United States	–	–	8	49	15	81
	Philippines	–	–	1	13	...	2
	South Korea	...	...	–	–	–	–
	Total	...	...	9	62	15	84
8102.10	Molybdenum powders						
	United States	...	2	...	10	...	6
	Australia	–	–	...	1	–	–
	Total	...	2	...	12	...	6
8102.91	Molybdenum, unwrought, including bars or rods simply sintered; waste and scrap						
	United States	7	56	–	–	12	35
	Total	7	56	–	–	12	35
8102.93	Molybdenum wire	–	–	–	–	–	–
8102.99	Molybdenum and articles thereof, n.e.s.						
	United States	1	32	...	7	...	3
	Total	1	32	...	7	...	3

TABLE 1 (cont'd)

Item No.		1990		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
IMPORTS							
2613.10	Molybdenum ores and concentrates, roasted						
	United States	11	94	197	1 373	286	1 831
	Netherlands	–	–	–	–	33	241
	Other countries	–	–	102	582	24	158
	Total	11	94	299	1 955	343	2 231
2613.90	Molybdenum ores and concentrates, n.e.s.						
	United States	248	1 711	22	179	18	171
	Belgium	–	–	13	95	–	–
	Total	248	1 711	35	274	18	171
2825.70.10	Molybdenum oxides						
	United States	176	1 336	211	1 402	217	1 344
	United Kingdom	...	...	...	...	...	...
	Chile	–	–	93	560	–	–
	Total	176	1 337	304	1 963	217	1 344
2825.70.20	Molybdenum hydroxides						
	United States	...	2	1	10	2	18
	United Kingdom	...	...	–	–	–	–
	Total	...	3	1	10	2	18
2841.70	Metallic molybdates						
	United States	336	2 372	382	2 294	410	2 287
	Netherlands	1	3	–	–	...	...
	France	42	211	28	131	–	–
	Total	379	2 587	410	2 425	410	2 287
7202.70	Ferromolybdenum						
	Chile	186	1 260	335	2 089	210	1 141
	United States	86	681	82	641	131	1 004
	United Kingdom	...	...	77	530	67	481
	Austria	93	641	16	87	17	98
	Other countries	217	1 656	34	196	...	5
	Total	582	4 238	544	3 543	425	2 729
8102.10.10	Molybdenum powders, not alloyed						
	United States	4	123	2	79	2	81
	Germany	...	7	–	–	–	–
	Total	4	131	2	79	2	81
8102.10.20	Molybdenum powders, alloyed						
	United States	2	93	3	81	1	37
	Germany	1	50	...	4	...	6
	Total	4	143	3	85	1	44
8102.91.10	Unwrought molybdenum, not alloyed						
	United States	27	814	10	334	1	20
	Total	27	814	10	334	1	20

TABLE 1 (cont'd)

Item No.		1990		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)							
8102.91.20.10	Unwrought molybdenum, alloyed						
	United States	2	59	–	–	. . .	1
	Total	2	59	–	–	. . .	1
8102.91.20.20	Unwrought molybdenum, waste and scrap						
	United States	5	124	11	211	1	24
	Total	5	124	11	211	1	24
8102.92	Molybdenum profiles, plate, sheet, strip or foil, including bars and rods not simply sintered						
	United States	7	336	4	230	5	229
	Total	7	336	4	230	5	229
8102.93.10	Molybdenum wire, not coated or covered						
	United States	9	359	5	250	5	209
	Austria	1	62	1	80	1	35
	Belgium	2	84	. . .	24	1	33
	Other countries	1	15	. . .	. . .	. . .	7
	Total	13	520	7	355	6	284
8102.93.20	Molybdenum wire, coated or covered						
	United States	1	68	1	32	4	106
	Belgium	–	–	–	–	. . .	7
	Austria	1	23	–	–	. . .	4
	Total	2	91	1	32	4	119
8102.99	Molybdenum and articles thereof, n.e.s.						
	United States	13	652	10	482	11	477
	Austria	. . .	12	. . .	6	. . .	11
	United Kingdom	–	–	. . .	1	–	–
	Total	14	664	10	490	11	489

		1990	**1991p**
		(kilograms)	
CONSUMPTION[2] (Mo content)			
	Carbon steel	354 918	498 270
	Stainless steel	126 341	98 684
	Other steel	485 445	834 196
	Cast iron	141 657	140 760
	Other uses[3]	71 013	71 947
	Total	1 179 374	1 643 857

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified; p Preliminary.
[1] Producers' shipments (Mo content of molybdenum concentrates, molybdic oxide and ferromolybdenum). [2] Available data, as reported by consumers. [3] Nonferrous alloys, electrical, pigments and other uses.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, MOLYBDENUM PRODUCTION, TRADE AND CONSUMPTION, 1975, 1980, AND 1985-92

		Exports[2]	Imports		
	Production[1]	Molybdenum Ores and Concentrates, Oxides and Hydroxides	Molybdic Oxides and Hydroxides[3]	Ferro-molybdenum[4]	Consumption[5]
		(kilograms)			
1975	13 323 144	15 710 300	56 400	269 281	1 436 883
1980	11 889 000	14 584 500	361 700	53 618	1 055 107
1985	7 852 060	5 637 000	187 000	274 076	772 301
1986	11 250 625	11 367 000	203 000	347 784	684 043
1987	14 771 252	14 253 000	193 000	233 335	969 993
1988[a]	13 535 186	14 026 855	187 691	345 664	1 213 448
1989	13 542 984	16 131 760	123 706	1 150 138	1 382 505
1990	12 188 487	11 086 429	176 481	581 782	1 179 374
1991	11 436 809	10 305 832	304 869	544 300	1 643 857
1992[p]	9 601 586	5 204 982[b]	219 363[b]	425 462[b]	..

Sources: Energy, Mines and Resources Canada; Statistics Canada; except where noted.
.. Not available; [p] Preliminary.
[a] Beginning in 1988, exports and imports are based on the Harmonized System and may not be in complete accordance with previous method of reporting. Exports include H.S. classes 2613.00 and 2825.70. Molybdic oxide includes H.S. classes 2825.70.10 and 2825.70.20. Ferromolybdenum includes H.S. class 7202.70.
[b] Exports and Imports are January-September figures.
[1] Producers' shipments (Mo content of molybdenum concentrates, oxide and ferromolybdenum). [2] Mo content, oxides, ores and concentrates. [3] Gross weight. [4] For the years 1975-80, U.S. exports to Canada are reported by the U.S. Bureau of Commerce, Exports of Domestic and Foreign Merchandise (Report 410), over 50% molybdenum, and for 1985-92 by Statistics Canada. [5] Mo content of molybdenum products reported by consumers.

Nepheline Syenite

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Nepheline syenite is a light-coloured, silica deficient, coarse- to medium-grained crystalline igneous rock, in which the principal mineral constituents are microcline, orthoclase or albite feldspars, nepheline and ferromagnesian minerals, chiefly hornblende, pyroxene and biotite. Nepheline, the most common feldspathoid mineral in nepheline syenite, is represented by the structural formula $Na_3KAl_4Si_4O_{16}$. Commercial deposits of nepheline syenite contain at least 20% nepheline and 60% feldspar.

Canadian Deposits and Producers

Nepheline syenite occurrences are numerous in Canada, but deposits of economic potential are found only in Quebec, Ontario and British Columbia. In Quebec, a nepheline syenite alkaline intrusive complex occurs in the Gouin Reservoir area, 145 km south of Chibougamau; three nepheline syenite bodies occur near Goodwood River, 75 km northwest of Shefferville; andthree principal bodies also occur in the general vicinity of Montréal.

Nepheline syenite occurs extensively throughout Ontario. Deposits in southern Ontario are located in Peterborough, Haliburton, Hastings, and Renfrew counties, and in the districts of Sudbury and Nipissing. The main deposits are the Blue Mountain in Methuen Township, and the Dungannon-Monteagle-Carlow area deposits in Hastings County. Occurrences in northern Ontario are located in the districts of Timiskaming, Sudbury, Algoma, Thunder Bay, Rainy River, Bigwood Township, and near Port Coldwell. The chief among these is the Nemegos deposit near Sudbury. In British Columbia, there are four main deposits, all in the southern portion of the province: at Kruger Mountain between Keremeos and Osoyoos; on the southern flank of Mount Copeland about 15 km northwest of Revelstoke; about 16 km west of Barrière; and at Trident Mountain, about 85 km northeast of Revelstoke.

Unimin Canada Corporation is the sole producer of nepheline syenite in Canada with an estimated capacity of 800 000 t/y. The company operates two quarries and processing facilities at Blue Mountain in Methuen Township, near Peterborough, Ontario.

Canadian Developments

In July 1991, the Feldspar Corporation of Ashville, North Carolina, petitioned for anti-dumping duties against nepheline syenite from Canada. The company claimed that nepheline syenite from Canada was being dumped primarily in the northeastern and north-central regions of the United States at less than fair market value, which was injurious to the U.S. industry. Following a preliminary determination by the U.S. Department of Commerce, the International Trade Commission (ITC) began its investigation in late 1991. In May 1992, the ITC delivered a unanimous negative final determination that the feldspar industry in the United States was not materially threatened by imports of nepheline syenite from Canada. The Feldspar Corporation is appealing the decision.

In September 1992, Unimin Corporation reached an agreement in principle to buy Elkem Nefelin of North Cape, Norway. This will increase Unimin's capacity by 270 000 t and access markets in Europe and the Far East.

Canadian Production and Trade

Production in 1992 rose by 12% from 498 441 t in 1991 to 558 372 t in 1992; the corresponding production value is confidential, since Unimin Canada Ltd. is now the only exporter of nepheline syenite. The apparent consumption (production adjusted to allow for differences between imports and exports) in Canada, however, is relatively unchanged at

93 132 t in 1992 from 92 821 t in 1991. The slight increase of 0.3% overall is the net balance between an increase of 5.7% in glass manufacture (which accounts for about 60% of consumption), and a decrease of 18.8% in filler-extender applications (which account for only 12% of consumption).

Exports of nepheline syenite in 1992 were 72.5% to the United States and 22.3% to Europe; the origin was almost entirely from Ontario with less than 550 t reported from western Canada. Exports in 1991 were 74.2% to the United States and 20.6% to Europe. Nepheline syenite is not imported into Canada.

WORLD PRODUCTION

Canada is the foremost producer of nepheline syenite in the world; nepheline syenite is also produced in Norway, the former U.S.S.R., South Africa, and China. Norway is the only country apart from Canada that exports nepheline syenite; production in the former U.S.S.R. and China is not reported.

USES

Nepheline syenite is used in the manufacture of container glass and glass fibre insulation, in ceramic whiteware products and glazes, in wall and floor tile compositions, and as a filler-extender in paints, plastics and foam rubber. The function of nepheline syenite in glass and ceramics is as a flux and chemical moderator; in glass manufacture, it provides alumina, which reduces the tendency to devitrify and improves the durability of glass. In filler applications, nepheline syenite improves strength and resistance to chipping, thermal shock resistance, and thermal expansion resistance. In adhesives and plastics applications, nepheline syenite is used because of its low optical dispersion and refractive index. Minor uses are inclusion in abrasives, scouring powders, and soaps; welding rod and electrode coating; road aggregate; and as a flame damper in the match industry.

PRICES

Canadian nepheline syenite is sold in four grades: (a) low-iron, 600-micron, glass-grade, bulk f.o.b. at C$36/t; (b) high-iron, 600-micron, glass-grade, bulk f.o.b. at C$28/t; (c) 75-micron, ceramic-grade, bagged, at C$86/t; and (d) filler-extender grade, bagged, at C$101-117/t. Prices in 1992 are unchanged from 1991 levels.

OUTLOOK

The largest market for nepheline syenite is in glass and ceramics, and the market for these uses is stable at present with little growth expected in the near future because of the reduced demand for glass which, in turn, is related to the reduction in new houses being built in Canada. The extender-filler market in Canada and the United States, although much smaller at about 35 000-40 000 t/y, is expected to grow 3.8%/y. Paint is expected to show the strongest growth because of the trend towards silica substitution; nepheline syenite has no free silica and, consequently, is not linked to silicosis. The use of nepheline syenite in PVC plastics applications is expected to grow by only 2%/y because of nepheline syenite's hardness and abrasivity.

Note: Information in this review was current as of February 1, 1993.

TABLE 1. CANADA, NEPHELINE SYENITE PRODUCTION AND EXPORTS, 1990-92, AND CONSUMPTION, 1991 AND 1992

Item No.		1990[a]		1991[b]		1992[b]	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
PRODUCTION (shipments)		532 911	x	498 441	x	558 372	x
EXPORTS							
2529.30.20	Nepheline syenite						
	United States	275 682	x	300 755	x	337 316	x
	Italy	24 767	x	37 982	x	38 089	x
	Australia	2 958	x	2 065	x	15 517	x
	Spain	6 525	x	5 020	x	6 190	x
	Japan	1 854	x	1 330	x	1 601	x
	Taiwan	3 867	x	4 496	x	2 163	x
	France	465	x	1 716	x	1 336	x
	Mexico	353	x	331	x	837	x
	Indonesia	270	x	804	x	1 186	x
	South Korea	601	x	5 534	x	1 788	x
	Thailand	505	x	–	x	–	x
	United Kingdom	6 353	x	–	x	4 817	x
	Netherlands	55 858	x	38 960	x	53 149	x
	Other countries	1 995	x	6 627	x	1 252	x
	Total	382 053	x	405 620	x	465 241	x

	1991		1992	
	(tonnes)	($000)	(tonnes)	($000)
CONSUMPTION[1]				
Primary glass and glass containers[2]	53 360	..	59 587	..
Ceramic products	12 969	..	13 327	..
Filler/extender[3]	11 927	..	9 685	..
Other products[4]	11 565	..	10 533	..
Total	92 821	..	93 132	..

– Nil; .. Not available; x Confidential.
[a] Sources for 1990: Energy, Mines and Resources Canada; Statistics Canada. [b] Sources for 1991 and 1992: Company supplied information.
[1] Available data, as reported by consumers. [2] Includes glass fibre wool and glass fibre. [3] Includes plastics, paints, adhesives and foam rubber. [4] Structural clay products, pulp and paper and paper products, and other minor uses.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, FELDSPAR CONSUMPTION,[1] 1987-91

	1987	1988	1989	1990	1991[p]
			(tonnes)		
CONSUMPTION					
Ceramic products	2 293	2 489	1 926	1 791	2 235
Other products[2]	47	85	123	386	111
Total	2 340	2 574	2 049	2 177	2 346

Source: Energy, Mines and Resources Canada.
[p] Preliminary.
[1] Available data, as reported by consumers. [2] Includes adhesives, abrasives and other minor uses.

TABLE 3. CANADA, CONSUMPTION AND VALUE OF IMPORTS OF CRUDE OR GROUND FELDSPAR, 1975 AND 1980-91

	Imports[1]	Consumption[2]
	($)	(tonnes)
1975	. .	5 630
1980	385 000	4 051
1981	642 000	4 606
1982	251 000	2 790
1983	309 000	2 213
1984	310 000	2 106
1985	308 000	2 014
1986	357 000	2 248
1987	475 000	2 340
1988	367 000	2 574
1989	516 000	2 049
1990	311 000	2 177
1991	269 000	2 346p

Sources: Energy, Mines and Resources Canada; Statistics Canada.
. . Not available; p Preliminary.
1 Beginning in 1988, exports and imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Imports include HS class 2529.10.
2 Available data, as reported by consumers.

Nickel

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Demand for nickel in the Western World declined by about 8% in 1992 which, in combination with high production levels and increased exports from Russia, resulted in weaker prices. Nickel prices on the London Metal Exchange (LME) were trading at US$2.65/lb at year-end, compared to about $3.40/lb at the beginning of 1992. The average price on the LME was US$3.18/lb compared to $3.70/lb in 1991. Production cuts announced in the third quarter by Inco and Falconbridge were a factor in stemming a downward price slide on world markets in November when nickel reached US$2.39/lb on the LME.

Nickel inventories on the LME increased to record levels during 1992 and, by year-end, had surpassed 67 000 t. Producer stocks also rose.

CANADIAN DEVELOPMENTS

Canadian nickel mine production decreased slightly in 1992 to about 191 200 t compared to 192 300 t in 1991.

Inco's 1992 capital expenditures were estimated at about $235 million, about $200 million less than in 1991. The reduction reflects the company's efforts to control costs and a reduction in the expenditures required for the sulphur abatement program. The company directed most of the expenditures toward mine development and productivity improvement programs, including work on the sulphur abatement program at Sudbury. The $600 million program is expected to be completed at the Copper Cliff complex by 1994.

In October, Inco announced that it was reducing previously planned mine production by about 18 000 t over the next 12 months. Finished nickel production in 1993 is expected to total about 172 000 t. Inco also postponed the re-opening of the Shebandowan mine near Thunder Bay, Ontario. Operations at the Ontario and Manitoba Divisions operated at a reduced rate for three weeks during the Christmas period. In addition, the two Divisions will shut down for a four-week vacation period in 1993. Inco reduced its workforce by 4% by offering voluntary early retirement to 400 employees.

Inco also announced that ore grades are expected to continue to improve at its Canadian operations. Grades of ore mined rose to 1.53% nickel in 1992 from the original forecast of 1.43% nickel. Improved grades and lower costs cut Inco's unit production costs by 11% from the third quarter of 1991 to the same period in 1992.

In December, Falconbridge also announced plans to cut production in 1993. The two-week Christmas shut-down was extended through January 1993, and mining will be suspended for two weeks in the summer. Together with shut-downs at the company's Nikkelverk refinery in Norway, total refined nickel and ferro-nickel production will be reduced by 12 700 t in 1993. Falconbridge expects to reduce its workforce by about 200 employees at its Sudbury operation either through voluntary retirement or layoffs.

Sherritt Gordon Limited's Fort Saskatchewan, Alberta, refinery continued to operate at less than full capacity in 1992. However, the company posted a profit in the third quarter of 1992, compared to a slight loss in the same period last year. Earnings for the first nine months doubled since 1991. Lower nickel prices were partially offset by higher cobalt prices.

Hudson Bay Mining and Smelting Company, Limited (HBMS) announced that it will close its Namew Lake nickel mine in northern Manitoba at the end of 1993. The Namew Lake mine is 60% owned by HBMS and 40% owned by Outokumpu Mines Ltd. Reserves at the mine, which opened in 1988, have been depleted. Exploration activity within the are continues; however, no new zones have been located to date. The capacity of the mine is 9200 t/y of nickel and 3500 t/y of copper in concentrate.

Timmins Nickel Inc. closed its mining activities at its two operations in northeastern Ontario. The company placed the Langmuir No. 1 and Redstone mines on temporary care and maintenance. The closures were due to weak nickel prices.

World Developments

Several producers announced plans to operate below their effective capacities in an attempt to stem the downward slide in prices. Despite weak nickel markets, consideration was given to the development of some new projects or an expansion of existing operations.

Commonwealth of Independent States

With the collapse of the former U.S.S.R., Russian exports of nickel to the West have increased significantly. Falling internal demand led some consumers within Russia to transform primary nickel into high-grade scrap, thereby by-passing export controls for shipment to the West. Russian authorities, to date, have had limited control over newly formed borders, which has resulted in significant re-exports of Russian metals through the Baltic republics. In addition, trade links between the former constituent republics of the U.S.S.R. were severed as the newly independent states diverted metal exports away from traditional customers to Western markets.

Increases on the LME were partly attributed to increased exports of Russian nickel to the West. Official exports from the former U.S.S.R. increased from an estimated 85 000 t in 1990 to 110 000 t in 1991 and 120 000 t in 1992. Another 20 000-30 000 t of "back-door" exports were made in 1992, primarily to Europe.

The Finnish company, Outokumpu Mining Oy, announced in August that it had signed an agreement with four organizations in the Russian state of Karelia to set up a joint-venture company. The new company, Kivijarvi Oy, will conduct feasibility studies of nickel-copper resources in the region. Outokumpu will hold 49% of the company.

Outokumpu continued discussions with Russian authorities concerning a proposed US$640 million modernization of the Pechenga nickel smelter at Nikel in the Kola Peninsula which would increase efficiency and reduce pollution. The three-year plan would include a new flash furnace to replace an existing electric furnace and the construction of a sulphuric acid plant. Both Outokumpu and Elkem Technology would supply the technology required for the project. The new smelter would process ore from the Pechenga mine as well as some ore from Noril'sk. The Pechenga smelter is reported to emit close to 300 000 t/y of sulphur dioxide (SO_2) and 3.19 t/y of heavy metals.

Inco announced that it had signed two technology protocols with the Russian nickel producer Noril'sk Nikel in December. Noril'sk is interested in acquiring Inco's environmental technology. The smelter at Noril'sk is a major source of pollution, emitting some 2400 Kt/y of SO_2. The first protocol is an agreement to meet further to eventually sell Inco's flash furnace technology to Noril'sk. The second protocol covers process technology.

Australia

Dominion Mining Ltd. postponed its decision to develop its A$470 million Yakabindie nickel project in Western Australia until early next year. Development of a large open-pit mine was to have started at the end of 1992 aimed at producing some 21 000 t/y of nickel in concentrates.

Sumitomo Metal Mining renewed its nickel matte long-term import contract with Western Mining Corp. of Australia in April. Annual imports under the 10-year contract were increased to 20 000 t/y from 15 000 t/y.

Western Mining Corporation (WMC) continued work on its A$105 million expansion at its Kambalda operations in Western Australia. The smelter capacity will be increased to 65 000 t/y from the current 50 000 t/y.

Outokumpu and CRA discovered two additional nickel deposits at their Honeymoon Well project in Western Australia, bringing the number of known deposits to four. The first two deposits contain an estimated 25 Mt grading between 0.7% and 0.9% nickel.

New mines and expanded processing plants are expected to increase Australian nickel output by 13% to 91 000 t over the year to June 1993, according to the Australian Bureau of Agricultural and Resource Economics. The value of Australia's nickel exports could rise almost 22% to A$855 million in 1992/93, compared to an 11% decrease the previous year. Australia produced 80 000 t of nickel in 1992.

New Caledonia

Société Métallurgique le Nickel (SNL) of France began a scheduled shut-down of one of three ferro-nickel furnaces at its Doniambo plant. The furnace, which was in its twentieth year of service, was closed for renovations. The renovation is expected to increase the Doniambo plant's capacity by about 3000 t/y to 52 000 t/y.

Indonesia

PT Aneka Tambang awarded Mitsui and Co. a contract to build a new 5500-t/y ferro-nickel smelter on Sulawesi Island to be commissioned in 1994. The plant, to be built in the southeast of the island, will be managed by Mitsui and will export to Japan and Europe.

In December, P.T. International Nickel Indonesia, a subsidiary of Inco, announced the shut-down of one of three electric furnaces for a major overhaul and upgrading. The six-month program will involve the installation of a new electrode system and an advanced suspended roof.

China

The Jinchuan Non-Ferrous Metals Corp. (JNFC) continued its expansion program at the Jinchuan smelter in Gansu Province. The plant's capacity will be increased by 20 000 t/y of nickel, 10 000 t/y of copper, and 220 000 t/y of sulphuric acid when it starts production in 1994. Finland's Outokumpu and Australia's WMC are supplying the flash smelter technology. Jinchuan produced 25 000 t of nickel in 1991. Once commissioned, the increased capacity will represent a significant increase in production, but will still fall short of the estimated 60 000 t/y of nickel consumed in China.

Japan

Ferro-nickel makers in Japan announced plans to cut production in early 1993 due the weak nickel market conditions. Japan's largest producer, Pacific Metals Co Ltd., will cut ferro-nickel production to 25 000 t in 1993 from 29 000 t in 1992 and 37 700 t in 1991. Sumitomo Metal Mining Co. Ltd., Japan's second largest producer, announced that it was also considering production cuts for next year.

Taiwan

Taiwan Nickel Refining Corp. announced that it would suspend production for six weeks starting January 1993 due to low prices in the nickel market. The shut-down will reduce pure nickel output by roughly 1200 t. The company's annual output is about 14 000 t, all for domestic consumption.

Africa

In Tanzania, Kagera Mining Co. Ltd. signed a mining exploration agreement with the Government of Tanzania to explore for nickel, cobalt and copper. Kagera Mining is a newly formed joint-venture project between Vancouver-based Sutton Resources Ltd. and Romanex International Ltd. Together the two companies own 90% of Kagera Mining, with the remaining 10% held by the Tanzanian government. Sutton Resources continued work on the Kabanga nickel-cobalt-copper project in the southwest corner of the Kagera region. Drilling to date has outlined about 40 Mt grading 1.05% nickel and 0.10% cobalt.

Production trials were reportedly started at the Tati Nickel Mining Co. in Botswana. A decision on whether or not to develop the Phoenix project is expected sometime in 1993. South Africa's Anglo American Corporation (AAC) acquired a 51% interest in the project in 1992.

Europe

Greek nickel producer Larco S.A. announced late in the year that it would cut production by about 50% to an average of 750 t/m. The company has an annual capacity of 25 000 t, but was producing about 15 000 t/y before the cutback.

Production cuts at Inco's and Falconbridge's Canadian operations will affect operations in Europe as well. Production at Inco's United Kingdom nickel and precious metals refineries will be reduced due to lower shipments of intermediate feed from Canada. As a result, Inco's nickel refinery at Clydach, Wales, will switch from a two-line to a one-line operation. In Norway, Falconbridge will shut down production at its Nikelverk refinery in conjunction with the announced summer shut-down at its Sudbury operations.

The 4500-t/y Feronikel Kosova plant in Serbia was reportedly closed in March 1992. The plant closure was the result of low ore grades, high energy costs, and the weak markets in Eastern Europe.

United States

Glenbrook Nickel Co., a subsidiary of Cominco Ltd., signed a contract to purchase ore from New Caledonia. The shipments from New Caledonia will supplement local ore and increase production capacity to 16 000 t of contained nickel. Due to weak market conditions, Glenbrook extended its two-week shut-down at Christmas to five weeks and later extended the shut-down until market conditions improve. The plant, which produced about 8900 t in 1992, is the only nickel producer in the United States.

Dominican Republic

Falconbridge Dominicana, C. por A., a subsidiary of Falconbridge Limited, announced that it would close its operations for three months beginning December 26, 1992, reducing production by 7700 t of ferro-nickel. Combined with cuts announced earlier in November, Falconbridge reduced total planned ferro-nickel production by 18 700 t.

Colombia

Cerro Matoso S.A. has postponed plans to build a second furnace, which would have nearly doubled production, at its Colombian refinery plant because of low world nickel prices, rising production costs, and a new government proposal to increase royalties. Cerro Matoso, 52% owned by the Royal Dutch Shell Group, decided to suspend the $600 million project in early January 1993. Cerro Matoso operates the country's only ferro-nickel mine through a 30-year concession, producing about 20 000 t/y of nickel exported in the form of ferro-nickel alloy.

CONSUMPTION AND USES

Western World nickel demand is estimated at 635 000 t in 1992, down from 694 000 t in 1991. Supply fell to an estimated 698 000 t from 708 000 t. Producer and London Metal Exchange inventories rose to about 154 000 t at the end of 1992 (about 12 weeks' consumption) compared to 90 000 t at the end of 1991. Stainless steel output is forecast to be unchanged at 11 Mt in 1992, and to increase slightly to 11.2 Mt in 1993.

Its 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. After stainless steels, which account for about 65% of total nickel consumption, the major uses are nickel-based alloys, electroplating, alloy steels, foundry products and copper-based alloys. Nickel is used extensively as an alloying agent and is a component in some 3000 different alloys which are used in more than 250 000 end-use applications.

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 many other applications.

Nickel-containing stainless steel tanks are used for road, rail and sea transport of various liquids, including dairy products, petrochemicals and toxic chemicals. These stainless steels are used for their resistance to corrosion, strength, and ease of cleaning. Their ability to handle a wide variety of liquids adds to the tanks' capability for backhaul loads.

In recent years, some Japanese and European auto manufacturers have been using a zinc-nickel-coated steel for various body panels and some structural parts. Zinc-nickel coatings can provide five to six times more resistance to road salt corrosion than ordinary galvanized steel. Bethlehem Steel Corporation acquired the licence from Nippon Kokan KK of Japan for the manufacture in the United States of the coating, which contains about 13% nickel. Commercial production of the coating started in 1989 from a plant in Walbridge, Ohio.

The major nickel markets of the United States, Japan and Western Europe continue to account for close to 90% of the demand for nickel in the Western World, but the newly industrialized countries, particularly in the Pacific Rim region, are increasing their share of the market and this trend is expected to continue in the future. While the United States is a major nickel consumer, its per capita consumption of stainless steel is only one half that of many Asian and European markets.

It is anticipated that the major growth areas for nickel will be in nickel stainless steels and new high-performance alloys, as well as in electroplating applications. In addition, it is expected that nickel will be used increasingly in the electronics industry.

HEALTH AND THE ENVIRONMENT

Under a 1985 Ontario government regulation, Inco and Falconbridge are required to reduce their emissions of SO_2 to 265 000 t and 100 000 t, respectively, by 1994. In 1985, the limit was 685 000 t for Inco and 154 000 t for Falconbridge.

To meet the regulations, Inco embarked on a $600 million SO_2 emission abatement project at its Sudbury operations. The ores at Sudbury contain eight pounds of sulphur for every pound of nickel. To deal with the complex problem of reducing sulphur emissions, Inco developed new production techniques to process a single bulk copper-nickel concentrate. New milling technology at the Clarabelle mill eliminates much of the pyrrhotite before it reaches the smelter, reducing SO_2 emissions by about 100 000 t/y. In addition, the program includes new fluid bed driers, two new oxygen flash furnaces, a new oxygen flash-smelting reactor, a sulphuric acid plant, and an oxygen plant. With the introduction of this technology, Inco will no longer burn fossil fuels in the smelting process, thereby reducing carbon dioxide (CO_2) production as well. The intensive use of pure oxygen will also reduce the production of nitrogen oxides (NO_x). Once the new facilities are fully operational, 90% of the sulphur originating in the ore will be contained.

Falconbridge is spending $38 million on research, development and capital projects related to increasing pyrrhotite rejection and greater roasting to be able to conform to the regulation. While actual emissions of sulphur dioxide in 1990 were below the required 1994 level, the company was producing below capacity. The company is conducting research on methods to reduce emissions to 75 000 t/y, at capacity production, by 1998. Increased pyrrhotite rejection is the focus of the research.

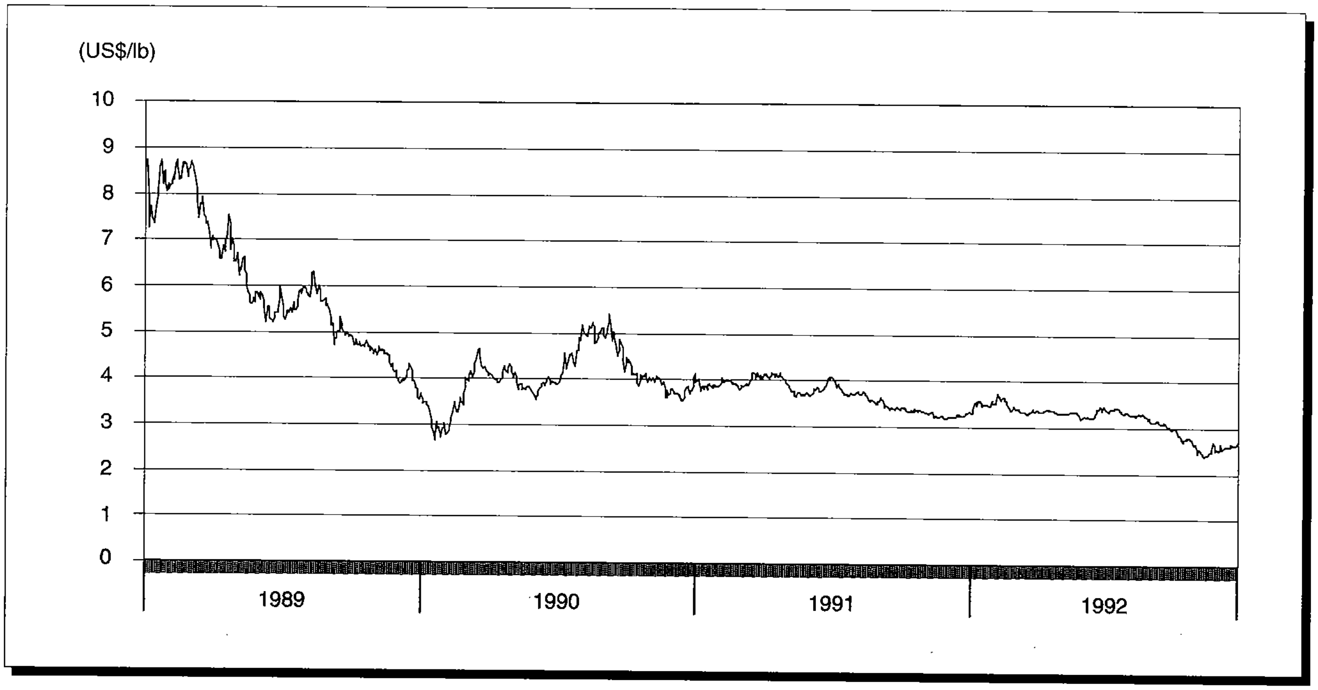
An issue of increasing concern to the nickel industry is the institution by various countries of stiffer regulations on exposure to nickel, some of which may be unduly restrictive or too broad in scope. Unnecessary expenses can result for nickel producers and consumers and, as well, certain markets can be adversely affected.

In Europe, the European Economic Community Commission is planning to introduce a Council directive restricting the marketing and use of certain substances and preparations. The draft directive will restrict the marketing of products containing nickel and its alloys that can be used in direct and prolonged contact with the skin. If adopted, the directive will ban the use of nickel and its compounds in a variety of jewellery, buttons, spectacle frames, tighteners, and zippers if the rate of nickel release from the parts in direct and prolonged contact exceed 0.5 micrograms per cm^2 per week.

MARKETS AND PRICES

Nickel prices on the London Metal Exchange (LME) peaked at a monthly average of US$3.57/lb in February. Reduced demand, increased inventories and greater-than-expected exports from the former U.S.S.R. depressed prices by year-end. Prices declined steadily until November when nickel averaged US$2.52/lb, recovering slightly before year-end to average $3.18/lb for the year.

Figure 1
London Metal Exchange Nickel Prices, 1989-92



SOURCE: Energy, Mines and Resources Canada.

Nickel stocks on the LME increased from 12 000 t in January 1992 to about 67 000 t by the end of the year. Producer stocks are also estimated to have increased from 90 000 t at the end of 1991 to about 95 000 t at the end of 1992. Total reported stocks currently stand at an estimated 215 000 t, up from 175 000 t at the end of 1991. The increased stocks, particularly in the third and fourth quarters of 1992, reflected the downturn in demand from the stainless steel sector.

OUTLOOK

Over the next few years, Canadian nickel production is forecast to increase slowly. Although nickel reserves have been declining, they are still sufficient to maintain forecast levels of production. Canadian nickel production is expected to be about 175 000 t in 1993. This is principally as a result of the cutbacks at Inco and Falconbridge announced in the fourth quarter of 1992. Overall, for the remainder of the 1990s, nickel production is expected to increase slightly, reaching about 215 000 t by the year 2000, assuming Falconbridge's New Quebec Raglan project comes into production.

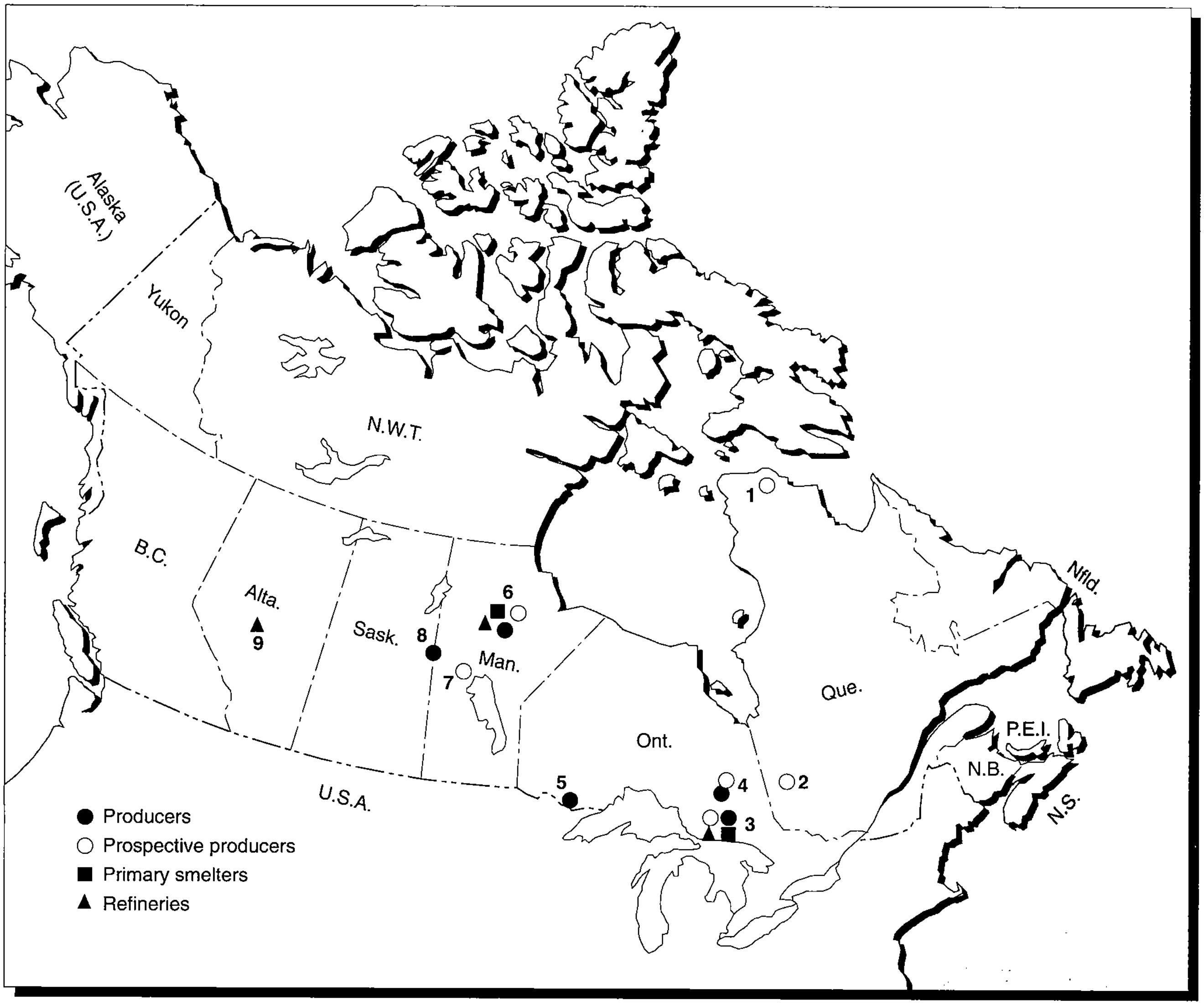
Stainless steel demand, which accounts for over 60% of nickel usage, slowed in both Europe and Japan. However, demand in this sector is forecast to increase in 1992 as the major economies emerge from the recession.

In 1993, prices are forecast to average within the range of US$2.75-$3.00/lb. Western World economies are forecast to recover from the recession in the latter half of 1993; however, prices will remain depressed until supply is brought back in line with demand. Increased consumption for stainless steel and other applications is expected to result in higher nickel prices by 1994.

Nickel prices have been weak since the break-up of the former U.S.S.R., which has led to uncontrolled metal exports since 1991. Official and unofficial exports in 1992 are estimated to have been about 130 000 t and are expected to be near the same amount in 1993. In the longer term, as Western World economies strengthen and stocks are reduced, prices are forecast to average between US$3.75 and $4.75/lb in constant 1992 dollars.

Note: Information in this review was current as of February 1, 1993.

Figure 2
Nickel in Canada, 1992



Numbers refer to locations on map above.

Producers

3. Falconbridge Limited (Fraser, Lockerby, Onaping, Strathcona)
   Inco Limited (Copper Cliff North, Copper Cliff South, Crean Hill, Creighton, Frood, Levack, Little Stobie, Lower Coleman, McCreedy West, Stobie and Whistle)
4. Timmins Nickel Inc. (Redstone, Langmuir)
5. Inco Limited (Shebandowan)
6. Inco Limited (Thompson, Birchtree, Thompson Open Pit)
8. Hudson Bay Mining and Smelting Co., Limited (Namew Lake)

Smelters

3. Falconbridge Limited (Falconbridge)
   Inco Limited (Copper Cliff, Sudbury)
6. Inco Limited (Thompson)

Prospective Producers

1. Falconbridge Limited (New Quebec Raglan)
2. Timmins Nickel Inc. (Dumont)
3. Inco Limited (Clarabelle, Garson, Murray Totten, McCreedy East, Victor)
   Falconbridge Limited (Craig, Lindsley)
4. Teck Corporation (Moncalm Township)
6. Inco Limited (Soab North, Soab South and Pipe No. 1)
7. Black Hawk Mining Inc. (Minago)

Refineries

3. Inco Limited (Sudbury)
6. Inco Limited (Thompson)
9. Sherritt Gordon Limited (Fort Saskatchewan)

TARIFFS

Item No.	Description	Canada			United States	EEC	Japan[1]
		MFN	GPT	USA	Canada	MFN	MFN
2604.00	Nickel ores and concentrates	Free	Free	Free	Free	Free	Free
7501.10	Nickel mattes	Free	Free	Free	Free	Free	Free
7501.20	Nickel oxide sinters and other intermediate products of nickel metallurgy	Free	Free	Free	Free	Free	Free-81 yen/kg[2]
7502.10	Unwrought nickel, not alloyed	Free	Free	Free	Free	Free	81 yen/kg
7502.20	Unwrought nickel alloys	Free	Free	Free	Free	Free	Free-9%[3]
7503.00	Nickel waste and scrap	Free	Free	Free	Free	Free	Free
7504.00.10	Nickel powders containing by weight 60% or more nickel	Free	Free	Free	Free	0.5%	Free
7504.00.20	Nickel powders containing by weight less than 60% of nickel; flakes	10.2%	6 .5%	Free	Free	0.5%	65 yen/kg-6%
7505.12	Bars, rods and profiles of nickel alloy	Free-10.2%	Free-6.5%	Free	Free	4.4%	5.8%
7508.00	Other articles of nickel	Free-11%	Free-7%	Free-5.5%	2.8%-3.3%	4.6%	5.8%

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992; Official Journal of the European Communities, Vol. 35, No. L268, 1992, "Conventional" column; Customs Tariff Schedules of Japan, 1992.
[1] GATT rate is shown; lower tariff rates may apply circumstantially. [2] Free except for nickel oxide sinters containing by weight not less than 88% nickel which is 81 yen/kg, and nickel oxide containing by weight not more than 1.5% copper which is 7.2%. [3] Tariff rate of 9% applies to nickel alloys other than those containing by weight less than 50% of nickel and not less than 10% of cobalt.

TABLE 1. CANADA, NICKEL PRODUCTION AND TRADE, 1991 AND 1992

Item No.		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)
PRODUCTION[1]					
	All forms				
	Ontario	125 790	1 219 277	124 181	1 112 874
	Manitoba	62 309	588 342	64 871	566 978
	Total	188 098	1 807 619	189 051	1 679 853
EXPORTS				(Jan.-Sept.)	
2604.00	Nickel ores and concentrates, nickel content				
	Finland	–	–	611	224
	United States	1	8	3	15
	United Kingdom	1	2	–	–
	Total	2	10	615	240
7501.10	Nickel mattes				
	Norway	40 905	431 224	21 766	206 683
	United Kingdom	33 572	238 240	21 038	149 059
	United States	130	162	–	–
	Total	74 607	669 626	42 804	355 743
7501.20	Nickel oxide sinters and other intermediate products of nickel metallurgy				
	South Korea	–	–	7 211	61 467
	Taiwan	–	–	1 212	9 419
	Singapore	–	–	763	7 025
	Belgium	–	–	343	3 266
	United States	500	4 134	417	3 124
	Other countries	–	–	103	1 425
	Total	500	4 134	10 049	85 726
7502.10	Nickel unwrought, not alloyed				
	United States	60 450	578 272	39 146	344 154
	Belgium	–	–	17 186	151 494
	Japan	–	–	5 299	49 629
	Netherlands	–	–	3 878	35 296
	Taiwan	–	–	3 319	28 394
	United Kingdom	–	–	2 654	22 842
	Other countries	–	–	5 636	49 603
	Total	60 450	578 272	77 118	681 412
7502.20	Nickel unwrought, alloyed				
	United States	679	7 224	767	7 219
	Belgium	491	6 460	499	5 391
	South Korea	22	284	58	774
	Other countries	300	3 162	51	351
	Total	1 492	17 130	1 375	13 735
7503.00	Nickel waste and scrap				
	United States	3 448	16 950	2 543	10 843
	Netherlands	225	1 413	129	466
	United Kingdom	173	422	65	404
	Venezuela	–	–	33	304
	Other countries	333	909	44	97
	Total	4 179	19 694	2 814	12 114
7504.00	Nickel powders and flakes				
	United States	7 083	81 431	4 368	53 999
	Japan	2 202	23 790	1 810	20 731
	Hong Kong	123	1 554	203	2 618
	Netherlands	372	3 676	198	2 113
	Belgium	41	487	107	1 258
	People's Republic of China	92	1 108	69	889
	Other countries	427	6 083	176	2 456
	Total	10 340	118 129	6 931	84 064
7505.12	Bars, rods and profiles of nickel alloy				
	United States	2	23	1	10
	Poland	1	12	...	1
	Total	3	35	1	11
7508.00	Other articles of nickel				
	Netherlands	..	4 859	..	830
	Cuba	..	2	..	398
	United States	..	727	..	190
	Sudan	..	551	..	93
	Other countries	..	427	..	89
	Total	..	6 566	..	1 600

TABLE 1 (cont'd)

Item No.		1991 (tonnes)	1991 ($000)	Jan.-Sept. 1992p (tonnes)	Jan.-Sept. 1992p ($000)
IMPORTS[2]					
2604.00.00.20	Nickel ores and concentrates, nickel content				
	United States	8	45	32	176
	Total	8	45	32	176
7501.00	Nickel mattes, nickel oxide sinters and other intermediate products of nickel metallurgy				
	Cuba	10 727	54 242	15 805	98 111
	C.I.S. (formerly U.S.S.R.)	–	–	861	9 220
	United States	4 371	8 582	3 004	5 027
	Belgium	3 017	4 608	2 861	4 158
	United Kingdom	790	2 358	724	2 671
	Other countries	3 970	21 725	2 280	6 697
	Total	22 875	91 515	25 535	125 884
7502.10	Nickel unwrought, not alloyed				
	C.I.S. (formerly U.S.S.R.)	5 404	53 128	878	7 617
	Norway	1 674	14 682	736	4 382
	United Kingdom	1 366	12 574	462	3 940
	Australia	–	–	381	3 361
	Other countries	255	2 258	130	1 011
	Total	8 699	82 642	2 587	20 311
7502.20	Nickel unwrought, alloyed				
	United States	191	1 256	430	2 074
	United Kingdom	52	521	62	731
	Switzerland	–	–	18	147
	C.I.S. (formerly U.S.S.R.)	853	7 650	–	–
	Other countries	268	1 851	1	110
	Total	1 364	11 278	511	3 062
7503.00	Nickel waste and scrap				
	United States	12 766	28 697	12 143	20 378
	United Kingdom	584	2 725	725	4 350
	Netherlands	–	–	773	2 618
	Germany	715	1 392	195	1 041
	C.I.S. (formerly U.S.S.R.)	156	824	163	1 035
	Belgium	129	113	218	517
	Other countries	461	1 393	400	678
	Total	14 811	35 144	14 617	30 617
7504.00	Nickel powder and flakes				
	United States	89	1 351	60	1 080
	Australia	20	189	18	154
	Germany	8	155	4	65
	Netherlands	297	2 799	–	–
	Other countries	15	305	–	–
	Total	429	4 799	82	1 300
7505.12	Bars, rods and profiles of nickel alloy				
	United States	139	2 433	138	2 477
	Other countries	20	338	8	151
	Total	159	2 771	146	2 628
7508.00.10	Nickel anodes for electroplating				
	United States	54	454	14	117
	Other countries	2	7	–	–
	Total	56	461	14	117

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available or not applicable; . . . Amount too small to be expressed; p Preliminary.
1 Refined nickel and nickel in oxides and salts produced, plus recoverable nickel in matte and concentrates exported. 2 Imports from "other countries" may include re-imports from Canada.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, NICKEL PRODUCTION AND CONSUMPTION, 1970, 1975, AND 1980-92

	Production[1]	Consumption[2]
	(tonnes)	
1970	277 490	10 699
1975	242 180	11 308
1980	184 802	9 676
1981	160 247	8 603
1982	88 581	6 723
1983	125 022	5 010
1984	173 725	7 502
1985	169 971	7 206
1986	163 640	8 865
1987	193 391	9 732
1988	216 589	9 250
1989	200 899	10 423
1990	196 225	8 410[r]
1991	192 259	11 577[a]
1992[p]	191 161	. .

Source: Energy, Mines and Resources Canada.
. . Not available; [p] Preliminary; [r] Revised.
[a] Increase in number of companies being surveyed.
[1] Refined nickel and nickel in oxides and salts produced, plus recoverable nickel in matte and concentrates exported. Data for 1987-92 are nickel contained in concentrates produced.
[2] Consumption of metallic nickel, all forms (refined metal, and in ferronickel oxides and salts) as reported by consumers on the EMR survey "Consumption of Nickel."

TABLE 3. CANADIAN PROCESSING CAPACITY, 1991

	Inco Limited		Falconbridge Limited	Sherritt Gordon Limited
	Sudbury	Thompson	Sudbury	Fort Saskatchewan
	(t/y of contained nickel)			
Smelter	110 000[a]	81 600	45 000	n.a.
Refinery	56 700	49 900	n.a.	25 000

n.a. Not applicable.
[a] Capacity is constrained to this level by the Ontario government regulation on SO_2 emission limits.

TABLE 4. WORLD MINE PRODUCTION OF NICKEL, 1990 AND 1991

	1990	1991
	(tonnes)	
C.I.S. (formerly U.S.S.R.)	300 000	260 000
Canada	196 225	192 259
New Caledonia	85 000	108 700
Australia	67 800	69 000
Indonesia	68 600	66 100
Cuba	40 800	33 300
People's Republic of China	33 200	30 000
Dominican Republic	30 200	29 100
South Africa	30 000	29 000
Botswana	19 700	20 400
Colombia	19 400	20 200
Greece	18 500	18 000
Other	70 300	66 000
Total	979 725	942 059

Sources: Energy, Mines and Resources Canada; International Nickel Study Group.

TABLE 5. WORLD CONSUMPTION OF NICKEL, 1990 AND 1991

	1990	1991
	(tonnes)	
Japan	165 500	180 100
C.I.S. (formerly U.S.S.R.)	175 000	150 000
United States	127 800	126 700
Germany	88 800	77 000
France	44 800	36 800
People's Republic of China	35 000	36 000
Italy	27 300	31 500
United Kingdom	32 600	29 500
Republic of Korea	14 000	23 200
Belgium/Luxembourg	21 300	19 600
Other	182 300	169 500
Total	914 400	879 900

Sources: Energy, Mines and Resources Canada; International Nickel Study Group.

TABLE 6. AVERAGE ANNUAL NICKEL PRICES, 1982-92

	London Metal Exchange - Spot
	(US$/lb)
1982	2.18
1983	2.12
1984	2.16
1985	2.22
1986	1.76
1987	2.19
1988	6.25
1989	6.04
1990	4.03
1991	3.70
1992	3.18

TABLE 7. AVERAGE MONTHLY NICKEL PRICES, 1991 AND 1992

	1991	1992
	(US$/lb)	
January	3.89	3.41
February	3.94	3.57
March	3.95	3.37
April	4.10	3.37
May	3.84	3.32
June	3.76	3.26
July	3.88	3.40
August	3.83	3.30
September	3.48	3.14
October	3.38	2.86
November	3.29	2.52
December	3.23	2.60

Peat

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Peat is an accumulation of organic residues obtained from the partial decomposition of plant debris under very high humidity and anaerobic conditions. In its raw material form, it is ligneous, fibrous and elastic. It has a pH of 2.8-4.0 and an ash content of 0.5%-2.5%. Peat is found in 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 20 times its weight in liquids and gas. Peat is divided into two principal types: horticultural peat and fuel peat. Horticultural peat is characterized by a low decomposition corresponding to a von Post value of H1-H5. It has a high fibre content, is light yellowish brown in colour, and contains few colloid residues. Fuel peat is highly decomposed, with a von Post value of H6-H10. It is blackish in colour and contains colloid residues.

The total area of peatlands in Canada is estimated at 111 328 000 ha, covering close to 12% of the country's land surface. Approximately 1.5% of that area is utilized for agriculture while urban development accounts for 0.8%, forestry for 0.022%, and horticultural peat harvesting for 0.014%. In 1984, Agriculture Canada estimated Canadian peat resources at 3 004 996 million m^3, a volume which is equivalent to 338 003 Mt of oven-dry peat.

Canada mainly produces sphagnum peat, which is used in horticulture and agriculture. It is harvested from May to September, primarily in the eastern and southeastern parts of the province of Quebec, in the eastern and northeastern parts of the province of New Brunswick, and in the western provinces near Edmonton, Alberta; Carrot River, Saskatchewan; and Giroux and Elma, Manitoba. Some peat production is also found in the provinces of Nova Scotia, Prince Edward Island and Newfoundland.

DOMESTIC DATA COVERAGE

Peat produced in 1992 was estimated by Energy, Mines and Resources Canada (EMR) at 745 000 t. That estimate represents a 13% decrease from the revised 1991 production of 856 418 t. The data collected show increases for Nova Scotia (58.0%),[1] Manitoba (19.6%) and New Brunswick (from 297 365 t to 307 496 t, or 3.4%), and decreases for Newfoundland (from 4313 t to 2182 t, or 49.4%), Saskatchewan (15.6%), Alberta (6.6%) and Quebec (from 335 060 t to 200 000 t, or 40%). As in 1991, no production was reported in Ontario and British Columbia. In eastern Canada, weather conditions allowed New Brunswick and Nova Scotia to enjoy a fairly good harvesting season. However, for Newfoundland and Prince Edward Island, the weather was not as good and producers in these provinces had a slightly better harvesting season than in 1991. In Quebec, weather conditions were generally quite bad. Producers were able to enjoy some sunny days at the beginning of the harvesting season, but the remainder of the season was very wet. Conditions were particularly disastrous in July, a month where normally half of the total peat volume is harvested. Things improved slightly in August and September, but not enough to compensate for what became an overall difficult harvesting season for Quebec. In western Canada, Saskatchewan was blessed with extremely good weather conditions for a second consecutive year, Alberta received enough sun to have a normal harvesting season, and Manitoba suffered from frequent rainfall.

Peat shipments in 1992 were estimated at 856 000 t valued at $108.2 million. That estimate represents a 2.7% increase in volume and an 8.1% increase in value over the revised 1991 shipments. Shipments from Quebec and New Brunswick, the two major producing provinces, each accounted for slightly less than 40% of total 1992 shipments. The balance of shipments originated largely from Alberta and Manitoba. Using 1991 shipment and export data, the apparent Canadian consumption is estimated at 23% of total shipments. In Atlantic and western Canada, shipments calculated from 1991 revised

[1] Production figures are confidential for the provinces of Nova Scotia, Manitoba and Saskatchewan.

data and the 1992 estimate increased respectively from 288 684 t to 326 333 t, and from 194 868 t to 197 476 t. In Quebec, a survey carried out in the fall of 1992 showed that producers expected overall 1992 shipments to decline slightly from 349 519 t to 331 771 t; however, at year-end, volumes reported to the province showed a much sharper decline from 8.6 million bales to 7.1 million bales, or 17.8%.

Peat stocks in January 1992 were at 4.74 million and 4.27 million bales of 170 dm^3 in Quebec and New Brunswick. When compared to the stock levels of January 1991, these stocks represent a drop of about 0.2 million bales in Quebec and an increase of 1.7 million bales in New Brunswick. During the first six months of 1992, stocks decreased gradually reaching, at the end of June, 1.89 million bales in Quebec and 1.99 million bales in New Brunswick. These stock levels were almost the same for Quebec and were 85% higher for New Brunswick when compared to the levels reported at the same time in 1991. A fairly good harvesting season in New Brunswick helped replenish stocks to a level estimated at 4.5 million bales in September. However, in Quebec, where the production was not as good, stocks grew to only 3.5 million bales during the harvesting season. In September 1991, stocks in Quebec were at 5.9 million bales. In New Brunswick, sales in the last four months of 1992 were good. Therefore, it is estimated that stocks were probably at around 3.5 million bales at the end of 1992, or 0.8 million bales less than that reported at the beginning of 1992. In Quebec, the other major producing province, unfavourable weather conditions had a major impact on the stocks. At the end of 1992, stocks in that province were 3.0 million bales, which is 1.7 million bales less than at the beginning of the year.

Exports in 1991 increased 4.8% to 650 124 t valued at $136 million. Canadian producers exported to 28 countries, with the United States again being by far Canada's major customer accounting for 88.7% of total peat exports. Japan ranked second with 10.2%, and the remaining 26 countries accounted for the balance of 1.1%. Peat exports to the United States increased 5.5% over 1990, and those to Japan increased 0.5%. Exports to countries other than the United States and Japan suffered a third consecutive loss (9.5%) going from 18 628 t in 1988 to 7205 t in 1991. Canada's intensive promotion campaign in the United States and more aggressive marketing by the producers in the last few years are having a positive impact on Canadian sales to that country. Since 1989, sales to the United States have increased 28% to reach 576 675 t in 1991 and, as noted below, further increases are reported for the first nine months of 1992. In Japan, Canadian producers have kept their 88% share of the peat market. Central and Atlantic Canada accounted for close to 73% of exports to the United States in 1991. The remaining 27% originated from western Canada. With respect to Japan, data from Statistics Canada show that 87% of Canadian peat exports to that country originated from Atlantic Canada. Central and western Canada accounted for 5% and 8% respectively of 1991 exports to Japan. Exports of peat to European countries decreased from 1489 t in 1990 to 438 t in 1991, while Canadian sales of peat to Asiatic countries, excluding Japan, increased from 1614 t to 2274 t. Taiwan was the leading country with 783 t, or 85% more than in 1990. The Canadian peat industry was also more successful in Australia with sales of 2442 t representing a 70% increase over 1990. When peat exports for the first nine months of 1991 and 1992 are compared, an overall volume increase of 12.4%, or 64 142 t, is observed. That significant increase can mainly be attributed to a 12.9% increase in the United States and, to a lesser extent, to an 8.4% increase in Japan.

Small quantities of low-value peat were imported from the United States in 1991. Statistics Canada shows that 15 496 t of peat, valued at $411 000, were imported into Canada in 1991.

CANADIAN ACTIVITIES

In Canada, 77 operations harvested and/or processed sphagnum peat in 1991. EMR estimates that the peat industry provided between 1600 and 1700 direct jobs in 1991 on an annual basis.

In Quebec, to cope with bad weather conditions, producers opened and harvested peat bogs that would have normally stayed closed. For example, Premier CDN Enterprises Ltd. re-opened its Tardif, St-Ulric, Sept-Îles and Trump Divisions in an attempt to harvest as much peat as possible.

In Ontario, there was little change from 1991. No peat production was reported from Atkins and Durbrow Ltd. and North Peat Inc., the only two companies involved in the peat business in that province.

In eastern Canada, weather conditions allowed the producers to have a fairly good field season. It is estimated that the volume of peat harvested in 1992 was about 10% lower than that of the record 1991 season of 9 million bales of 170 dm^3. Two new operations were added in New Brunswick in 1992. They are Beauséjour Peat Moss Inc., a family enterprise located near Shediac involved in selling loose peat, and Tourbières Premier Atlantic, a subsidiary of the important Canadian peat producer Premier CDN Enterprises Ltd., which has prepared a bog near Acadieville for harvesting in 1993. A new bog was also opened and harvested in New Brunswick by Berger Mix Inc. at Bay-au-Vent, and plans were developed by Le Groupe Qualité Lamèque Ltée to put a plant in place in 1993 that will produce peat-based mixes.

In western Canada, the 1992 harvesting season was a normal one. Weather conditions were particularly favourable in Saskatchewan but, for market reasons, it was estimated last fall that the volume of peat to be produced or bagged in that province would be 15% less than that of 1991. Contrary to conditions in Saskatchewan, weather conditions in Manitoba were not very good. Nevertheless, that province increased its peat production by about 20% over 1991. That increase can be accounted for by the use of important reserves of loose peat gathered from the 1991 harvesting season. In Alberta, where weather conditions were fair, field and production activities were normal and similar to those of 1991.

Premier CDN Enterprises Ltd. of Rivière-du-Loup pursued its efforts to modernize its operations in Quebec as well as in western Canada. For instance, in 1992, Premier completed the installation of an automatic bag-closing system in all of its plants. The implementation of that system will permit Premier to eliminate the small wooden board and metal cramps traditionally used to close the plastic bags. This change will make it easier to recycle used bags, a situation that should contribute to the protection of the environment. In research and development (R&D), Premier's major themes remain horticulture and environmental protection. The company hopes to be able to introduce products in 1993 which will be used to protect the environment. Premier Tech, a subsidiary of Premier CDN Enterprises Ltd., continues to develop equipment related to the handling of large volumes of peat or any other fibrous materials, and to design equipment that permits the linkage of different plant operations.

Fafard et Frères Ltd. increased its activity at Sainte-Marguerite in order to respond to a growing demand for Johnson and Johnson Inc.'s new sanitary napkins. At that locality, peat is harvested in blocks and, as such, was unaffected by the bad weather conditions that prevailed in the province of Quebec during the summer and fall of 1992. In Abitibi, Quebec, Fafard was unable to confirm the usefulness of its mining effluent peat filter due to underground contamination. The filter used at the East Sullivan mine will be re-positioned in 1993 to a site where ground contamination can be controlled. Results on domestic effluents have been more conclusive. In that area, peat biofilters have proven to be far superior to conventional systems.

Tourbières Lambert Inc.'s divisions were all open in 1992. The company pursued modernization of its operations following a strategy of cost reduction established a few years ago. In 1992, special efforts were made to improve the plant used to prepare peat-based mixes.

Sphag Sorb Inc., a subsidiary of Lakeland Peat Moss Ltd. of Edmonton, Alberta, continued to promote dried peat moss as a non-toxic and biodegradable solution to oil spills. According to the company's marketing manager, sales of that product are increasing each month, and a 1000-barrel oil spill in a Louisiana marsh was successfully cleaned up using the product.

In 1992, nine research projects on the restoration of peat bogs were undertaken in Canada, reflecting the Canadian peat industry's firm commitment to protect the environment. On these projects, the industry is working closely with the Department of Botany of the University of Alberta, the Department of Phytology of Laval University, Le Centre Québécois de Valorisation de la Biomasse (CQVB), the New Brunswick Peat Research and Development Centre (PRDC), and the Quebec and New Brunswick provincial governments. Also in 1992, the industry contributed, through its Canadian Sphagnum Peat Moss Association, to the publication of a report entitled *Canadian Peat Harvesting and the Environment*. The report was prepared by Maritime Groundwater Inc. of Fredericton, New Brunswick, under contract to the Secretariat to the North American Wetlands Conservation Council (Canada).

INTERNATIONAL SCENE

World Production

In 1992, world peat production was estimated by the U.S. Bureau of Mines (USBM) at 169.4 Mt, a small 1.1% increase over the recently revised 1991 production figure of 167.5 Mt. In 1991, the former Soviet Union (FSU) remained the largest producer of agricultural peat with a 97% share, followed by the Republic of Germany (0.89%), Canada (0.53%) and the United States (0.44%). Fuel peat production accounted for 13.3% of total world output and was mainly produced in the FSU (44.9%), Ireland (33.4%) and Finland (20.7%). Because of the vast spreads of peat around the world, the world's peat resources in 1991 and in the years to come will remain almost unchanged at 1.9 trillion t, of which the FSU has about 770 billion t, Canada has 500 billion t, and the United States has 310 billion t.

United States

In 1992, U.S. peat production increased from 632 000 t to 662 000 t, reaching an estimated plant value of about US$18 million. About 75 operations harvested and processed peat in 20 of the contiguous states and Alaska. Florida and Michigan accounted for approximately 63% of the total peat produced. Sixty-three percent (63%) of the total volume produced was reed-sedge peat. Humus peat accounted for 25%, sphagnum peat for 7%, and hypnum moss for 5%. When compared to the 1991 revised figures, the apparent consumption rose 4.7% in 1992 to 1.32 Mt. Sphagnum peat imported almost entirely from Canada accounted for almost 50% of U.S. consumption. In 1991, sphagnum peat was produced by 14 operations and production amounted to about 38 000 t, or 6% of total U.S. peat output. Assuming that only sphagnum peat is imported into the United States, the 1991 domestic consumption of that type of peat is estimated at 608 000 t, or only 1% less than in 1990. Canada exported 576 675 t of sphagnum peat to the United States in 1991, a 5.5% increase over 1990. On a volume basis, U.S. peat import reliance increased from 44% to 50% in 1991. That dependence on foreign suppliers remained at 50% in 1992. The average price, f.o.b. plant, was US$23 per short ton of peat in 1991. From preliminary information, it seems that this price will be the same in 1992. In 1991, Canada accounted for almost all (99.5%) U.S. peat imports. According to the USBM, the imported sphagnum peat price representing the average customs value was quoted at US$152 per short ton in 1991, an increase of 4% over 1990. In the United States, the horticultural peat market is projected to grow at about 3%/y, reaching 1.45 Mt by 1996. The Bureau forecasts that Canadian imports to the United States will increase by another 100 000 t by 1996. The future demand for peat in the United States could be even greater if new uses for peat are developed. There is considerable interest in using peat as a filtration medium; for the treatment of domestic, municipal and commercial effluents; for composting; for oil absorption; and for hygienic products.

Japan

In 1991, Japan remained Canada's second largest importer of Canadian peat with imports of 66 196 t valued at $14.7 million. The 1991 volume imported from Japan was almost the same as that of 1990, but the value of these peat imports decreased by 11.3%. Consequently, the unit value for that commodity dropped to $221, or close to the 1989 unit value, marking an end to a positive trend observed since 1988. According to Statistics Canada, 58 917 t of peat valued at $13.2 million were exported to Japan in the first nine months of 1992, compared to 54 354 t valued at $12.1 million for the same period in 1991. These figures show that in 1992 the volume of peat exported to Japan for the January-September period had increased by 8.4% over 1991 and its corresponding value by 9.1%. The unit value for the first nine months of 1992 was $224, or $3 more than the value recorded for 1991. Canada remained the major supplier of peat to Japan in 1991 with, on a value basis, an 88% share of the market followed by Germany (7%), with the United States, the FSU and the Netherlands each having about 1% of the Japanese peat market. There was little change in trends in 1991. Industrial landscaping remains the single largest outlet (50%) followed by traditional usage for rice nursery bedding (20%), greenhouse usage (20%), and horticulture and golf courses (10%). For industrial uses, peat sales are handled by large buyers while distributors and wholesalers handle sales for other uses. Japan continues to import six-cubic-foot (170 dm^3) bales to serve its market.

In 1991, the Japanese market increased by 3.4% over 1990. That increase, which is the smallest ever reported, pushed the Japanese peat market to 81 972 t in 1991. Such a volume is slightly more than twice the volume recorded for 1987. Although the Japanese peat market is expected to remain firm, statistics for the first nine months of 1992 seem to indicate that, like last year, future market increases will be in the range of 5%-10%/y. Japan will continue to rely heavily on Canada. However, we are observing significant import increases from smaller suppliers such as China, Finland and the United States. These countries have respectively registered increases of 200% to 682 t, 280% to 990 t, and 290% to 1294 t during the first nine months of 1992. It is the second consecutive large increase for the United States, which increased its peat exports to Japan by a factor of 10 since 1990. However, Germany, which is the second largest exporter of peat to Japan after Canada, has seen its sales drop by 1713 t, or 26%, in the January-September 1992 period.

The Canadian Embassy in Tokyo informs EMR that some exporters and importers have started to introduce their "private branded peat moss" to indicate quality assurance and integrity to their customers.

Finland

Finland, the third largest peat producer in the world after the FSU and Ireland, reports a 1992 overall peat production of 21 million m^3. That volume represents an increase of about 100% over the poor 1991 production and an increase of about 15% over the 1989 and 1990 seasons. Finland's production of horticultural peat, which is far less important than its production of fuel peat, reached 1.6 million m^3 in 1992. When compared to the data provided to EMR by Vapo Oy (a state-owned corporation that accounted for 87% of total Finnish peat production in 1990), that volume of horticultural peat is slightly higher (7%) than that of 1990, but significantly higher (100%) than that of 1991. In 1992, the use of fuel peat in Finland decreased. According to Vapo Oy, that change in consumption can be accounted for by the shut-down of two big power plants for several months during the year. Data provided by the company show a drop in fuel peat consumption of about 10%-15%. With a much better harvesting season than that of 1991 for horticultural peat, it is expected that Finland will intensify its marketing efforts in Japan to further penetrate a market which is currently served mainly by Canadian producers.

In the past decade, Finnish fuel peat output varied from 3.9 million to 20.4 million m^3, while horticultural peat production ranged from 0.6 million to 1.8 million m^3. In contrast, as expected, data related to consumption show a fairly regular increase for both types of peat. Except for the year 1989 when 1.7 million m^3 of horticultural peat was used, a steady increase in consumption from 0.9 million to 1.3 million m^3 was observed for that type of peat in the last decade. The year 1989 also marked a break in fuel peat consumption with 11.8 million m^3 being consumed. Setting aside the 1989 consumption, the data show that the consumption of fuel peat increased regularly and, on a percentage basis, more rapidly than horticultural peat in the last decade. During that period, the consumption of fuel peat went from 7.0 million to 14.8 million m^3. Fuel peat currently represents 5% of Finland's primary energy. Vapo Oy expects that dependence to rise between 7% and 8% by the year 2000.

Ireland

EMR was unable to obtain information on Ireland's recent peat production. However, during the 1990/91 production year, that country produced 7.56 Mt of peat, of which 196 000 t were horticultural peat. Bord na Mona, the state-owned corporation, contributes approximately 80% of Irish peat production. In 1990/91, it was the sole producer of milled peat with production reaching almost 6 Mt. About half of that production was used by the Electricity Supply Board to generate electricity. In Ireland, 97% of the peat produced is used as a fuel.

USES

Peat is used in several applications due to its wide range of physical and chemical properties. It is used in its natural state in agriculture and horticulture to condition 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. It is also used in the production of peat pots for sprouting plants.

Peat has several industrial applications. It can be used in the production of paper towels, chemical products, metallurgical coke, and activated carbons. Peat is also used to treat industrial and domestic effluents. Its cellular structure, absorbing properties and high capacity for ionic exchange form the basis for its use as a natural filter. Peat can reduce the acidity of drainage from old mines and remove iron oxides from waste and drainage water. Peat has also been used as an oil spill absorbent and in certain medical applications.

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, Finland and the C.I.S. Fuel peat has a high degree of humification, a high bulk density, a high calorific value, a low ash content, and a low percentage of pollutants such as sulphur and mercury. Canadian peat possesses a calorific value of about 4700-5100 kcal/kg. In comparison, the value for coal is 4800-5800 kcal/kg, and for oil, 9900-10 000 kcal/kg. Fuel peat is fired in furnaces to produce the steam needed to drive turbines, which in turn generate electricity. It can also be processed to produce coke, synthetic natural gas, and methanol.

OPPORTUNITIES

A 1990 study, supported by the Canadian Embassy in France, indicates that substantial quantities of peat could be sold to France and eventually to other European countries if producers took advantage of backhauling to reduce freight costs. The study shows that Canadian peat could be shipped to Le Havre, France, and delivered to Paris and Angers at competitive prices. EMR still believes that the industry should pursue this lead. It could develop into an interesting market opportunity for Canada.

Japan continues to be a good market for the Canadian peat industry, particularly for Atlantic producers. However, requests for information from other Pacific Rim countries in 1991 and 1992 seem to indicate that, in addition to Japan, other countries such as Taiwan should be approached to develop new markets.

Opportunities still lie in new applications such as the use of peat to manufacture extra-thin super-absorbent sanitary napkins. The potential for utilizing peat in the treatment of domestic and industrial effluents also remains. Experimental work presently carried out in Canada in these areas should soon lead to the development of new peat markets.

The development and manufacture of field and plant equipment is progressing rapidly in Canada. A vast experience in peat harvesting and processing is being put to use to design equipment that will allow operation costs to be maintained at a competitive level. New engineering products that can be used to handle large volumes of peat or other fibrous materials are currently marketed worldwide. This area represents an interesting diversification and market opportunity for the Canadian peat industry.

Note: Information in this review was current as of February 1, 1993.

PRICES[1] IN THE UNITED STATES, BY TYPE OF PEAT, 1991

Type	Domestic			Imported[2]
	Bulk	Packaged or Bales	Average	Total
	(U.S. dollars per short ton)			
Sphagnum moss	29.05	82.85	62.04	152.14
Hypnum moss	31.52	59.82	48.92	n.a.
Reed-Sedge	20.61	23.24	22.08	n.a.
Humus	13.13	10.42	12.09	n.a.

Source: U.S. Bureau of Mines, "Peat," 1991.
n.a. Not applicable.
[1] Prices are f.o.b. plant. [2] Average customs values.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2703.00	Peat (including peat litter) whether or not agglomerated	10.2%	6.5%	Free	Free
6815.20	Articles of peat	6.8%	4.5%	3.4%	Free

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992.

TABLE 1. WORLD PRODUCTION OF PEAT, BY COUNTRY, 1987-91

Country	1987	1988	1989	1990	1991p
			(000 tonnes)		
AGRICULTURAL USE					
U.S.S.R.e	163 260	163 260	163 260	149 655	140 600
Germany, Republic of	2 000	2 124	1 580	1 500	1 300
Canada (shipments)	662	736	812	715	856
United States	865	765	690	690	632
Netherlandse	400	300	300	300	300
Irelandr	258	300	266	300	200
Finland	190	363	444	450r	450
Swedenr	210	230	230	260	260
Francee	210	200	200	200	200
Polande	250	200	200	200	200
Denmark	50	50	50	110r	100
Spain	67	75	75	70	70
Hungarye	70	70	70	70	60
Norway	30	30	30	30	30
Israel	20	20	20	20	20
Other	30	20	55	55	55
Subtotal	168 572	168 743	168 282	154 662	145 343
FUEL USE					
U.S.S.R.e	11 430	17 500	16 800	14 965	10 000
Irelandr	6 135	4 055	7 760	6 350	7 440
Finlandr	1 815	3 720	4 445	4 080	4 600
West Germanyr	240	232	232	232	230
Subtotal	19 620	25 507	29 237	25 627	22 270
Total world	188 042	194 080	197 349	180 019	167 613

Sources: U.S. Bureau of Mines, "Peat," 1991; Energy, Mines and Resources Canada.
e Estimated; p Preliminary; r Revised.

TABLE 2. CANADA, PEAT SHIPMENTS BY PROVINCE, 1988-92

Province	1988		1989		1990		1991		1992p	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
Newfoundland	2	53	1	77	2	68	3	141	1	53
Prince Edward Island	–	–	–	–	–	–	–	–	–	–
Nova Scotia	x	x	x	x	x	x	x	x	x	x
New Brunswick	241	25 428	251	24 910	266	23 857	263	28 510	309	32 465
Quebec	317	30 313	335	41 516	350	41 058	350	40 221	332	40 558
Ontario	x	x	x	x	–	–	–	–	–	–
Manitoba	x	x	x	x	x	x	x	x	x	x
Saskatchewan	x	x	x	x	x	x	x	x	x	x
Alberta	78	15 150	93	18 626	72	13 268	102	15 639	100	17 250
British Columbia	–	–	–	–	–	–	–	–	–	–
Total	736	82 832	812	99 666	775	89 735	833	100 133	856	108 199

Source: Energy, Mines and Resources Canada.
– Nil; **p** Preliminary; x Confidential.
Note: Totals may not add due to rounding.

TABLE 3. CANADIAN DOMESTIC EXPORTS OF PEAT, BY COUNTRY, 1988-92

Country	1988		1989		1990		1991		Jan.-Sept. 1992p	
	Tonnage	Value	Tonnage	Value	Tonnage	Value	Tonnage	Value	Tonnage	Value
		($000)		($000)		($000)		($000)		($000)
Angola	–	–	7	6	–	–	–	–	–	–
Anguilla	1	2	30	21	18	3	–	–	–	–
Australia	2 723	1 403	1 938	645	1 464	366r	2 490	445	2 248	496
Austria	171	77	–	–	–	–	–	–	–	–
Barbados	5	6	5	5	15	6	38	28	15	7
Belgium	497	147	32	20	179	33	57	19	28	10
Bermuda	66	33	56	11	20	7	31	7	20	3
Chile	–	–	–	–	–	–	36	4	–	–
China, People's Republic of	25	3	24	6	90	20	16	6	54	23
Costa Rica	16	6	–	–	–	–	–	–	–	–
Denmark	27	69	75	145	129	385	68	154	–	–
Dominican Republic	14	6	68	11	54	10	–	–	66	78
Egypt	404	162	–	–	–	–	–	–	–	–
France	19	27	24	62	117	50	8	10	–	–
Germany	502	182	79	14	7	11	23	32	7	22
Greece	1 220	425	–	–	–	–	–	–	–	–
Guadeloupe	–	–	13	6	–	–	–	–	–	–
Haiti	49	51	76	67	135	143	22	13	–	–
Hong Kong	65	9	86	18	37	19	96	28	90	30
Iceland	9	2	50	9	9	2	9	2	9	2
India	–	–	27	16	–	–	–	–	–	–
Indonesia	–	–	–	–	–	–	–	–	114	179
Ireland	9	2	–	–	–	–	18	2	–	–
Israel	417	101	167	39	475	87	134	35	–	–
Italy	277	71	16	47	250	26	–	–	–	–
Japan	52 691	11 020	56 226	12 640	65 765r	16 522r	66 196	14 654	58 917	13 211
Jordan	–	–	243	115	199	84	148	73	65	48
Korea, North	–	–	–	–	–	–	–	–	96	21
Korea, South	154	44	269	88	1 051	202	594	160	1 191	228
Kuwait	–	–	62	29	–	–	–	–	57	20
Lebanon	–	–	–	–	–	–	3	4	–	–
Malaysia	–	–	–	–	–	–	219	38	313	57
Mexico	77	16	16	5	36	15	215	61	76	39
Namibia	21	4	–	–	–	–	–	–	–	–
Netherlands	2 718	539	4 571	149	719	140	247	48	214	49
Netherland Antilles	13	6	17	4	–	–	–	–	–	–
New Caledonia	–	–	2	3	–	–	–	–	–	–
Niger	139	31	–	–	–	–	–	–	–	–
Norway	47	18	–	–	–	–	–	–	–	–
Puerto Rico	2 018	617	2 672	489	–	–	–	–	–	–
St. Kitts-Nevis	19	4	–	–	–	–	–	–	–	–
St. Lucia	73	38	5	2	–	–	–	–	–	–
St. Pierre and Miquelon	–	–	–	–	1	. .	–	–	31	7
Saudi Arabia	5 593	1 572	1 975	579	41	11	–	–	–	–
Singapore	–	–	–	–	12	1	539	100	–	–
South Africa	393	119	709	252	2 300	607	1 382	323	635	134
Spain	100	11	50	14	4	6	–	–	–	–
Switzerland	56	50	8	23	7	13	–	–	8	16
Taiwan	166	70	135	40	424	206	783	331	1 355	617
Thailand	–	–	–	–	–	–	23	4	–	–
Trinidad-Tobago	15	6	32	28	82	61	46	15	16	10
United Kingdom	510	158	7	10	79	41	8	17	15	5
United States	445 286	86 556	460 606	90 669	542 431r	110 816r	576 675	119 505	514 919	112 321
Uruguay	–	–	–	–	8	4	–	–	–	–
Total	516 605	103 682	530 378	106 303	616 158r	129 914r	650 124	136 132	580 559	127 642

Source: Statistics Canada.
– Nil; . . Not available or not applicable; p Preliminary; r Revised.
Note: Numbers may not add to totals due to rounding.

Platinum Group Metals

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The term "platinum group metals" (PGMs) refers to six closely related metals generally found together: platinum (Pt), palladium (Pd), rhodium (Rh), ruthenium (Ru), iridium (Ir) and osmium (Os). These "noble" metals possess unusual qualities such as high melting points and chemical inertness and, most importantly, exceptional catalytic properties, even under conditions of severe temperature and corrosion.

Demand for PGMs in the market economy countries for 1991 and 1992 was estimated at:

	1991	1992e
	(t)	
Platinum	132.5	127.7
Palladium	119.3	123.0
Rhodium	11.2	11.0
Iridium	1.1	1.2
Ruthenium	5.3	6.4

Source: Johnson Matthey Public Limited Company.
e Estimated.
Notes: One tonne = 32 150.7 troy ounces. Figures may not round in tables as they have been converted from troy ounces.

These data understate total demand as they are net of material recovered from recycling (except for autocatalysts).

The largest uses for platinum and rhodium are in catalysts, especially in autocatalysts. The major uses for palladium are in dental work and electrical applications.

Japan is the leading industrial consumer of both platinum and palladium, accounting for almost half of the Western World's industrial demand. The industrial demand for PGMs in North America and Western Europe is about equal at between 20% and 25% of Western industrial demand. Western Europe consumes about twice the quantity of palladium as North America does. Estimated geographic shares of consumption were:

	Platinum	Palladium
	(%)	
Japan	48	47
Western Europe	20	23
North America	22	20

The supply of primary PGMs from market economy countries and Russian exports, plus the recovery of platinum, palladium and rhodium from autocatalysts, was estimated at:

	1991	1992e
	(t)	
Platinum	136.1	128.6
Palladium	124.3	119.6
Rhodium	11.3	11.2

Source: Johnson Matthey Public Limited Company.
e Estimated.

The Republic of South Africa and the Russian Republic are by far the major producers of PGMs. Canada and the United States, with much smaller outputs, are second-rank producers. In both Canada and Russia, PGMs are by-products of nickel production. Inco is the largest PGM producer outside of South Africa and the Russian Republic. The relative shares of primary output of the leading producers in 1991 were:

	Platinum	Palladium	Other PGMs
Total production of which:	128.8 t	136.8 t	26.0 t
South Africa	70.0%	30.0%	50.0%
Russia	23.0%	60.0%	42.0%
United States	4.4%	1.3%	. .
Canada	4.4%	3.4%	3.8%

Source: International Consultative Group on Nonferrous Metals Statistics, July 1992.
. . Not available.
Note: See Table 3 for more complete production information for 1988-91.

Prices of PGMs are determined daily in a number of markets; London, New York and Tokyo are the principal markets for platinum and palladium. Johnson Matthey issues prices daily for platinum, palladium, rhodium, iridium and ruthenium.

The average London Bullion Market prices for the three principal PGMs were (in U.S. currency/troy ounce):

	1991	1992
	(t)	
Platinum	376	360
Palladium	88	88
Rhodium	3 918	2 466

Source: Metals Week.
Note: See Table 4 for monthly prices; see Figures 1-3 for daily prices.

CANADIAN DEVELOPMENTS

Primary PGM output in Canada declined from 1990 to 1992 due to nickel production curtailment. Canadian PGM data show the PGM content in nickel-copper mattes exported by Canadian smelters plus the recoverable PGM content in concentrates exported. While the Canadian export statistics do not show the exports of contained PGMs in the matte exported to Norway, this figure is incorporated into the PGM output data as:

	1990	1991	1992[e]
		(t)	
Canadian PGM output	11.12	11.12	10.50

[e] Estimated.
Note: See Table 2 for historical Canadian PGM output data, 1980-92.

In addition to primary PGM output, Canadian nonferrous producers recover considerable amounts of PGMs by recycling domestic and imported post-consumer materials. Obsolete autocatalysts, industrial catalysts, electronics, telecommunications equipment and other post-consumer materials are the main sources of post-consumer items which contain sufficient PGMs to warrant recovery.

The main Canadian PGM producers are Canada's primary nickel producers: Inco Limited and Falconbridge Limited. Their Sudbury operations are the source of the majority of Canada's primary PGMs. Both companies ship contained PGMs to refining facilities in Europe for final recovery. Falconbridge sends its PGMs, contained in a copper-nickel matte, to the company's Nikkelverk refinery in Norway; the contained PGMs in the matte are not reported separately in Canadian export tables. This refinery also processes primary materials from other sources. Inco operates a platinum refinery at Acton in the United Kingdom. The plant processes Inco's primary and secondary material. In addition, Acton toll refines PGMs. Inco deliveries of PGMs in 1991 from its Canadian ores and from recycling of non-toll material were 4.1 t of platinum, 5.7 t of palladium, 0.4 t of rhodium and 0.15 t of other PGMs.

Small amounts of primary PGMs are produced in Manitoba from Inco's nickel operations at Thompson and the Namew Lake mine near Flin Flon. Hudson Bay Mining and Smelting Co., Limited (HBMS) and Outokumpu Mines Ltd. own the Namew Lake mine, which is expected to close late in 1993.

In September 1991, Inco announced the discovery of two high-grade copper-nickel orebodies in the Sudbury area that were enriched with PGMs and gold. The Victor deposit contains 6.2 Mt of proven and probable ore (with three to six times as much indicated ore). Grades are between 7.5 and 19 g/t PGMs plus gold, in addition to the 5%-7% copper and 1.5%-2.6% nickel. The second orebody was found near the McCreedy East mine and contains 7.25 Mt of indicated ore (5.35 Mt proven and probable) grading 8.8% copper and 0.6% nickel. Inco postponed capital expenditures for development due to declining nickel prices.

Falconbridge's sales of platinum and palladium, which showed an increase starting in 1990, are shown below:

	Average 1986-89	1990	1991
		(t)	
Platinum	0.72	1.18	1.04
Palladium	1.23	2.97	3.38

Madeleine Mines Ltd. has a palladium-platinum property in northwestern Ontario called Lac des Îles mine. The 3000-t/d property is not in production. Madeleine has conducted hydrometallurgical test work, and this work is continuing.

At the Lac des Îles mine, the Roby ore zone was evaluated in 1980 at 6.5 Mt of probable ore grading

0.1% copper, 0.1% nickel, 5.6 g/t PGMs and 0.3 g/t gold. After dilution, the ore grade of the Roby zone was expected to be 5.4 g/t PGMs. In November 1992, the company reported that it was in full compliance with applicable rules and regulations. At the end of January, Madeleine was in the final stages of the approvals process and it intends to start production as soon as practical after the approvals have been granted. At full production, the operation could produce 4.67 t of palladium, 0.45 t of platinum and 0.62 t of gold annually.

Exploration for PGMs in Canada has slowed substantially from the pace of the 1980s due to lower PGM prices, changes in taxation rules, and the reduced availability of risk capital.

Both Inco and Falconbridge recover PGMs from scrap and secondary materials. Inco concentrates on autocatalysts from both domestic and U.S. sources. These autocatalysts are processed at Inco's Sudbury operation. In a typical year, Inco recovers about 2.8 t/y of PGMs from autocatalysts. At the Horne smelter in Quebec, Noranda Inc. processes electronics and telecommunications equipment to yield about 4.7 t/y of palladium and platinum.

World Developments

South Africa and Russia are the leading producers of PGMs. The United States and Canada are the third and fourth largest producers of primary PGMs, but their combined output is less than 10% of world PGM production. Finland, Japan, the former Yugoslavia, Ethiopia, Colombia, Zimbabwe and Australia each produce less than 1% of world PGM production (see Table 3). Primary PGMs are also produced in the People's Republic of China. Japan recovers platinum and other PGMs from imported copper and nickel concentrates.

Generally, only South African orebodies are exploited principally for their PGM values. Elsewhere, PGMs are the by-products of the mining of other metals (usually nickel), except for the Stillwater mine in the United States and the presently inoperative Lac des Îles mine in Canada. For example, the Russian Noril'sk complex, which produces all of the country's PGMs, also produced about 240 000 t of nickel, 450 000 t of copper and most of the country's cobalt.

Primary Platinum Supply

The primary platinum supply available to market economy countries declined in 1992, mostly due to reduced sales from Russia. Primary output in the Western World was estimated at 97.7 t, compared to 95.2 t in 1991.

PLATINUM SUPPLY, 1991 AND 1992

	1991	1992[e]
	(t)	
South Africa	86.2	87.7
North America	6.8	6.5
Others	2.2	3.4
Russian exports	34.2	23.3
Total primary supply	129.4	121.0

Source: Johnson Matthey.
[e] Estimated.

In addition, Johnson Matthey estimated that 6.8 t of platinum were recovered from the recycling of autocatalysts in 1991 and that this number rose to 7.5 t in 1992. Such recycling means that the total supply available to market economy countries was at least 136.1 t in 1991 and an estimated 128.6 t in 1992. But the recycling of autocatalysts was not the only source of recycled PGMs; Johnson Matthey's supply data reflect primary sales by mines and show only the net demand (total demand less recycled material for each sector), except for autocatalysts.

South Africa is the largest platinum producer with estimated sales of 86.2 t in 1991 and 87.7 t in 1992. South African production comes from three reefs located in the Bushveld Igneous Complex near Pretoria. Each reef has a different ratio of PGMs. Their estimated in-situ contents are:

	Merensky	UG2
	(g/t)	
Total of which:	7.8	8.65
Platinum	4.8	3.7
Palladium	2.0	3.0
Rhodium	0.24	1.05

It is estimated that about two thirds of the in-situ PGMs are recovered, on average, for sale as metal. The Platreef is more variable than the Merensky or UG2 reefs with contents varying between 7 and 27 g/t total PGMs.

In October 1991, Johannesburg Consolidated Investment Company (JCI) reorganized its platinum-producing subsidiaries. The three divisions were transformed into discrete subsidiaries: Rustenburg Platinum Mines, Lebowa Platinum Mines, and Potgietersrust Platinums.

Rustenburg Platinum operates three mines on the western rim of the Bushveld complex: the Rustenburg Section, the Union Section, and the Amandelbult Section. At Lebowa Platinum's Atok mine, production declined in 1991 due to an inexperienced workforce. New workers were hired after the mine had laid off striking workers in late 1990. Prior to the work stoppage at the Atok mine, an expansion was planned to increase capacity from 2-3 t/y of platinum to over 4 t/y by mid-1992.

At the end of September 1990, Rustenburg and Lebowa announced a joint decision to proceed with the development of a mine on the Platreef near Potgietersrus. This mine had been planned to reach full production of 200 000 t/y in 1994. However, plans were changed in mid-1991 to reduce capital expenditures. The PPRust project of Potgietersrust Platinums, as it has become known, is now expected to come on stream in mid-1993. PPRust will open-pit the Platreef at a rate of 200 000 t/m. Annual output of 5.3 t of platinum, 5.1 t of palladium and 0.4 t of rhodium, with by-product nickel, is planned.

Impala Platinum Holdings Ltd., controlled by General Mining Union Corporation Limited, is the second largest PGM producer in South Africa. In the fiscal year ending in mid-1992, Impala reported production of 33.3 t of platinum, 15.5 t of palladium and 2 t of rhodium. The company operates four platinum mines and has three properties on standby. The operating mines are: Bafokeng North, Bafokeng South, Wildebeestfontein North, and Wildebeestfontein South. Located in Bophuthatswana, a South African homeland, these mines experienced frequent labour difficulties throughout 1991 and 1992. The company's refinery also experienced labour difficulties, compounded by metallurgical problems. In June, Impala reported it was sending some of its material to Russian facilities for toll refining. Impala's platinum production target for 1995 is 40.4 t/y.

In January 1992, Impala announced that its 9.3-t/y Messina project would be postponed, giving no date for recommencement. Ore reserves at Messina were estimated at 26 Mt grading 5.9 g/t PGMs plus gold for the Merensky reef, and 33.8 Mt grading 6.7 g/t PGMs for the UG2 reef.

In mid-1991, Impala obtained management control of the Crocodile River mine by acquiring a 38% interest in the Barplats Group. After obtaining this interest, Impala first revised the production goals downward to 130 000 t/m of ore, or 2.8 t/y of platinum, and then shut down the operation in stages. Underground mining was terminated in the fall of 1991. The pit was closed in the spring of 1992. Kennedy's Vale (formerly called Rhodium Reefs) has remained on care and maintenance since late 1990.

Western Platinum Limited and Eastern Platinum Limited are owned by Lonrho Plc. Western Platinum Limited is the third largest South African producer. The company's platinum capacity is estimated at about 5 t/y, although an expansion to approximately 8.5 t/y is planned.

Northam Platinum Limited, controlled by Gold Fields of South Africa Ltd., began operation at its 2-km-deep high-grade mine on the southeastern boundary of Rustenburg's Amandelbult Section mine. Milling began in January 1992, but metal was not expected to be available until January 1993. Problems of poor rock conditions led to delays and to increased stoping width. Wider stopes will reduce head grades from 10 g/t to about 9 g/t. At full production, Northam is scheduled to produce 6.8 t/y of platinum.

Russia is the second largest producer of platinum. Russian exports peaked in 1992.

RUSSIAN PLATINUM EXPORTS, 1986-92

	Tonnes
1986	9.0
1987	12.4
1988	13.7
1989	16.2
1990	22.4
1991	34.2
1992	23.2[e]

[e] Estimated.

Noril'sk Nickel, the Russian PGM producer, mines these metals at its Taimyr, Siberia, operation. The nickel-copper ore contains PGM grades varying between 45 and 340 g/t. No other significant PGM producers are known to exist in the former Soviet Union. Public data have been scarce; observers have used nickel production as a proxy for indications of PGM output. Noril'sk's nickel production declined from 300 000 t in 1991 to 240 000 t in 1992. A further 15% reduction is possible in 1993.

Despite production declines, Russian exports have remained high compared to historical levels. This phenomenon (seen with nickel and aluminum as well) results from a need for hard currency, inventory drawdown, and reduced domestic consumption. With high domestic inflation, hard currency from foreign sales maintains purchasing power. In late 1990 and in 1991, it is believed that Soviet PGM (and other) inventories were largely liquidated in an effort by the former Soviet Union to raise cash. Domestic PGM consumption in Russia appears to have declined faster than domestic production of PGMs, thereby freeing up increased amounts of material for export.

In the United States, Chevron Resources Company and Manville Corporation jointly own the single primary PGM producer, the Stillwater Mining Company. Located near Billings, Montana, the mine came on stream in 1987. It produced 7.8 t of PGMs in both 1991 and 1992. Low prices forced postponement of plans to develop a second mine 30 km to the west of the current operation, but plans were announced in April 1992 to seek approval to double ore production to 2000 t/d from the existing mine. Stillwater started up a 15-20-t/d smelter in July 1990 in Columbus, Montana, about 60 km from the mine site. Stillwater ships matte to Belgium for refining.

In Zimbabwe, exploration for PGMs continued along the Great Dyke. BHP Minerals Inc. continued exploratory work to earn a greater share in the Hartley project, 65 km south of Harare. A bulk sample was taken for metallurgical testing and the feasibility of the project is to be assessed in early 1993. Early plans had called for an output of about 6 t/y of PGMs plus gold, nickel, copper and cobalt. The cost of the project is estimated at US$193 million. Other projects on the Hartley Complex are being pursued, but are at earlier stages of evaluation.

Other areas of interest for platinum exploration include Greenland, Australia, Brazil, Peru and Botswana.

Platinum Recycling

Recycled PGMs are commodities that compete with primary material. Platinum and other PGMs are recovered from a variety of post-consumer scrap and other sources. Used industrial catalysts, electronic scrap, jewellery sweepings, autocatalysts and telecommunications equipment are important sources of PGMs. In Johnson Matthey's extensive reviews of the PGM industry, demand in each sector (except autocatalysts), is net of recycling, effectively understating actual PGM use.

In Canada, as noted above, Noranda and Inco are the principal recyclers of non-oil PGM catalysts. Inco mainly processes spent autocatalysts while Noranda chiefly treats telecommunications equipment and electronic scrap. In the United States, recycling yields an estimated 76 t of PGMs from scrap and other sources. Belgium, Finland, Sweden and Japan are other significant recyclers of PGMs. Johnson Matthey estimated that the recycling of autocatalysts in market economy countries yielded:

	1991	1992[e]
	(t)	
Platinum	6.7	7.6
Palladium	2.6	3.0
Rhodium	0.5	0.6

[e] Estimated.

Primary Palladium Supply

The primary palladium supply to market economy countries declined in 1992, mostly due to reduced sales from Russia. Unlike for platinum, South Africa is not the premier palladium producer. Russian exports provide about twice the amount of palladium to market economy countries as South African production does. Primary palladium output in the West was estimated at 54.7 t compared to 54.4 t in 1991.

PALLADIUM SUPPLY, 1991 AND 1992

	1991	1992[e]
	(t)	
Russian exports	66.9	62.2
South Africa	39.5	39.8
North America	12.9	12.3
Others	2.3	2.3
Total primary supply	121.6	116.6

Source: Johnson Matthey.
[e] Estimated.

In addition, Johnson Matthey estimates that 2.6 t of palladium were recovered from the recycling of motor vehicle catalysts in 1991 and 2.7 t were recovered in 1992. This raised the total supply to market economy countries to 124.3 t in 1991 and an estimated 119.6 t in 1992. However, as was the case for platinum, only the recycling of autocatalysts is shown by Johnson Matthey, so actual palladium use is understated. As well as in Canada and the United States, secondary palladium is recovered in nonferrous facilities in Finland, Belgium, Sweden and Japan.

Primary Rhodium Supply

The primary rhodium supply (10.8 t) to market economy countries declined in 1991 and 1992 from the 1990 level of 11.5 t, due mostly to reduced sales from Russia. South Africa is the largest rhodium producer. Russian exports are the second most important source of supply to market economy countries.

RHODIUM SUPPLY, 1991 AND 1992

	1991	1992e
	(t)	
South Africa	6.8	6.8
Russian exports	3.4	2.5
North America	0.6	0.6
Others	–	–
Total primary supply	10.8	10.8

Source: Johnson Matthey.
– Nil; e Estimated.

Higher prices in 1990 (see Table 4) prompted producers to attempt to increase rhodium recovery by changes in refineries and by targeting the relatively rhodium-rich UG2 reef in South Africa.

CONSUMPTION AND USES

PGMs are used in a wide variety of applications in pure form, in alloys with other PGMs, or alloyed with other metals. The diversity of uses reflects their varied and unique attributes. PGMs' qualities include:

- chemical inertness;
- resistance to corrosion;
- high temperature oxidation resistance;
- very good ability to catalyze chemical reactions;
- high melting point;
- high strength at elevated temperatures;
- low coefficient of thermal expansion;
- stable thermo-electric properties;
- good mechanical durability; and
- stable electrical contact resistance.

Johnson Matthey's net demand data of 246.6 t of PGMs for 1991 show that the four largest industrial consuming sectors and their percentage shares were:

	PGMs	Percentage
	(t)	
Electrical	64.7	26
Autocatalysts	59.7	24
Jewellery	52.3	21
Dental	36.1	15

An additional 28.3 t of PGM demand in 1991 was accounted for by investments and net stock movements.

Platinum and palladium are the most widely used PGMs. The net industrial demand for the various PGMs was estimated by Johnson Matthey at:

	1991	1992e
	(t)	
Platinum	113.1	112.9
Palladium	116.6	120.1
Rhodium	10.7	10.4
Ruthenium	5.3	6.4
Iridium	1.1	1.2

e Estimated.

Platinum Consumption

Japan is the leading industrial consumer of platinum, taking almost half of industrial demand. Industrial demand in North America and in Western Europe each accounts for between 20% and 25% of Western industrial demand.

	1991	1992e
	(%)	
Japan	48	47
Western Europe	20	23
North Amercia	22	20

Source: Johnson Matthey.
e Estimated.

These markets have different patterns of platinum demand. In Japan, the major use for platinum is in jewellery. Japanese jewellers accounted for 72% of Japanese industrial demand in 1991, or 38.6 t. In contrast, in Western Europe and North America, autocatalysts are the largest consumers of platinum at 59% (14.2 t) and 63% (14.5 t) of the net industrial demand of the two respective regions.

Two uses dominate platinum consumption: autocatalysts and jewellery. By sector, the estimated net industrial demand and share of demand in 1992 were:

	Tonnes	Share
		(%)
Autocatalysts	43.9	39
Jewellery	42.1	38
Chemical	7.0	6
Petroleum	5.6	5
Electrical	5.4	5
Glass	2.6	2
Other	5.6	4

Source: Johnson Matthey.

Autocatalysts

Automobile emission limits were first legislated in the United States in the late 1960s. The emission limits were progressively tightened and oxidation catalysts were required to meet air pollution control limits. By 1983 all light-duty gasoline-powered vehicles in the United States were fitted with three-way catalysts. In the autocatalyst, platinum efficiently transforms hydrocarbons (HC) and carbon monoxide (CO) in the exhaust gases to more benign substances, while rhodium is most efficient at handling oxides of nitrogen (NO_x). Palladium can handle all three pollutants, but less efficiently than either platinum or rhodium.

U.S. emission limits per mile in 1983 were 1 g NO_x, 3.4 g CO and 0.41 g HC, thereby necessitating three-way catalysts. Current California plans for future emission standards are:

	HC	CO	NO_x
		(grams/mile)	
TLEV	0.125	3.4	0.4
LEV	0.125	3.4	0.3
ULEV	0.04	1.7	0.2
ZEV	–	–	–

Source: Johnson Matthey.
– Nil.
TLEV = Transitional Low Emissions Vehicle
LEV = Low Emission Vehicle
ULEV = Ultra Low Emission Vehicle
ZEV = Zero Emission Vehicle

California is expected to continue to be at the forefront in establishing regulatory limits on emissions. Starting in 1994, automakers selling cars in California will be required to sell 10% of their vehicles that meet TLEV standards. By 2003, 10% of all new vehicle sales in California will have to be ZEVs.

PGM catalysts will continue to be required on vehicles with internal combustion engines. But internal combustion vehicles cannot achieve the ZEV emission standards. Ironically, the increasingly strict emission standards which had generated substantial new demand for PGMs will render autocatalysts redundant on ZEVs. There may be a role for PGMs in fuel cells which could power ZEVs, but there is considerable competition with other technologies for this market–competition that is largely lacking in the autocatalyst market.

Canada introduced automobile emission regulations for new automobiles sold after September 1, 1987. These limited emissions to 3.4 g/mile of CO, 0.41 g/mile of HC, and 1.0 g/mile NO_x. In February 1992, domestic manufacturers and importers agreed to a reduction in emission limits, beginning with the 1994 model year. Target limits are 3.4 g/mile CO, 0.25 g/mile HC, and 0.4 g/mile NO_x. Progressively greater shares of sales in Canada will be required to meet these limits, paralleling the U.S. federal emission program from 1994 to 1996.

Other countries have adopted emission controls modelled on those of the United States and California, thereby spreading the market base for PGM consumption in autocatalysts. As of 1993, Western Europe, Japan, Australia, South Korea, Taiwan, Mexico and Brazil will have emission limits that effectively require autocatalysts for compliance.

Various proposals have been announced to minimize platinum content in catalysts, favouring instead lower-priced palladium. Ford (in 1988), Nissan (in 1991) and Isuzu (in June 1991) have released information on their programs to use palladium catalysts. In July 1992, the Japanese National Institute for Resources and Environment (NIRE) announced the development of a palladium catalyst for automobiles. This project was at an early stage and targets diesel engines, so it appears unlikely that platinum demand will be affected in the near future.

Because there are various emission standards around the world, there is no "standard" formula for the one or more catalysts fitted in each vehicle. According to Johnson Matthey, the average three-way catalyst in a 75-cubic-inch European car engine would contain 1.75 g of PGMs (1.46 g of platinum and 0.29 g of rhodium). In Japan, palladium is more widely used in autocatalysts as lead poisoning is not a problem.

Jewellery

In 1992, Japanese jewellers consumed almost as much platinum (38.6 t) as did all of the autocatalyst demand in the market economy countries (41.1 t). In contrast, in 1992, total jewellery consumption in Western Europe and North America was a mere 3.4 t. Even with a decline in industrial output in the Japanese economy and declining stock prices and land values, platinum consumption by the jewellery sector increased in 1991 (up 5.9%), but was forecast (by Johnson Matthey) to decline slightly in 1992 by 1.6%.

Consumers in Japan purchased platinum jewellery that was, on average, less expensive than in previous years. The Platinum Guild in Japan reported that platinum jewellery sales for the first six months of 1992 increased 14% from the same period the previous year. Increases were recorded mainly from items selling in the price range of C$300-$600.

Neighbouring Asian economies that were experiencing high economic growth rates have also become increasingly interesting markets for platinum jewellery. The potential exists for substantial increases from a low consumption base in these countries.

Other Platinum Consumption

No other single use of platinum comprises more than 6% of the market, compared to the 39% consumed in autocatalysts and the 38% consumed by jewellery. Chemical uses, petroleum refining, electrical applications and glass-making together comprise 19% of industrial demand. The chemical and petroleum industries use platinum in catalysts to increase the speed and efficiency of chemical reactions. The electronics industry uses platinum in substrates in the manufacture of computer hard disks. Thermocouples use platinum and other PGMs to sense temperature for control of industrial processes. The glass industry uses platinum, drawing on its corrosion resistance and strength, in the manufacture of glass fibres.

One minor application that shows promise for increased future consumption is the manufacture of fuel cells. Fuel cells generate power by combining oxygen and hydrogen, and yielding water and energy as products. Various technologies are being investigated: the two popular technologies are the phosphoric acid fuel cell (PAFC), and the proton exchange membrane fuel cell (PEM). Stationary fuel cells are being built in the United States and Japan to demonstrate this technology to generate electrical power. These installations vary from 1 to 40 MW. In 1991, the Japanese government predicted that 2250 MW of fuel cell installations would be completed by the year 2000, incorporating 11.2 t of platinum. Fuel cells for propulsion systems also have a possible application in ZEV cars.

Investment Offtake

Platinum bars and coins are a form of investment to hedge against inflation or a means to speculate against platinum prices. However, as platinum is also an industrial metal like silver, material previously taken off the market for investment can later appear as feed for industrial demand. In 1992, investment is estimated to have amounted to 7.2 t, or 6%, of industrial demand. In 1991, investment equalled 12.8 t.

Japan is the leading buyer of platinum for investment. The quantities of platinum purchased in 1991 and 1992 by geographic area were:

PLATINUM INVESTMENTS, 1991 AND 1992

	1991	1992e
	(t)	
Japan	9.5	4.2
United States	1.4	1.9
Western Europe	1.1	1.4
Other	0.8	0.2

Source: Johnson Matthey.
e Estimated.

The Royal Canadian Mint's sales of the platinum Maple Leaf coins in 1992 were 1.59 t, up from 1.15 t in 1991. As well as increasing total sales, the Royal Canadian Mint increased domestic sales from 0.9% of total sales in 1991 to 1.5% in 1992.

In 1992, Australia announced a 1-kg Koala coin. It sells at a 1% premium and is intended to be an alternative to bars. Australia has already marketed five platinum coins weighing between 0.05 and 1.0 oz.

Palladium Consumption

As was the case with platinum, Japan is the leading industrial consumer of palladium, accounting for almost half of industrial demand. North

American demand generally is about twice that of Western Europe. The 1992 palladium demand of 116.6 t was estimated by Johnson Matthey at 44% in Japan, 31% in Western Europe, 17% in North America, and 7% in other countries.

As was the case for platinum, Japanese demand for palladium differs from that in Western Europe and North America. In Japan, the major use for palladium is in electrical applications, representing about two thirds of Japanese industrial demand. In North America, equal amounts are consumed in the dental and electrical sectors, as is the case in Western Europe.

Due largely to Japanese consumption, electrical applications of palladium predominate. The second largest consuming sector is dentistry. Primary demand for palladium in autocatalysts was a mere 10% of industrial demand in market economy countries in 1992.

The net industrial demand and share of demand in 1992, by sector, for market economy countries was estimated at:

	Tonnes	Share
		(%)
Electrical	55.7	46
Dental	36.5	30
Autocatalysts	12.4	10
Jewellery	6.5	5
Other	8.9	7

Source: Johnson Matthey.

Silver-palladium pastes are used in integrated circuits and in ceramic capacitors. There is considerable recycling of palladium from the processing of obsolete electrical goods. As noted earlier, Noranda recovers considerable amounts of palladium from electrical and telecommunications scrap at its Horne smelter. Johnson Matthey's estimates of demand are net of the recycled material in each sector, except for autocatalysts.

The second largest use for palladium is in dental alloys, orthodontic devices and prothodontic devices. Other industrial uses for palladium include industrial catalytic applications, pharmaceutical and nitric acid production, petroleum refining, and jewellery. Autocatalysts were described above in the section on platinum.

Rhodium Consumption

Unlike platinum or palladium, Japan does not dominate the much smaller rhodium market. Both North America and Western Europe consumed more rhodium than Japan in 1991. Autocatalysts account for over 80% of rhodium consumption in market economy countries.

The net 1992 rhodium demand of 10.4 t was estimated by Johnson Matthey at 36% in both North America and Western Europe, 19% in Japan, and 9% in other countries.

Small amounts of rhodium were used in the chemical, electrical and glass industries. In these applications, rhodium is used with other PGMs to produce an alloy with enhanced physical or catalytic properties.

In November 1992, Tohoku Electric Power Co. Ltd. and Hitachi Ltd. announced the development of a rhodium-manganese catalyst. The new catalyst can be used to convert carbon dioxide to methane at nearly 100% efficiency compared to efficiencies of 80% for conventional catalysts, but even at prices of $2000/oz for rhodium, the catalyst was uneconomic for use in steam power plants.

Consumption of Other PGMs

Ruthenium and iridium demand is much lower than the demand for platinum or palladium. Estimated demand in 1992 for ruthenium was 6.4 t, or about two thirds of rhodium demand. Estimated demand in 1992 for iridium was about 1.2 t, or about 12% of rhodium demand.

The main applications for ruthenium and iridium are in the chemical and electrical sectors. Ruthenium has important applications in the electrical, chlorine, and caustic soda industries. Iridium is used in the chemical industry to produce sodium chlorate, chlorine, and rare earth crystals. In this latter application, iridium crucibles are used to grow the crystals that are used in lasers and other electronic applications.

MARKETS AND PRICES

The average annual prices of the major PGMs for the past three years were:

	1990	1991	1992
		(US$/troy oz)	
Platinum	471	376	360
Palladium	115	88	88
Rhodium	4 463	3 918	2 466
Iridium	307	283	158
Ruthenium	61	55	29
Osmium	416	400	400

Source: Metals Week.

Table 4 shows average monthly prices for the three major PGM metals for the past three years. Figures 1 and 2, respectively, show the daily London a.m. fix for platinum and palladium prices in 1991 and 1992. Figure 3 shows a longer-term view of daily platinum prices from 1986 to 1992.

Platinum's twin price peaks in dollars of the day were in March 1980 and September 1986. In March 1980, platinum prices averaged $760/oz on the New York Mercantile Exchange. For the same month, the average price of palladium was $230/oz on the Mercantile Exchange. For comparison, Handy and Harman's average monthly prices for gold and silver were $554/oz and $24.13/oz respectively. In September 1986, the average monthly London p.m. fixes for platinum and palladium were $603/oz and $142/oz, while Handy and Harman's prices averaged $419/oz and $5.68/oz respectively for gold and silver.

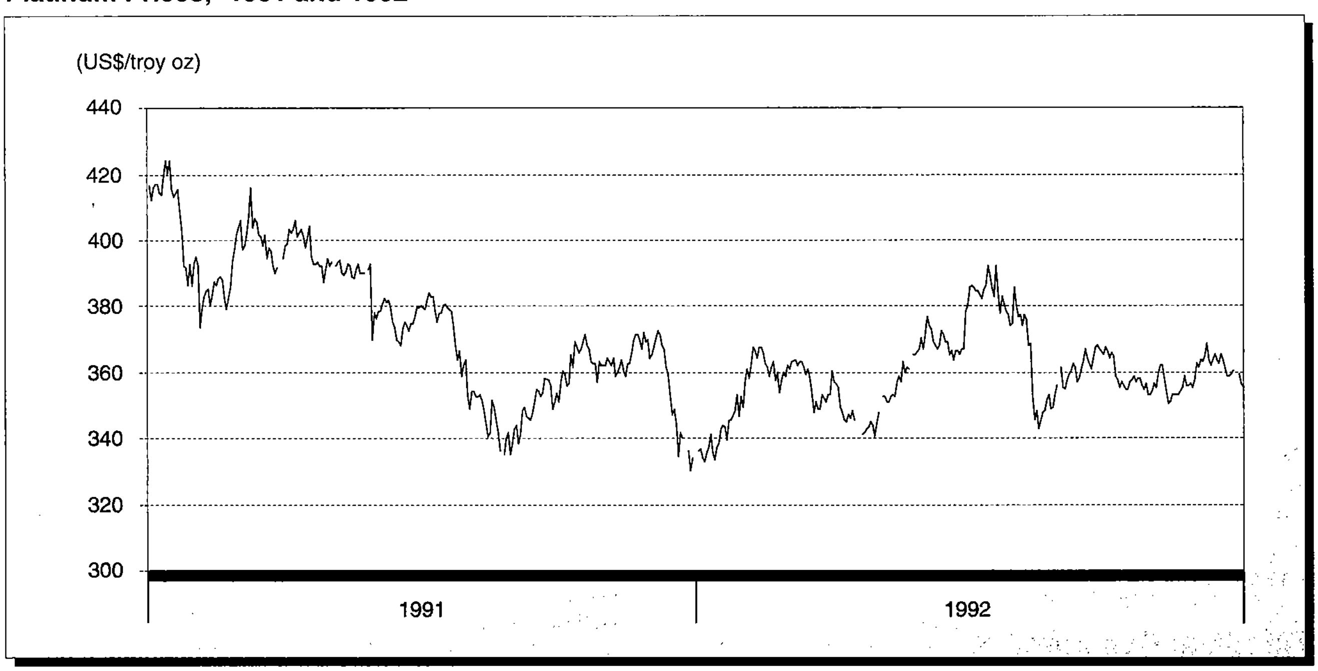
Both 1991 and 1992 were marked by events that threatened the stability of the PGM market. Upward pressures on prices came from strikes, political uncertainty, economic problems in Russia, and cutbacks by nickel producers. Counterbalancing this were announcements of new autocatalysts, declining car sales, a sustained recession, and economic problems in Japan, the largest consumer of PGMs. It appeared that the market participants became inured to frequent alternating bearish and bullish news.

South Af.ica and Russia together produce over 90% of the world's primary platinum, palladium and rhodium supplies. Events that would threaten the stability of these two politically metastable producers strike fear into the hearts of PGM consumers and support increased prices. During 1991 and 1992, South Africa moved towards a more participatory government and the U.S.S.R. dissolved into independent republics.

By the end of 1992, lower nickel prices resulted in production cutbacks by both Russian and Canadian nickel producers who produce by-product PGMs. While these production cutbacks were taking place, the market became increasingly convinced that the Russian PGM stockpiles had been largely liquidated.

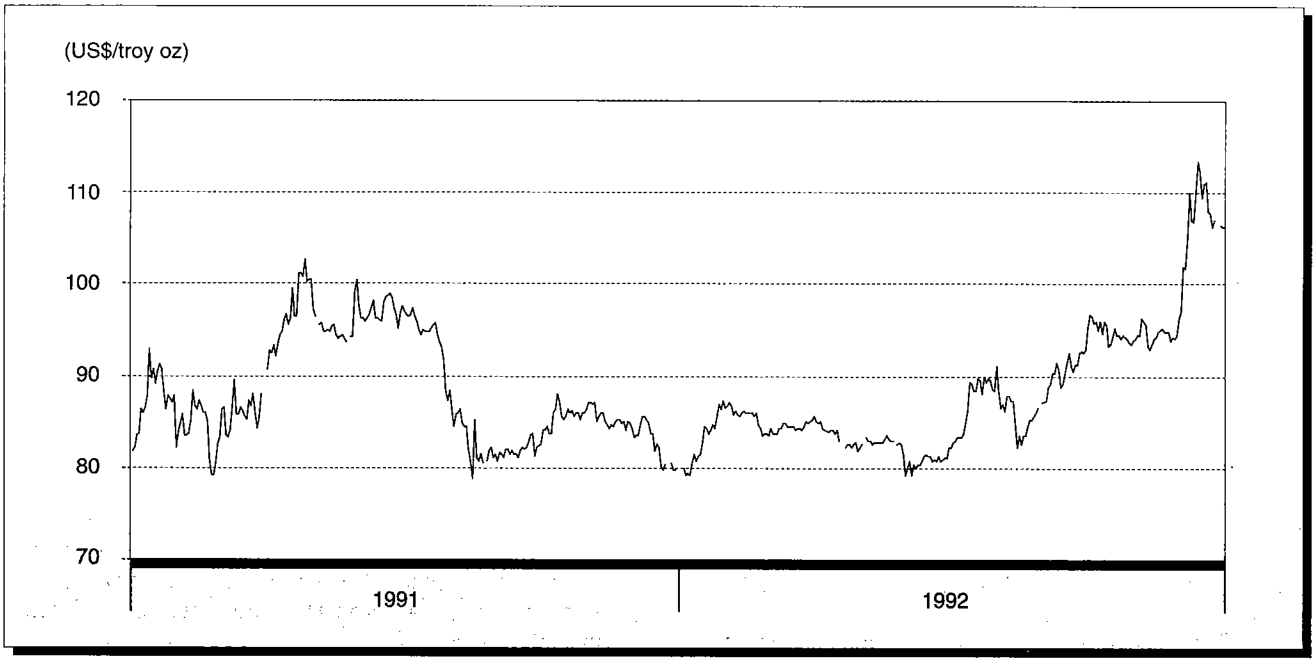
Offsetting the upward pressures on prices was the dismal news from consuming sectors. Not even a U.S. election provided the sought-after economic stimulus. Automobile sales, which account for over one quarter of PGM consumption, continued to

Figure 1
Platinum Prices,[1] 1991 and 1992



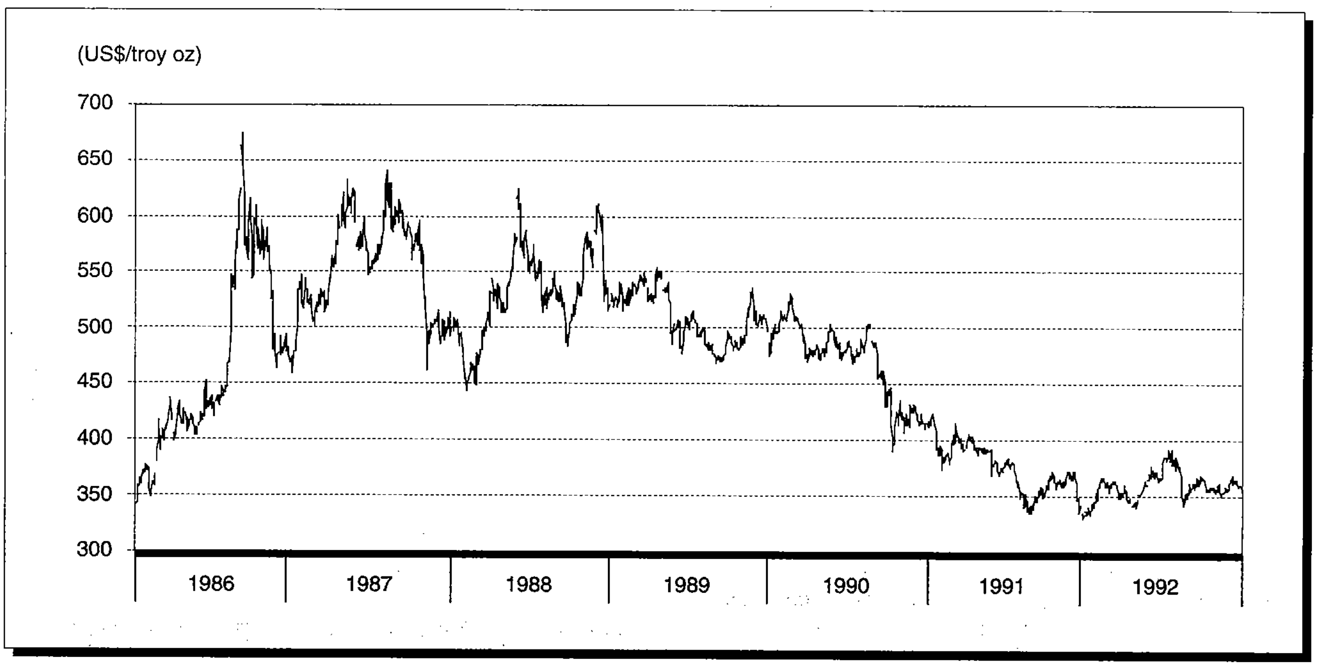
1 Morning fix.
SOURCE: London Bullion Market Association.

Figure 2
Palladium Prices,[1] 1991 and 1992



1 Morning fix.
SOURCE: London Bullion Market Association.

Figure 3
Platinum Prices,[1] 1986-92



1 Reuters "Free Market" to 1988/89, then London Bullion Market Association morning fix.
SOURCES: Reuters; London Bullion Market Association.

decline in 1991 and 1992. During 1992, the expected economic recovery did not materialize and motor vehicle sales remained so low that autocatalyst manufacturers evidently drew down inventories of PGMs. With the advent of increased pollution control standards that required autocatalysts on all new cars, sales in Europe had been seen as a hopeful source of increased demand by PGM producers. But preliminary data for 1992 show sales were down.

With lower-than-expected sales continuing into 1992, automakers drew on accumulated inventory to meet some of their PGM needs. This compounded the weakness in consumption, further dampening prices.

Japan is the leading PGM market, with almost half of the world's industrial PGM consumption. As property and stock prices continued their decline, Japanese consumers turned to less expensive platinum jewellery; they also cut investment purchases of platinum by half to an estimated 6.8 t.

If Russian production cutbacks provided encouraging news for other primary PGM producers, then the continued high levels of Russian PGM exports more than offset this sentiment. While estimated Russian platinum exports declined 34.2 t in 1991 to 23.3 t in 1992, this level was still about twice the five-year average preceding the platinum export boom of 1990, and it continued to have a depressing influence on prices. While Russian exports of palladium declined only slightly from 66.9 t to 66.2 t, it was the second highest yearly export of Russian palladium. Meanwhile, rhodium exports from Russia declined to pre-1987 levels.

OUTLOOK

While Canadian PGM production is largely a function of nickel production, nickel producers can, over time, shift the PGM-to-nickel ratio. Canadian PGM production is forecast to rise to 12 t in 1993 with the expected start-up of Lac des Îles, and then increase to a level of about 16 t/y over the period 1995-2000.

A large proportion of PGM production is produced as the by-products of other metals. Production from Canada and Russia is less sensitive to PGM prices than production from the United States or South Africa. In some applications, such as autocatalysts, demand is fairly price-insensitive in the short to medium term. To manufacture an autocatalyst that contained about 1.5 g of platinum and 0.3 g of rhodium, an automaker would have had to pay about $40 for the PGMs, based on average 1992 prices. Since this catalyst was essential, PGM demand for autocatalysts is fairly insensitive to price in the short term.

PGMs are more susceptible to substitution in applications other than autocatalysts. Other metals can substitute for PGMs in certain catalytic or electronic applications. These industrial applications are more immediately threatened with substitution when PGM prices increase. Jewellery and investment purchases are more sensitive to prices, although this sensitivity is tempered by investors loath to take a loss when prices decline sharply, and by those with sentimental attachment to jewellery.

With a potential for supply disruption in South Africa and Russia in the short-to-medium term, the possibility for spectacular price increases cannot be ruled out. In the event of major supply disruptions, speculative demand would compound price rises as no other producers have the capacity to fill a void left by severe shortfalls in Russian or South African production.

The demand for PGMs in the short term will depend largely on the level of industrial activity in Europe, the United States and Japan. Increased demand leading to an orderly price rise, if sustained, could lead to the re-opening of South African mines presently on stand-by. It is doubtful if by-product producers would react to significant price rises, except to increase recoveries or to increase recycling.

In contrast, the secondary market for PGMs has the potential to react more quickly to supply and demand changes. This ability could be compromised by regulations that treat used autocatalysts and other secondary forms of PGMs as hazardous wastes. While the Basel Convention has the potential to seriously disrupt international trade in certain secondary PGMs, the bulk of the secondary PGM trade amongst 23 of the countries of the Organization for Economic Co-operation and Development (OECD) is covered by a March 1992 OECD Decision. This decision established a mechanism for the control of transfrontier movements of secondary metals and other recyclables. PGM scrap and spent catalysts were listed as "green" materials. Such materials will normally trade as commercial goods unless individual members of the OECD direct otherwise.

Automobile sales did not recover in 1992 as PGM producers (or automakers) had hoped. Even with a modest recovery in sales in the United States, 1992 sales were one million units below the 1990 level.

Domestic sales (millions of vehicles) in the three major markets were:

	1991	1992e
United States	12.3	12.9
Japan	7.5	7.0
Western Europe	13.4	13.4

e Estimated.

Autocatalysts should remain a dependable market for PGMs in the medium-to-long term. The market for emission control technology will grow as vehicle numbers increase and emission limits are decreased. There were about 430 million motor vehicles worldwide in 1992 and, by the end of the century, the number is expected to exceed 500 million. Since it is likely that gasoline engines will continue to be used in most motor vehicles, the use of PGMs (especially platinum and rhodium) in autocatalysts will remain a secure demand. One can expect some increased efficiencies in PGM use in autocatalysts but, as of yet, no substitutes appear to be sufficiently advanced to threaten PGM use in autocatalysts. There is room for inter-PGM substitution as low lead and low sulphur levels in gasoline permit substitution of platinum by palladium in some catalysts.

However, as the use of autocatalysts becomes more widespread, increasing amounts of PGMs are recovered from scrapped vehicles. Once the population of vehicles equipped with PGM catalysts is sufficiently widespread, then the rate of demand increase for primary PGMs will slow. Primary PGMs will only be needed to make up for losses in recycling, for net new internal combustion vehicle registrations, and for increased PGM loadings per vehicle to meet new standards.

PGM recovery from autocatalysts is becoming less dependent upon metal prices. Even if PGM prices were to be very low, their recovery from autocatalysts should increase due to the restrictions on disposal in landfills. Future recovery of PGMs, if not economic for the metal values, will be supported by environmental considerations. Therefore, autocatalysts will become a less important market for primary PGMs, and will especially affect rhodium prices. Eventually, as ZEVs become more widespread, fewer catalysts will be required on automobiles. While the fuel cell has the potential to become the power source for ZEVs, so do many other competing technologies such as lead-acid batteries, the aluminum battery, nickel hydrides, and others.

With the change in the world's economy to low inflation, hedges against inflation have become less appealing. Yen prices of platinum have declined, making it less expensive for the Japanese to invest in platinum. But the declining prices have made platinum a poor investment for those who bought at much higher prices.

A very large above-ground inventory of platinum exists that could be mobilized by a spectacular price rise. As is the case with silver, when prices rise above certain levels, despite the potential for further price increases, temptation results in even heirlooms being brought in for melting. Since 1980, the estimated cumulative investment sales total over 120 t of platinum, or about one year of current demand. Jewellery sales since 1980 represent an estimated reservoir exceeding 400 t, or over three years of current demand.

Price Outlook

Due to the narrow production base of PGMs, volatile prices are more likely than with the industrial metals, such as copper. Assuming that events in Russia and South Africa permit producers to continue normal operations, then, on average, platinum is expected to oscillate at a level of about US$385/oz in constant dollars, or a value that keeps up with the rate of inflation until the end of the century. Assuming an average annual inflation rate of 3%, average platinum prices would reach $500/oz by the year 2001 in money of the day. In 1993/94, prices are expected to rise above this trend line if car sales increase and automakers are forced to restock inventories.

If palladium prices rise to levels of $150-$200/oz, its use in the dental and electronics industries becomes strikingly vulnerable to substitution. Already, silver has been increasingly attractive in some electrical applications due to its continued relatively weak price (averaging US$3.95/oz in 1992).

With autocatalysts accounting for 80% of demand, the outlook for rhodium is tied to autocatalyst technology and motor vehicle sales. With relatively low production and demand volumes, rhodium can be expected to continue to display greater price volatility than platinum or palladium.

The longer the period over which platinum and palladium prices stagnate, then the greater the incentive is for past speculators and investors to liquidate holdings. If central banks continue to sell gold reserves and inflation remains low, a stable gold price would depress platinum prices and, to a lesser extent, palladium prices. The considerable above-ground stocks of platinum in jewellery and investment purchases would pose an additional challenge to prices under such circumstances.

The world's PGM production comes as a "package" of PGM metals. Increased demand for one of these metals, preferentially to the others, can be accommodated slowly but, in the shorter term, price increases for one metal will result in increased supply of the other PGMs.

While long-term prices will remain very sensitive to political events in South Africa and Russia, the long-term use of PGMs in autocatalysts is not expected to maintain past rates of growth. Recycling and changes in vehicle fleet sales to ZEVs or non-gasoline-powered vehicles will give rise to the possibility of drawdowns in the world inventory of autocatalysts, resulting in possible net additions to the available PGM supply.

Future challenges to the PGM industry will be to diversify markets, but PGMs will face more intensive competition for these new markets. The platinum industry actively promotes platinum use in jewellery. Success at promoting Japanese tastes in jewellery to other Asian markets could be very important in developing new markets. Offsetting this, relatively low gold prices will continue to pose a marketing challenge to promoters of platinum jewellery.

Other challenges will be posed to the industrial uses for PGMs. New technological developments, such as fuel cells, will require sustained efforts by those promoting platinum since there are competing technologies for low- and zero-emission energy production. Continued low silver prices will encourage more substitution away from PGMs in electrical applications. PGMs will always be required in an industrial economy, but they face increasing competition.

Notes: The author can be contacted through Internet (bmccutch@emr.ca) or Bitnet (bmccutch@emrcan.bitnet). Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada			United States	EEC	Japan[1]
		MFN	GPT	USA	Canada	MFN	MFN
26.16	Precious metal ores and concentrates						
2616.90.00.30	Platinum group	Free	Free	Free	Free	Free	Free
71.10	Platinum, unwrought or in semi-manufactured forms, or in powder form						
	Platinum						
7110.11	Unwrought or in powder form	Free	Free	Free	Free	Free	Free
7110.19	Other	Free	Free	Free	Free	0.9%-4%	Free-4%
	Palladium						
7110.21	Unwrought or in powder form	Free	Free	Free	Free	Free	Free
7110.29	Other	Free	Free	Free	Free	2%	Free-4%
	Rhodium						
7110.31	Unwrought or in powder form	Free	Free	Free	Free	Free	Free
7110.39	Other	Free	Free	Free	Free	2%	Free-4%
	Iridium, osmium and ruthenium						
7110.41	Unwrought or in powder form	Free	Free	Free	Free	Free	Free
7110.49	Other	Free	Free	Free	Free	2%	Free-3.7%
71.12	Waste and scrap of precious metal or of metal clad with precious metal						
7112.20	Of platinum, including metal clad with platinum but excluding sweepings containing other precious metals	Free	Free	Free	Free	Free	Free
71.15	Other articles of precious metal or of metal clad with precious metal						
7115.90.10.20	Crucibles of platinum	Free	Free	Free	Free	4.4%-5.1%	3.7%
7115.90.90.90	Other	11%	7%	Free	1.2%-1.6%	4.4%-5.1%	3.7%

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States 1992; Official Journal of the European Communities, Vol. 35, No. L268, 1992, "Conventional" column; Customs Tariff Schedules of Japan, 1992.

[1] GATT rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. PLATINUM METALS, SHIPMENTS AND TRADE, 1990-92

Item No.		1990		1991		1992p	
		(kilograms)	($000)	(kilograms)	($000)	(kilograms)	($000)
SHIPMENTS[1]	Platinum, palladium, rhodium, ruthenium, iridium	11 123	189 423	11 123	150 155	10 505	117 099
EXPORTS						**(Jan.-Sept.)**	
2616.00	Precious metal ores and concentrates						
2616.90.83	Platinum metals group content						
	United Kingdom	10 246	135 259	7 921	108 876	7 041	72 840
	United States	76	514	–	–	–	–
	Total	10 323	135 773	7 921	108 876	7 041	72 840
7110.11	Platinum unwrought or in powder form						
	United States	97	905	6	97	144	2 802
	Hong Kong	125	2 058	321	4 565	169	2 332
	Switzerland	31	558	41	586	–	–
	Japan	410	9 210	6	81	–	–
	Other countries	–	1	21	371	–	1
	Total	663	12 732	395	5 700	313	5 135
7110.19	Platinum in other semi-manufactured forms						
	Portugal	31	587	–	–	69	944
	United States	1	13	...	7	39	665
	Hong Kong	271	4 981	102	1 298	–	–
	Australia	566	11 819	–	–	–	–
	Other countries	178	3 721	28	66	1	11
	Total	1 047	21 121	130	1 371	109	1 620
7110.21	Palladium unwrought or in powder form						
	United Kingdom	3 670	16 834	3 095	11 266	2 233	8 229
	United States	735	3 252	1 939	7 219	1 693	6 199
	France	311	1 342	560	2 206	454	1 676
	Hong Kong	–	–	24	75	313	1 006
	Other countries	1	3	2	9	...	2
	Total	4 717	21 431	5 620	20 775	4 693	17 112
7110.29	Palladium in other semi-manufactured forms						
	United States	237	1 154	21	118	33	174
	Portugal	94	430	–	–	47	157
	Singapore	17	5	10	8	9	10
	People's Republic of China	40	282	–	–	–	–
	Total	388	1 874	31	126	89	342
7110.31	Rhodium unwrought or in powder form						
	United States	25	596	1	58	–	–
	Total	25	596	1	58	–	–
7112.20	Waste and scrap of platinum; including metal clad with platinum, except sweepings containing other precious metals						
	United States	644	12 284	878	20 102	346	4 675
	Germany	–	–	14 246	1 852	3 560	1 314
	Japan	–	–	9 378	590	8 368	279
	United Kingdom	–	–	–	–	39	51
	Total	644	12 284	24 502	22 544	12 313	6 319
7115.90	Articles of precious metal or of metal clad with precious metal, n.e.s.						
	United States	41	409	30	300	68	684
	United Arab Emerates	–	–	–	–	27	25
	Saudi Arabia	–	–	–	–	2	8
	Costa Rica	–	–	11	413	–	–
	United Kingdom	6	3	168	49	–	–
	Other countries	98	60	16	83	...	2
	Total	145	472	225	845	97	719

TABLE 1 (cont'd)

Item No.		1990 (kilograms)	1990 ($000)	1991 (kilograms)	1991 ($000)	1992p (kilograms)	1992p ($000)
IMPORTS							
2616.00	Precious metal ores and concentrates						
2616.90.00.30	Platinum group metal content						
	United States	60	1 489	3	30	4	52
	Germany	–	–	–	–	55	1 322
	Total	60	1 489	3	30	59	1 375
7110.11	Platinum unwrought or in powder form						
	South Africa	782	13 403	986	13 336	609	8 259
	United States	664	12 333	366	5 106	259	4 250
	U.S.S.R.	–	–	113	1 450	277	3 849
	Switzerland	. . .	4	–	–	51	694
	Saudi Arabia	–	–	–	–	47	635
	United Kingdom	194	3 450	156	2 455	1	15
	Other countries	218	3 827	. . .	1	6	87
	Total	1 858	33 017	1 621	22 348	1 250	17 789
7110.19	Platinum in other semi-manufactured forms						
	U.S.S.R.	1 284	23 699	735	9 532	1 963	27 625
	United States	463	7 551	319	4 765	635	11 047
	Germany	42	597	65	863	93	1 233
	South Africa	–	–	–	–	47	874
	United Kingdom	421	10 595	690	9 233	32	421
	Other countries	76	1 472	47	632	14	105
	Total	2 286	43 914	1 856	25 025	2 784	41 305
7110.21	Palladium unwrought or in powder form						
	United States	93	615	156	544	285	852
	U.S.S.R.	62	242	–	–	119	419
	South Africa	–	–	62	215	31	97
	United Kingdom	468	1 876	59	231	3	19
	Other countries	29	237	. . .	1	. . .	2
	Total	652	2 970	277	991	438	1 389
7110.29	Palladium in other semi-manufactured forms						
	United States	753	6 015	878	6 501	546	4 300
	Germany	212	1 219	197	1 284	95	538
	United Kingdom	62	264	33	125	62	207
	Other countries	2	31	153	522	74	266
	Total	1 029	7 529	1 261	8 432	777	5 311
7110.31	Rhodium unwrought or in powder form						
	U.S.S.R.	126	15 128	121	16 936	86	8 681
	South Africa	69	12 466	104	11 117	88	7 300
	United States	107	8 978	15	972	25	2 615
	Germany	36	5 333	–	–	5	542
	Other countries	9	1 256	19	2 308	6	617
	Total	347	43 161	259	31 333	210	19 755
7110.39	Rhodium in other semi-manufactured forms						
	U.S.S.R.	14	1 871	–	–	17	1 367
	United States	. . .	14	13	308	17	1 248
	Germany	–	–	–	–	103	762
	United Kingdom	–	–	13	1 130	–	–
	Total	14	1 885	26	1 438	137	3 377
7110.41	Iridium, osium and ruthenium unwrought or in powder form						
	United States	1	10	. . .	1	2	18
	Other countries	1	1	–	–	3	8
	Total	1	11	. . .	2	5	27
7110.49	Iridium, osmium and ruthenium in other semi-manufactured forms						
	United States	14	182	45	519	4	38
	United Kingdom	–	–	1	13	–	–
	Total	14	182	47	533	4	38

TABLE 1 (cont'd)

Item No.		1990		1991		1992p	
		(kilograms)	($000)	(kilograms)	($000)	(kilograms)	($000)
IMPORTS (cont'd)							
7112.20	Waste and scrap of platinum, including metal clad with platinum but excluding sweepings containing other precious metals						
	United States	844 984	8 295	1 134 042	14 844	680 236	7 024
	Cuba	–	–	4 142	459	46	1 100
	Other countries	55 256	5 218	12 091	913	6 633	210
	Total	900 240	13 513	1 150 275	16 216	686 915	8 334
71.15	Other articles of precious metal or of metal clad with precious metal						
7115.90	Other						
7115.90.10.20	Crucibles of platinum						
	United States	503	20 090	818	36 258	542	18 218
	Other countries	4	119	–	–	. . .	3
	Total	507	20 209	818	36 258	542	18 221
7115.90.90	Other						
7115.90.90.30	Of platinum						
	United States	26	492	195	832	52	278
	Other countries	–	–	1	11	6	104
	Total	26	492	196	843	58	383

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified; p Preliminary.
[1] Platinum metals, content of concentrates, residues and matte shipped for export.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, PLATINUM METALS SHIPMENTS, 1980-92

	kilograms	$000
1980	12 776	159 088
1981	11 902	136 186
1982	7 105	82 253
1983	6 965	79 180
1984	10 369	133 467
1985	10 534	141 396
1986	12 190	193 730
1987	10 930	181 849
1988	12 541	190 914
1989	9 870	141 730
1990	11 123	189 423
1991	11 123	150 155
1992p	10 505	117 099

Source: Energy, Mines and Resources Canada.
p Preliminary.

TABLE 3. WORLD PRODUCTION OF PLATINUM GROUP METALS, 1988-91

	1988	1989	1990	1991e
	(kilograms)			
EUROPE				
Finland				
Palladium	106	100e	100e	100
Platinum	54	60	60e	60
Yugoslavia				
Palladium	142	199r	130r	120
Platinum	23	23r	21r	15
Total, Europe	325	382r	311r	295
AFRICA				
Ethiopiae				
Placer platinum	1	2e	2e	2
South Africa1,e				
Platinum	80 200	81 500	85 800	90 000
Palladium	34 400	35 800	38 300r	41 000
Other	17 000r	15 000r	15 800r	16 000
Total, South Africa	131 600r	132 300r	139 900r	147 052
Zimbabwe				
Palladium	46	43	31r	30
Platinum	28	25	21r	20
Total, Africa	131 675	132 370	139 954r	147 052
ASIA				
Japan				
Palladium	1 170	821	1 047r	1 053
Platinum	647	1 031	1 425r	988
Total, Asia	1 817	1 852	2 472r	2 041
AMERICAS				
Canada				
Palladiume	5 643	4 442	5 044	6 028
Platinume	5 393	4 244	4 829	4 384
Othere	1 505	1 184	1 336	548
Total, Canada	12 541	9 870r	11 209	10 960
Colombia				
Placer platinum	815r	973r	1 316r	1 550
United States				
Palladium	3 730	4 850	5 930	6 050
Platinum	1 240	1 430	780	1 730
Total, Americas	18 326	17 123	20 265	20 290
AUSTRALIAe				
Palladium	411r	400	400	400
Platinum	106r	100	100	100
Total, Australia	517r	500	500	500

TABLE 3 (cont'd)

	1988	1989	1990	1991e
		(kilograms)		
EASTERN COUNTRIES				
U.S.S.R.e				
Platinum	32 000	32 000	31 000	30 000
Palladium	85 000	85 000	84 000	82 000
Other	10 500	10 500	10 000	9 500
Total, Eastern countries	127 500	127 500	125 000	121 500
Total, world	280 160r	279 727r	288 502r	291 678
of which platinum	120 507	121 388	126 384	128 849
of which palladium	130 648	131 655	134 982	136 781
of which other PGMs	29 005	26 684	27 136	26 048
% platinum	43	43	44	44
% palladium	47	47	47	47
% other PGMs	10	10	9	9

Source: International Consultative Group on Nonferrous Metal Statistics, July 1992.
e Estimated; r Revised.
1 Includes osmiridium produced in gold mines.

TABLE 4. PRICES, MAJOR PGMs,[1] 1990-92

	Platinum			Palladium			Rhodium		
	1990	1991	1992	1990	1991	1992	1990	1991	1992
					(US$/troy oz)				
January	498	408	342	135	87	83	2 067	5 448	1 882
February	516	367	362	135	84	85	2 117	5 399	2 659
March	497	400	357	130	86	84	2 079	5 309	2 862
April	478	397	348	127	97	83	2 116	5 159	2 905
May	488	389	359	119	95	83	2 338	4 259	2 746
June	481	376	369	115	97	81	3 062	3 862	2 582
July	479	376	383	117	95	87	5 287	3 767	2 649
August	492	347	360	115	83	85	5 154	2 958	2 518
September	461	349	362	105	82	91	5 364	2 923	2 396
October	425	362	358	95	85	95	4 827	2 768	1 989
November	422	365	356	90	85	94	4 512	2 386	1 942
December	421	357	363	90	83	107	4 888	1 775	1 834
Year	471	376	360	115	88	88	4 463	3 918	2 414
High	532	424	392	138	102	114	5 365	5 454	3 025
Low	394	332	331	82	78	78	2 067	1 775	1 825

Source: Metals Week.
1 Platinum and palladium prices are averages of the London afternoon fixes; rhodium price is the Dealer Mean Price.
Note: Rounded to nearest dollar.

Potash

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World Overview

World production of potash in 1992 dropped 8.5% to 23.9 Mt in K_2O equivalent compared to 26.1 Mt in 1991. Most of the decline occurred in the former Soviet Union (FSU) and in Germany; production decreased in most other producing countries with few exceptions. The reduction in world potash production was in response to a lower demand for fertilizer potash, which accounts for 95% of overall potash sales, the persistence of severe economic conditions that prevailed in Central Europe and in the FSU, and the decline in agricultural subsidies in key consuming areas such as Western Europe, India and Brazil.

In 1992, potash supply capability continued to exceed world demand; several producers reduced their output to achieve a better balance between potash supply and demand. As in the past, inventory shut-downs occurred in Canada, both in Saskatchewan and New Brunswick, but were also reported in the United States, Germany and the Middle East. On an annualized basis, Canadian mines ran at close to 60% of capacity in 1992 (62% in 1991) while other major world producers (excluding the FSU, which operated at less than 58% in 1992), operated at 80%-95% levels. Lower output prevailed in the FSU, Germany, North America, Latin America and the Middle East. Capacity was curtailed in Germany, Belarus and Russia, while some expansions occurred in China, Chile and the United Kingdom.

Several events figured predominantly during the year which affected current and future potash supply. These include the announcement of a major restructuring and rationalization plan late in December for former East and West German mines; the announcement of a joint China-Israel potash project for the development of a new 800 000-t/y KCl mine in China for completion by 1998; and the conclusion of major one-year trade agreements between several U.S. potash producers and Potash Corporation of Saskatchewan Inc. for exporting U.S. potash to offshore markets.

During the year, the intensifying competition from FSU products created major disturbances in the marketplace; shipments from the FSU were aggressively priced in all major markets and displaced traditional suppliers in key countries such as India and China. In 1992, potash producers in the FSU faced a falling demand in their domestic market and pursued efforts to increase their exports in a drive to earn hard currencies. Lower-priced potash sales from the FSU resulted in more competition amongst exporters, lagging negotiations between suppliers and buyers, and downward pressures on prices. Anti-dumping measures against FSU potash imports were initiated in Western Europe while, by the end of 1992, U.S. potash producers were contemplating filing dumping charges.

World potash consumption declined significantly in 1992 to 23.6 Mt K_2O, despite stronger demand for potash in the United States. The most important event that affected world potash demand in 1992 was the termination of potash subsidies and controls on prices and distribution by the Indian government. In 1991, India was the third largest potash-importing country in the world with imports close to 1.4 Mt K_2O. In September, the Indian government decontrolled domestic prices and the distribution of potash fertilizers, which caused prices to soar and potash imports to drop. Later in the fall, the government readjusted its policy and provided short-term support to potash purchases, but the overall impact was a drop in India's potash consumption for the whole year. In other markets, the situation in 1992 was mostly a continuation of what prevailed in 1991. The demand for potash continued to remain depressed in the FSU and Central Europe, as these areas were plagued by severe economic conditions, which led to the removal of subsidies, a lack of credit, and high prices for fertilizers. In Western Europe, the demand for potash continued to slide as new agricultural policies affecting the future level of subsidies and planted acreages led to a decline that will likely continue for the foreseeable future. In 1992, deteriorating farm incomes and adverse weather conditions affected European consumption of potash. In Asia, potash demand had a mixed review for 1992. Potash consumption in China, Japan and Indonesia was reported steady; however, in China, delays in the allocation of credit for potash imports and competition between foreign suppliers resulted in China modifying its sourcing of potash from traditional suppliers. Canada's exports to China dropped by half, while the FSU's share almost doubled. In Latin America, demand for potash improved in Brazil, recovering from the weak consumption level of 1991.

In the United States, potash fertilizer demand was strong during 1992. The spring planting season was excellent as increases in planted acreage, coupled with favourable weather, led to an increase in the rate of fertilization and in potash consumption. Record yields were achieved for corn, soybean and wheat. In the fall, weather conditions were less favourable and weaker levels of potash consumption were reported. At the beginning of 1992, prices showed a relative stability, but a strong demand for potash in the spring resulted in higher quotations; in the fall, prices in the United States started to fluctuate downward, leading to a slight decline in quotations by the end of 1992.

CANADIAN DEVELOPMENTS

In 1992, Canadian mine production decreased 2% from 7.40 Mt to 7.25 Mt K_2O; declines in potash output were registered both in Saskatchewan and in New Brunswick, with the latter accounting for 15% of total Canadian production. Canadian potash shipments declined to 7.0 Mt K_2O; lower offshore sales were only partially offset by stronger exports to U.S. markets. Total sales were estimated at $917 million, compared to $932 million in 1991. Canadian inventories rose by about 0.2 Mt to 1.78 Mt K_2O.

At the end of 1992, Canadian potash productive capacity was estimated at 12 Mt/y K_2O, a level that could sustain an operating rate of 95% on an annual basis. The capacity figure was upgraded from 11.8 Mt/y in accordance with improvements that were implemented in several potash operations during the last three years. Of this capacity, close to 1.2 Mt/y K_2O could be considered dormant with idle milling units at the Cory and Lanigan operations. It is believed that such facilities could be reactivated in a relatively short period of time. Of the total Canadian capacity, New Brunswick accounts for 1.28 Mt/y K_2O.

In 1992, mine shut-downs amounted to 118 mine-weeks, of which 95% occurred in Saskatchewan; Potash Corporation of Saskatchewan accounted for 60% of these temporary closures. Potash operations were mostly shut down during the third quarter of 1992, when shut-downs totalled 50.5 mine-weeks.

In 1992, the average unit value of potash shipped by Canadian producers was computed at C$80.31/t KCl (f.o.b. mines), unchanged from 1991. For the first nine months of 1992, the average unit value of exports on the basis of port of exit (e.g., Vancouver or Saint John, or a border crossing to the United States) was C$112.51/t KCl; for the same period in 1991, that value was $116.54/t. For the first nine months of 1992, potash exports totalled 8.31 Mt KCl valued at C$935 million.

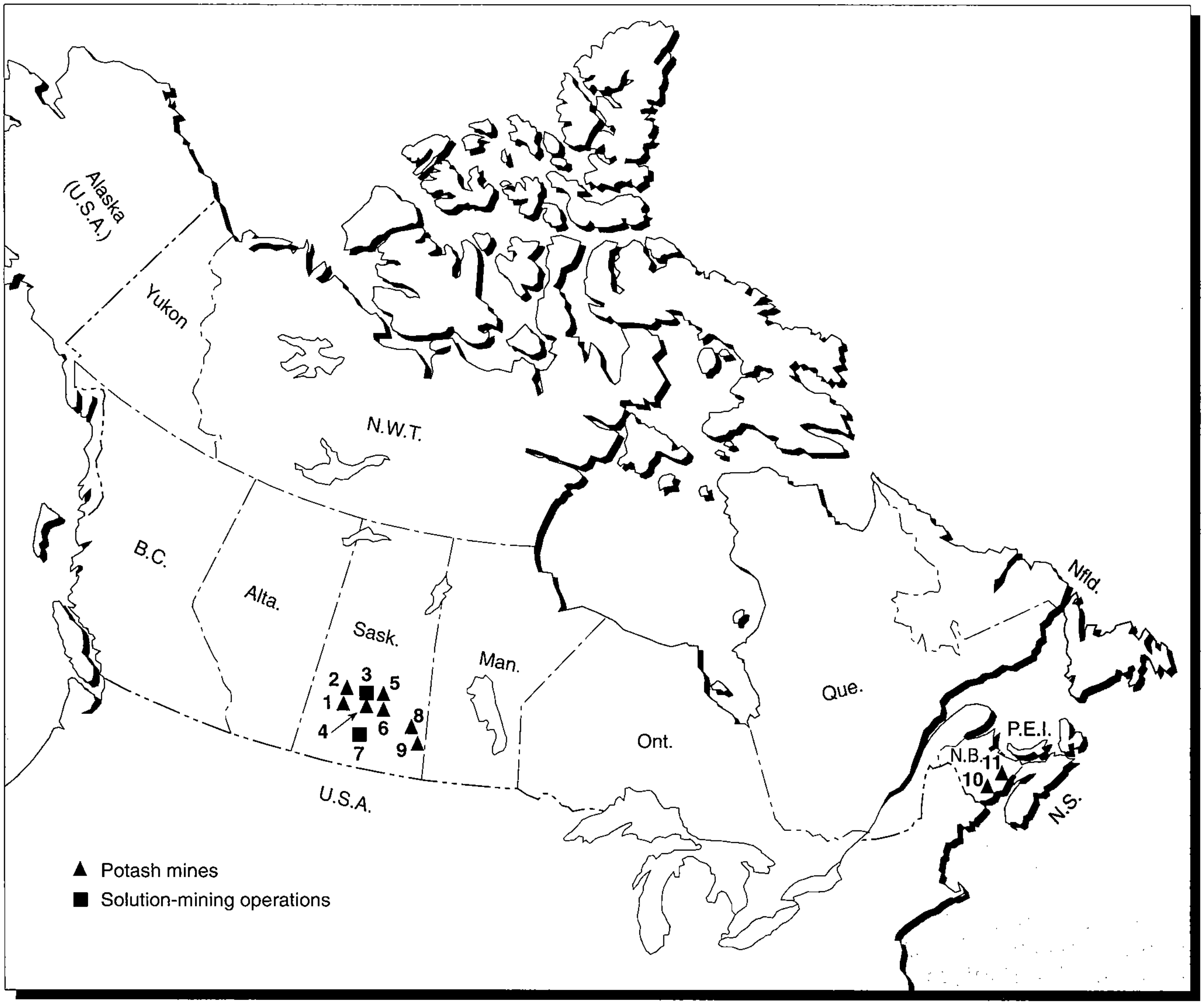
According to the Canadian Fertilizer Institute, the Canadian potash industry (except for one producer) reported a net profit, after taxes and interest, of $137.1 million in 1991 compared to $87.2 million in 1990. Sales rose 6% between 1991 and 1990. Profits in 1992 were expected to be slightly higher due to improved netbacks from export sales caused by an increase in offshore prices and a decline in the Canadian dollar during the year.

Saskatchewan

Saskatchewan produced about 85% of Canada's potash in 1992. During the year, several temporary shut-downs were called by mine operators in Saskatchewan for maintenance, vacation and, mostly, for inventory control.

Potash Corporation of Saskatchewan Inc. (PCS) is the largest publicly held potash producer in the world. In 1992, PCS operated four mines in Saskatchewan. Potash production from all of PCS's operations, including tonnage from International Minerals & Chemical Corporation (Canada) Limited, was estimated at 3.9 Mt KCl, a 2.5% decrease over 1991. During the year, PCS concluded several agreements with U.S. potash producers in New Mexico. PCS Sales Ltd., a wholly owned subsidiary of PCS, is to be the exclusive offshore sales representative for Horizon Potash Corp., Mississippi Chemical Corp., New Mexico Potash Corp., and Eddy Potash Inc. In December, the Province of Saskatchewan's shareholding in PCS was reduced from 38% to 11% after close to 10.5 million shares of PCS retained by the province were converted by public investors from Potash Ownership Bonds, which matured on December 1, 1992. In 1992, the PCS Cory operation near

Figure 1
Location of Potash Mines and Operations in Canada, 1992



Numbers refer to locations on map above.

Potash Mines

1. Cominco Ltd.; Vanscoy, Saskatchewan
2. Potash Corporation of Saskatchewan Inc., Cory Division; Saskatoon, Saskatchewan
4. Potash Corporation of Saskatchewan Inc., Allan Division; Allan, Saskatchewan
5. Noranda Minerals Inc., Central Canada Potash Division; Colonsay, Saskatchewan
6. Potash Corporation of Saskatchewan Inc., Lanigan Division; Lanigan, Saskatchewan
8. International Minerals & Chemical Corporation (Canada) Limited; Esterhazy, Saskatchewan
9. Potash Corporation of Saskatchewan Inc.; Rocanville, Saskatchewan
10. Potacan Mining Company; Sussex, New Brunswick
11. Potash Company of America (a Division of Rio Algom Limited); Sussex, New Brunswick

Solution-Mining Operations

3. Potash Company of America (a Division of Rio Algom Limited); Saskatoon, Saskatchewan
7. Kalium Canada, Ltd.; Belle-Plaine, Saskatchewan

Saskatoon continued to recover small quantities of calcium chloride-rich brine from mine inflows; the brine, containing 28% calcium chloride, is being marketed locally for dust suppression on gravel roads. In 1992, PCS had 5.65 Mt/y K_2O of installed capacity, or 9.27 Mt/y KCl at 60.9% K_2O equivalent, corresponding to 47% of the potash production capacity in Canada. For 1992, PCS reported a net income of $58.2 million, a 29% improvement over 1991. Operating costs were $151 million, or $1 million higher than in 1991. In 1992, PCS sold 3.8 Mt of potash KCl, a 2% decline over last year. Its sales in North America rose 10% while offshore exports dropped 9.5%. Total revenues were $382.8 million, up 10% from 1991, reflecting stronger domestic sales, improved offshore prices, and a slight devaluation of the Canadian dollar.

Throughout 1992, PCS continued to pursue its policy of strict inventory control with intermittent shutdowns at all of its operations. In January, all of its mines were partially shut except for Allan, which was shut until mid-February; in March, the Rocanville mine shut down temporarily for four weeks, and in April the Lanigan operation was shut down, also for four weeks. As a countermeasure to weak sales to offshore markets, PCS called its summer shut-downs earlier; operations at Rocanville and Allan ceased in May while the summer shut-downs at all operations started in July and lasted until the first week of August. In past years, PCS had extended its summer shutdowns from July 1 to the first week of September. Late in the fall of 1992, PCS announced shut-downs at all of its operations for December; Rocanville and Lanigan shut-downs began in November.

International Minerals & Chemical Corporation (Canada) Limited (IMC Canada), which is wholly owned by IMC Fertilizer Group Inc., extracted potash ore from two interconnected underground mines, K1 and K2, at Esterhazy in southeastern Saskatchewan. In 1992, IMC Canada produced about 2.6 Mt KCl, of which close to 0.5 Mt was for PCS's account. Employment at the mines was reduced to 885 jobs, down from 916 jobs in 1991; close to 138 workers were dedicated to water inflow-related problems. Throughout 1992, both K1 and K2 operated on a 10/4 (working 10 days out of 14) schedule; maintenance and vacation shut-downs in the summer and winter equated to 6.5 mine-weeks.

During 1992, the K2 mine continued to experience water inflow problems; in December, water inflows increased dramatically to reach 7000 gallons per minute (gpm), compared to a rate of 3500 gpm that prevailed in past years. This new inflow level of 7000 gpm is the highest level recorded since 1985. The company has proceeded with its current practices of chemical grouting with calcium chloride in the "B block" mining panel. In the spring of 1992, IMC Canada submitted an Environmental Impact Statement for a new replacement mine near Esterhazy. In June, the company received environmental approval from the Saskatchewan government to sink new shafts and to develop a satellite mine. The $400 million project encompasses a new 4.2-Mt/y KCl mine that would be located 8 km northeast of the existing K2 mine; present milling facilities at K1 and K2 will continue to be used. A decision from the parent company, IMC Fertilizer Group Inc., is expected in the near future.

Kalium Canada, Ltd. operates a large solution mine at Belle-Plaine, west of Regina. During 1992, the company produced 1.76 Mt KCl, a 1% increase over the previous year. Sales were also slightly higher. The plant shut down for one week during both February and July, and for two more weeks in November. The plant is set to run continuously, 24 hours per day, 365 days per year. At Kalium, by-product salt brine is shipped to the nearby salt evaporation plant, operated by Canadian Salt Co. Ltd., and some volumes of salt waste are dissolved and re-injected underground.

Central Canada Potash (CCP), a division of Noranda Minerals Inc., produced 1.0 Mt KCl in 1992. Potash is mined from the underground mine at Viscount, east of Colonsay. Shipments were slightly lower than those of last year; inventories were stable. The operation shut down for one week in January and for three weeks in the summer. In 1992, the company initiated the recovery of de-icing salt from its potash process; the volume of salt recovered is estimated at close to 100 000 t/y.

Cominco Ltd. produced 0.95 Mt KCl in 1992 at its Vanscoy mine, a 6% reduction over 1991. The operation ran on a seven-day-per-week schedule throughout the year except for three weeks in January and five weeks in the summer. Nu Salt Corp. recovered some salt from the tailings to sell as a de-icer in local markets.

Potash Company of America (PCA), a division of Rio Algom Limited, extracts potash by solution from its old underground mine that flooded in 1987. The potash extraction process involves the pumping of diluted brine down into the mine for dissolving in-situ potash ore and the recovery of concentrated brine into surface cooling ponds that cover more than 130 acres. During periods of cold temperature, the potash in the brine precipitates at the bottom of the ponds where it is dredged; the potash material is then processed by crystallization and compaction to produce crystalline standard and coarse grades. In 1992, the mine produced about 280 000 t of KCl. Also during 1992, the company had its summer shut-down, which lasted from June until the first week of October.

Big Quill Resources Inc. produced potassium sulphate from sodium sulphate brine from Big Quill Lake and from potash supplied by Potash Corporation of Saskatchewan. The operation, formerly owned by PCS, was purchased last year by former PCS employees. The plant located in Wynyard will be expanded from 3500 t/y to 7000 t/y K_2SO_4. Potassium sulphate products were used in the chemical and wallboard sectors.

New Brunswick

In New Brunswick, potash was mined at two underground operations located in the Sussex area in Kings County.

Potash Company of America (PCA), a division of Rio Algom Limited, operates the Penobsquis underground mine, also referred to as the Plumweseep mine, about 5 km east of Sussex. In 1992, production was about 670 000 t of KCl, a similar level to that of 1991. In 1992, RTZ Corp Plc of London (England) sold its 51.5% equity in Rio Algom Ltd. for US$362.3 million; the change in Rio Algom's ownership did not affect PCA. The mine operated throughout the year at high capacity but was shut down for 2.5 weeks in July and 1 week in late December. It operates on a seven-day-per-week schedule. Common salt is also co-produced at an annual rate of 400 000 t and is sold commercially through a sales agent as de-icing material on North American markets.

Potacan Mining Company (PMC), the former Denison-Potacan Potash Company, produced 1.1 Mt KCl in 1992, a 5% decrease over 1991. The company extracts potash at the Cloverhill mine located 20 km southeast of Sussex. Since 1991, PMC has been owned by Potash Company of Canada Limited, which in turn is owned jointly by Entreprise Minière et Chimique (EMC) of France, and Kali und Salz AG of Germany. In early December 1992, PMC temporarily laid off its contract workers due to some weakness in sales; later in the month, the whole operation was shut down for eight days.

In 1992, the New Brunswick government recovered the mineral rights of the Millstream potash deposit from BP Canada Inc., formerly BP Resources Canada Ltd. The company had held the mining rights since 1980. The deposit, located 10 km east of Sussex in Kings County, has proven reserves estimated at 256 Mt grading 20.6% K_2O, at depths ranging between 950 and 1050 m.

In New Brunswick, potash products for export are hauled 60-80 km from the Sussex area to the Barrack Point potash terminal in Saint John. The terminal, which is operated by Furncan Marine under contract with PCA, has a storage capacity of 165 000 t of potash. The shipping port, equipped with a 2700-t/h shiploading facility, can accommodate cargo sizes between 3000 and 50 000 t.

Manitoba

In 1992, the Manitoba Potash Corporation, held 51% by Entreprise Minière et Chimique (EMC) of France and 49% by the Government of Manitoba, continued its evaluation of a proposed 1.2-Mt/y K_2O potash mine near Russell at the Manitoba-Saskatchewan border. Completion of the project is contemplated for after the year 2000. Late in the 1980s, the mineable ore reserves were estimated at 165 Mt grading 24.5% K_2O; the average depth of potash horizons is about 850 m. EMC created a new subsidiary, Potamine Mining of Canada Inc., for managing its share of the project.

British Columbia

In British Columbia, a new potash handling system was commissioned in 1992 at Neptune Bulk Terminals (Canada) Ltd. The $26 million project included a new portal type scraper/reclaimer with a capacity of 3000 t/h and a new 100 000-t storage facility. At Vancouver Wharves, development projects that are being evaluated include a 150 000-t storage facility that would double the current mineral storage capacity, and a new railcar unloading system that would allow the terminal to increase its mineral throughput capacity by 29% to 9 Mt/y.

CANADIAN POTASH TRADE

Canada is the world's largest potash exporter with a 40% share of international trade. Germany is the second largest, followed by the former Soviet Union (FSU). Canada exports potash to more than 35 countries, although only 6 countries account for close to 80% of Canada's total exports of potash.

Canadian potash is shipped mostly to the United States (55%) and Asia (33%), with the remainder being sent to Latin America (6%), Western Europe (4%) and Oceania (2%). Exports to Europe and Africa originate mostly from New Brunswick, while shipments to Latin America come from both Saskatchewan and New Brunswick. Saskatchewan accounts for 90%, 90% and 88% respectively of Canada's exports to the United States, Oceania and Asia.

On a nine-month basis in 1992, data compiled by Statistics Canada indicate that potash exports were valued at C$935.1 million, with tonnages totalling 8.3 Mt KCl, a 5% increase compared to the same period the previous year. The United States remained the dominant destination with 5.2 Mt KCl, an 11% increase over last year. In the off-shore markets, sales to Asia were down, mostly due to reduced sales to China, overshadowing gains registered in India. Exports to South Korea, Japan and Indonesia were steady. Canada's exports to Asia accounted for 26% for the first nine months of 1992 compared to 33% for the same period in 1991. Shipments to Latin America rose slightly with higher sales to Brazil and new customers in Cuba, Martinique and Venezuela. Sales to Western Europe demonstrated some stability in 1992 with steady levels sold to Norway, Belgium and Denmark, and a decline in the United Kingdom; new sales to the Netherlands were reported. Exports to Africa were marginally lower compared to last year, while shipments to Oceania rose 30% with higher sales to both New Zealand and Australia.

INTERNATIONAL DEVELOPMENTS

World production of potash continued to decline for the fourth consecutive year to an estimated 23.9 Mt K_2O in 1992, compared to 26.1 Mt in 1991. Most of the 8.5% decrease was registered in the FSU. North America was the major producing region with a 37% share of world potash output, a 2% increase over last year. Canada contributed 30% to world production in 1992. The FSU was second with a 29% share, compared to 32% in 1991. Western Europe accounted for 24%, the same level as in 1991. (Germany's contribution dropped marginally from 15% to 14.5% in 1992.) The Middle East accounted for close to 9%, compared to 8% in 1991.

Americas

Argentina

Potasio Rio Colorado S.A. continued its work as project operator for the first phase in the development of a new 250 000-t KCl solution mine near Marlague in the southern Mendoza Province, 960 km south of Buenos Aires. The project, estimated at US$60 million, is due for completion by the end of 1994.

Potash reserves in Argentina have been estimated at 75 Mt of sylvinite grading 25% K_2O at depths ranging between 700 and 1300 m. During the first nine months of 1992, solution mining was tested on a cavity at a depth of some 1100 m and brine was directed to a solar pond for potash and salt precipitation. In 1993, further tests will be carried out to complete the feasibility study, which represents phase one of the project. Phase two of the project consists of the construction and commissioning of extraction and processing facilities.

Brazil

Following the settlement for a 25-year lease of the Taquari-Vassouras mine in the Sergipe District of Brazil between the government-owned oil and gas company Petrobas and the state-owned mining company, Comphania Vale do Rio Doce (CVRD), late in 1991, the new operator (CVRD) faced technical difficulties in 1992 and produced only half of its 1991 potash production; 1992 output was estimated at 45 000 t K_2O. CVRD reported that its 1992 earnings would reach US$30 million. The company has pursued its upgrading work at the mine in order to double its revenues in the medium term, when the mine would have reached a higher and acceptable production level. Potash reserves at the Taquari-Vassouras complex were estimated at 13 Mt K_2O. During 1992, CVRD also extracted close to 2000 t/m of by-product salt.

Chile

In 1992, Sociedad Quimica y Minera de Chile (SQM) acquired the interest of AMAX Inc. of the United States in the Minsal project. This project was initiated in 1986 by Sociedad Mineral Salar de Atacama Ltda (Minsal Ltda) for extracting potash and other salts from brines in the Atacama desert in northern Chile. SQM now has a 75% share in Minsal Ltda, with the remaining 25% being held by Corporacion de Fomento de la Produccion. The Minsal project calls for a total investment of US$80 million for a 300 000-t/y KCl potash operation; close to US$40 million will be for the construction of processing facilities. Exclusive rights for extracting lithium carbonate from the effluent brines were reportedly negotiated with a U.S.-based corporation. KCl and K_2SO_4 reserves were estimated at 47 Mt and 21 Mt respectively.

During 1992, Sociedad Chilena del Lithio Ltda (SCL), a Cyprus-Foote subsidiary, announced a small expansion for the recovery of potash in Salar de Atacama. Its potash capacity is to increase to 35 000 t/y K_2O by 1993. All potassic products produced by SCL are transported to a potassium nitrate plant operated by SQM Nitratos SA. Also in 1992, the company SQM Nitratos announced plans to invest US$7 million to increase its potassium nitrate capacity by one third to 300 000 t/y KNO_3 by the mid-1990s.

United States

Production in the United States in 1992 decreased 1.8% to 1.66 Mt K_2O, compared to 1.69 Mt in 1991. Total sales rose 1.4% to 1.67 Mt K_2O as gains in domestic markets (+2%) offset losses on potash exports (–2%). Inventories at year-end dropped 17% to 280 000 t K_2O. Based on an estimated production capacity of 1.98 Mt/y K_2O, the U.S. potash industry ran at 84% of its capacity, compared to 88% in 1991.

In the United States, potash is extracted in four states, of which New Mexico accounts for more than 85% of total U.S. potash production. In New Mexico, potassium chloride is mined by conventional underground mining methods at Eddy Potash Inc., Horizon Potash, IMC Fertilizers Inc., Mississippi Chemicals Corp., and New Mexico Potash Corp.; Western Ag-Minerals Co. mines langbeinite ore to produce magnesium-potassium sulphate. In Utah, Moab Salt Inc. extracts potassium chloride from brines, Great Salt Lake Minerals and Chemicals Corp. (GSL) exploits brines from the Great Salt Lake to produce potassium sulphate, and Reilly Industries Inc. extracts potassium chloride from near-surface brines. In California, North American Chemical Corp. produces potassium sulphate and potassium chloride at Searles Lake. In Michigan, Kalium Chemical Ltd. operates a pilot solution mining plant near Hershey to recover potassium chloride.

In 1992, GSL pursued development work at Little Mountain, Utah, to increase its production capacity of potassium sulphate by 180 000 t/y to 360 000 t/y K_2SO_4 by 1995. The US$20 million project includes the construction of dikes for expanding its solar evaporation ponds by 17 500 acres and the construction of brine tranfer systems. In February 1992, Horizon Gold Corporation purchased the 300 000-t/y K_2O potash operation of AMAX Potash Corp. in Carlsbad, New Mexico; the potash facilities are operated by Horizon Potash. PCS Sales Ltd., a U.S. subsidiary of Potash Corporation of Saskatchewan, negotiated a long-term agreement to serve as the exclusive sales agent for Horizon Potash for domestic and offshore sales. In November, Horizon Potash shut its potash operations for two months for inventory control; close to 275 workers were affected. In Utah and New Mexico, land use conflicts emerged between potash companies and oil and gas developers. Potash producers raised concerns regarding drilling activities near their operations. In Utah, Buttes Resources Company continued its prospective quest for partners in the development of a new potash mine near Moab. In the last quarter of 1992, Western Ag-Minerals Co. commissioned a new 100 000-t/y compaction plant for expanding its production of granulated magnesium-potassium sulphate at Carlsbad, New Mexico. In December 1992, the U.S. Department of Commerce (DOC) sought to terminate the five-year "suspension agreement" negotiated in 1988 between U.S. and Canadian potash producers. This agreement, which was due for review by February 1, 1993, was concluded in the wake of anti-dumping complaints filed by U.S. producers against Canadian exporters; it suspended anti-dumping investigations by DOC for five years. Late in January 1993, several U.S. producers requested and obtained from DOC a one-year extension to the agreement.

Europe

In 1992, the European Community (EC) imposed anti-dumping duties on potash imports from Russia, Belarus and the Ukraine. The duties were in response to a petition filed in 1990 by the European Potash Producers Association (EPPA) on behalf of potash producers within the EC. After the EC Commission determined that dumping margins averaged 35%, it imposed duties in the form of minimum prices: Ecu58-66/t[1] for potash containing less than 40% K_2O, Ecu87-99/t for potash containing between 40%-62% K_2O, and Ecu137/t for potash containing more than 62% K_2O.

Former Soviet Union

Following the breakdown of the U.S.S.R. in 1991, the former Soviet potash industry is now spread among three republics: in Russia, potash is produced at the Silvinit and Uralkali complexes (which together account for 53% of total capacity in the FSU); in Belarus, potash is mined at the Soligorsk complex (with a 44% share); and in the Ukraine, kainite and langbeinite ores are extracted at Kalush (a 3% share). In 1992, total potash production in the FSU was estimated at close to 6.9 Mt K_2O, a 19% decline compared to 1991. The decline was in response to a much-reduced demand for potash in both the domestic and central European

[1] Ecu = European currency unit.

markets due to a lack of credits and weaker farmer incomes. In 1992, domestic potash consumption in the FSU was estimated at close to 3 Mt K_2O, of which Russia accounted for 1.4 Mt; in 1991, FSU potash consumption was reported at 4.56 Mt. During 1992, FSU potash remained highly available for export despite cutbacks in production. Major gains in sales were registered in Asia, Brazil and the United States. Also in 1992, the utilization rate of potash production capacity varied between 50% and 60%.

During 1992, in an effort to earn hard currency, the Russian state fertilizer organization, Rosagrochim, was waived export taxes on its potash sales. In Russia, exports of most fertilizer minerals were controlled mainly by Agrochimexport based in Moscow; in 1992, the agency became a joint-stock company instead of a state-owned organization. Since 1990, potash plant managers have been granted the latitude to sell a certain amount of production directly for hard currency; these potash exports, dubbed perestroika potash, have since reached international markets at very low prices. However, late in 1992, the Council of Ministers of the Republic of Belarus and the Belarus potash producer negotiated a protocol to control potash exports. The State Committee for External Economic Relations was ordered to curb its issue of export licences for potash. Strict control of fertilizer exports is to be enforced in 1993. An extended export protocol, which would include Russian potash producers, was being put in place late in 1992.

In Russia at the Uralkali complex, the first phase of the new 1.25-Mt/y K_2O processing plant at Berezniki 4 was commissioned in 1992, with a 625 000-t/y K_2O capacity; the plant will initially be used for producing refined table salt (NaCl). The second phase of Berezniki 4 is set to be put on stream sometime after 1995. The Berezniki 1 operation is expected to reduce its activities in 1993 with cutbacks in capacity from 0.99 Mt/y to 0.58 Mt/y K_2O. At the Silvinit complex, the Solikamsk 1 operation is reportedly facing a gradual phase-out; in 1992, its capacity dropped by 0.25 Mt/y to 0.13 Mt/y K_2O. In Belarus, the Soligorsk 1 mine is facing a rapid exhaustion of its reserves and may shut down by the year 2000; its capacity has been curtailed by 0.2 Mt/y to 1.4 Mt/y K_2O in 1992. During 1992, the potash operations at the Soligorsk complex were affected by a six-week labour strike which ended late in April; production resumed in early May 1992.

France

Production in 1992 rose marginally from 1.13 Mt to 1.15 Mt K_2O. During 1992, Mines de Potasse d'Alsace (MDPA), a subsidiary of Entreprise Minière et Chimique (EMC), extracted potash at two underground mines, Amélie and Marie-Louise, near Mulhouse in Alsace. Due to depleting reserves, the Amélie mine is subject to closure by the end of the decade; however, its associated processing plant will continue to operate with potash ore from the Marie-Louise underground workings.

Germany

Germany's production of potash decreased in 1992 by 11% to about 3.47 Mt K_2O, with much of the decline occurring in the former East German operations. In December 1992, Kali und Salz AG (a subsidiary of BASF) and Mitteldeutsche Kali AG (owned by the state privatization agency Treuhandanstalt) announced a major restructuring plan under which a new joint venture will jointly operate their respective potash operations. The new venture will be managed by Kali und Salz (K&S), which holds a 51% share. K&S will contribute six potash operations, and Mitteldeutsche Kali AG (MdK), four operations; close to DM1 billion (approximately US$600 million) will be provided by Treuhandanstalt. According to the rationalization plan, several uneconomic potash operations will be shut down in the next five years: Bergmannssegen-Hugo (K&S), Niedersachsen-Riedel (K&S), and the Merkers processing plant (MdK). The future of the Bischofferode processing plant (MdK) will be linked to market conditions. K&S has not inserted its holdings in other companies, including Potash Company of Canada Ltd., in the joint venture. The five-year program will result in a major reduction in the workforce from 11 100 to 7500 workers by 1997. Expansions are planned at the Zielitz plant (MdK) and at the integrated mining complex of Hattorf/Merkers/Unterbreizbach (MdK). Overall German potash capacity is projected to decrease to 3.7 Mt/y K_2O by 1997.

Late in 1991, MdK closed the 350 000-t/y K_2O Rossleben-Halle mine. In April 1992, K&S shut the 310 000-t/y K_2O Salzdetfurth mine near Hildesheim. In the last quarter of 1992, MdK temporarily shut down the Zielitz mine due to declining offshore sales. During the year, both Merkers and Zielitz operations had inventory control shutdowns.

Italy

Italian production of potassium sulphate (K_2SO_4) in 1992 was estimated at 120 000 t K_2O equivalent, compared to 31 000 t in 1991. Italkali resumed its operation late in 1991 at its potassium sulphate plants in Sicily after shutting down in June 1990 due to water shortages. In Italy, kainite ore is mined by Societa Italiana Sali Alkalini SpA, a state-controlled company, at the Pasquasia, Pantanelle, Racalmuto and Realmonte mines. Potassium sulphate and magnesium-potassium sulphate products are produced at two processing plants at Pasquasia and Casteltermini. Total Italian production capacity is estimated at 500 000 t/y K_2SO_4.

Spain

Production of potash in 1992 remained stable at 580 000 t K_2O. The restructuring of the Llobregat mine, which was to compensate for the closure of the Cardona mine in mid-1990, suffered some delays. Following its purchase of Potasas del Llobregat S.L. in 1991, the Instituto Nacional de Industria (INI), a state-owned industrial holding company, was to invest up to US$9 million to upgrade the mine's infrastructure and to provide access to the nearby Suria mine.

United Kingdom

In 1992, Cleveland Potash Ltd. (CPL) extracted potash ore from its Boulby mine (North Yorkshire) and produced close to 530 000 t K_2O, a 7% increase over 1992. CPL also marketed close to 400 000 t of by-product salt. Potash products are railed 32 km south from the mine site to the Teesdock terminal where it is distributed by Teesbulk Handling Ltd., a subsidiary of CPL. Since 1991, the company has invested more than US$2.7 million for new compaction and screening equipments. A new 60 000-t/y compactor was installed, increasing CPL's compacting capacity by one third to 320 000 t/y of potash products. Overall U.K. potash capacity increased from 520 000 t/y to 550 000 t/y K_2O.

Middle East

Israel

Dead Sea Works Ltd. (DSW) produced about 1.29 Mt K_2O in 1992, a 1.6% increase over 1991. DSW's operations were shut down for three weeks in April and one week in October. During the year, the company contracted for a new US$60 million power station with a capacity of 60 MW to supply electricity and steam to potash plants at Har Sdom. In 1992, Dead Sea Works installed two new potash compactors with a combined capacity of 400 000 t/y of products.

DSW has been studying proposals to expand its potash operation at Yotava in southern Israel. The project would include new solar evaporation ponds that would increase DSW's production capacity from 1.38 Mt/y to 1.5 Mt/y K_2O by 1995.

Jordan

In 1992, the Arab Potash Company Ltd. (APC) produced about 790 000 t of K_2O, a 3.5% decline over 1991. During the year, the company continued its activities on the US$106 million expansion, which will increase APC's production capacity by 240 000 t/y to 1.08 Mt/y K_2O by 1994; a further 240 000-t/y K_2O expansion is contemplated by 1996 at an estimated cost of US$140 million. A new processing plant, based on cold leach crystallization technology, is expected to be built at costs estimated near US$66 million. Currently, APC extracts potash ore from solar evaporation ponds; close to 1.4 Mt/y of ore feed is required to run the 840 000-t/y K_2O processing plant at Ghor Al-Safi.

Asia

China

Potash production in China is derived from brines in the Qarhan Lake of the Qinghai Province situated about 4000 km west of Beijing. Two plants operated in 1992 with an estimated output of 100 000 t K_2O equivalent. In 1992, a new joint venture was announced between China and Israel, more specifically with Dead Sea Works Ltd., for the development of a new 480 000-t/y K_2O potash mine to be located in northern China near Qarhan Lake. DSW and the Eisenberg Group of Israel were reported to be involved; DSW would supply technical assistance for the US$300 million project, which will use the cold crystallization process. National Chemicals Co. of China would hold a 75% share in the joint venture. Completion has been projected for 1995.

Thailand

In 1992, development work was carried out at the ASEAN-supported project to construct a new 0.6-Mt/y K_2O underground potash mine at Bamnet Narong in the Chaiyaphum Province in northeastern Thailand. The US$286 million project is slated for completion in 1995, with full production to be reached by 1997. Potash reserves at Banmet Narong were estimated at 350 Mt K_2O. The potash ore is carnallite with grades between 12% and 14% K_2O at depths averaging 180 m. The

ASEAN Potash Mining Company Limited, who is managing the project, plans for the development of an underground mine, the construction of a processing plant, and rail transportation to port and storage facilities. Employment is forecast at 1000 workers.

The rail network in Thailand is currently being upgraded and extended by the State Railway of Thailand in order to provide a direct link from the northeastern part of Thailand to new port facilities under construction at Mab Ta Phut. In 1992, nearby gas fields were being developed which would allow ample access to energy sources. The water supply will likely be secured by 1995 with the construction of a new dam on the Lam Khan Chu River by the Thai government; the water reservoir is expected to be filled by 1997. A 25-km pipeline will be constructed to supply the potash plant.

PRICES

The potash price quoted on an f.o.b. Vancouver-U.S. dollars basis is considered the major pricing indication for most Canadian international offshore sales. The importance of China in world potash trade, and especially for Canada, has resulted in making the Canada-China negotiated price a benchmark in pricing potash on international markets. In many markets, prices are also quoted on a delivered basis, c.i.f. national ports. Canpotex Limited, representing all Saskatchewan potash producers, sells both f.o.b. Vancouver or c.i.f. foreign ports, or out of warehouses in Southeast Asia.

On average, potash prices in 1992 were higher than in 1991. Domestic prices remained unchanged, with a slight weakening by the end of the year. In offshore markets during 1992, exporters reported a 3%-4% price increase to $114-115/t, f.o.b. Vancouver, on most of their sales to the Asian market. Prices in Brazil continued to face strong fluctuations as discounts varied from US$3/t to over $10/t.

Entering 1992, world potash markets showed relative stability after a period of price consolidation that prevailed throughout the second half of 1991. Early in 1992, demand for potash was weak and international contract negotiations between major buyers and suppliers lagged until the middle of the first quarter. By the beginning of the second quarter, most negotiations were settled with the exception of the key Canpotex-Sinochem contract; contracts with other buyers, such as Japan and South Korea, were concluded with a US$4/t increase to US$114/t, f.o.b. Vancouver. Negotiations with China lapsed until early June, when a contract for 800 000 t at US$114/t was concluded. Shipments in the first half of 1992 were for 400 000 t; the remaining 400 000 t were under an option to be exercised by July 31. During the second half, the deadline was extended several times until the end of 1992 without being exercised by Sinochem. In December, intense negotiations were initiated with China for the first-half 1993 contract; a US$4/t decrease in price was signalled in early 1993.

At the beginning of 1992, North American prices were under downward pressures after sluggish sales prevailed in the last quarter of 1991. Canadian granular potash was quoted in the US$73-77/t range (f.o.b. Saskatchewan), but sales were moving at lower levels. The strong level of sales in the second quarter kept potash prices up; quotations for granular products rose to US$80-83/t. By July, the market stabilized and granular product quotations fluctuated upward at the US$79-81/t level. During the rest of the year, weak levels of sales resulted in a gradual erosion in prices, and granular products were quoted at US$78/t close to the end of 1992.

OUTLOOK

In the short term, world consumption of potash for fertilizers is expected to decrease by 4% in the fertilizer year 1992/93, with most of the decline to be registered in the former Soviet Union. Declines in potash consumption are also expected in Western Europe, Eastern Europe, North America, and Socialist China; potash consumption is projected to increase in Latin America, South Asia and Southeast Asia. Overall, potash fertilizer consumption is expected to drop by 8% compared to the 1991/92 period.

In the 1993 calendar year, world potash demand for fertilizers is forecast to decrease to less than 22 Mt K_2O. Marginal growth is anticipated in Africa and Oceania. Declines are forecast in North America (–2%), Western Europe (–5%), Eastern Europe (–50%), and the FSU (–7%). Consumption in Latin America is expected to increase by 3%, with Brazil remaining stable at 1.25 Mt K_2O. In Asia, overall potash consumption is expected to remain unchanged at close to 5.8 Mt K_2O; demand for potash in Asia will be affected by future governments' subsidy policies. In China, potash consumption is forecast to increase by 4%, while a 17% drop is anticipated in India.

In the United States, potash consumption is set to decrease as lower planted acreages for soybean and corn are projected, following the record harvest in

1991/92 of corn, soybean and wheat. The 1992/93 Acreage Reduction Program for corn and soybean has been raised from 5% to 10%, but will remain at zero for wheat. The subsequent reduction in plant acreages and a shift in crop seeding will result in a slight 2% decline in potash consumption to 4.8 Mt K_2O for 1993.

Total world demand for potash in 1993 is projected at 24 Mt K_2O. Potash usage is mostly in fertilizers with a 95.4% share of total potash consumption, with the remainder being used in industrial chemicals.

For the medium term, a June 1992 report of the World Bank/FAO/UNIDO/Industry Fertilizer Working Group forecasts that world potash consumption for the 1990-96 period will grow at an annual rate of 0.7% to reach 25.5 Mt/y K_2O by 1996. Major increases in consumption are anticipated in Africa (+3.8%/y), Latin America (+3.5%/y) and Asia (+2.8%/y). Consumption is expected to remain relatively flat in North America (+0.4%/y) and Oceania (+1.1%/y). Consumption in the FSU is expected to recover slowly, assuming a smooth transition to a market-driven economy; the FSU should reach its 1989/90 consumption level by 1996 through an annual growth rate of 0.4%. In the FSU, potash consumption in the pre-1990 period was based on a high nitrogen-to-potash ratio, which is expected to be reduced in the future for a more efficient fertilization. In Europe, potash consumption is forecast to decrease by 1.4%/y in Western Europe and by 3.3%/y in Eastern Europe.

The demand for industrial potash is forecast to reach 1.17 Mt/y K_2O by 1996, a 5% overall increase from the 1990 level. There is limited trade for industrial potash as its consumption is mostly centred in developed countries, including the United States, which accounts for more than 60% of the total industrial demand.

Total world demand for potash is forecast at 28 Mt K_2O by 1996, taking into account both fertilizer and industrial potash consumption, and distribution losses.

On the supply side, announcements made during 1992 will have an important impact on future potash capacity. In the next five years, mine closures in Germany, France, Spain, and possibly the FSU, will translate into a 2.0-Mt/y K_2O reduction in world capacity. During that period, several projects that were initiated in 1992 will be commissioned. Expansions at North American Chemical (United States), at Dead Sea Works (Israel), at Arab Potash (Jordan), and at a new plant at Berezniki 4 (Russia) will bring more than 1.6 Mt/y K_2O of additional capacity into the marketplace by 1997. Other projects that may also be developed or commissioned include a replacement mine at IMC Canada (Saskatchewan), an expansion at Kalium (Michigan), and new mines in Manitoba, Thailand, China, Chile and Argentina. These potential projects will offset the gradual phase-out of operations in the United States, France and the FSU due to reserves depletion and poor economics in the period beyond 1997. However, taking into consideration the projected growth in potash demand for the rest of the decade, it is expected that the current over-capacity will prevail, but at a much reduced level from close to 4 Mt/y K_2O in 1992 to 2.5 Mt/y by 1999.

The emergence of new capacity in developing and high potash-consuming countries will have a major impact on international trade patterns and current producers. New producers will challenge the economics of established suppliers; however, suppliers who benefit from lower operating costs, advantageous transportation charges, or large natural markets will be best positioned to survive in an increasingly competitive potash marketplace where the influence of new government policies in buying countries has been intensifying.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada			UnitedStates
		MFN	GPT	USA	Canada
3104.20	Potassium chloride	Free	Free	Free	Free
3104.30	Potassium sulphate	Free	Free	Free	Free
3104.90.00.10	Magnesium potassium sulphate	Free	Free	Free	Free
3104.90.00.90	Other potassic fertilizer	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States 1992.

Figure 2
Distribution, Canadian Potash Sales, 1991

NOTE: Sales figures in tonnes K_2O equivalent.
SOURCE: Potash and Phosphate Institute.

TABLE 1. CANADA, POTASH PRODUCTION, SHIPMENTS AND TRADE, 1991 AND 1992

Item No.		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)
PRODUCTION, Potassium Chloride					
Gross weight		12 125 266	. .	11 997 740	. .
K_2O equivalent		7 405 575	. .	7 326 865	. .
SHIPMENTS					
K_2O equivalent		7 087 027	931 932	7 324 179	963 260
IMPORTS, Fertilizer Potash				(Jan.-Sept.)	
3104.20	Potassium chloride, in packages weighing more than 10 kg				
	United States	7 472	941	4 358	529
	Germany	247	32	3	. . .
	United Kingdom	18	2	4	1
	Total	7 737	975	4 365	530
3104.30	Potassium sulphate, in packages weighing more than 10 kg				
	United States	6 422	1 956	7 147	2 185
	United Kingdom	2	4	3	7
	Netherlands	2	. . .	–	–
	Germany	. . .	. . .	–	–
	Total	6 426	1 961	7 150	2 192
3104.90.00.10	Magnesium potassium sulphate				
	United States	59 038	9 326	35 718	6 262
	Other countries	79	11	–	–
	Total	59 117	9 337	35 718	6 262
3104.90.00.90	Other potassic fertilizer				
	United States	2 609	1 078	2 925	1 040
	Other countries	2 035	424	39	17
	Total	4 644	1 502	2 964	1 057
	Potash Chemicals				
2815.20	Potassium hydroxide (caustic potash)	11 842	4 691	. .	3 388
2834.21	Potassium nitrate	4 908	2 517	4 243	2 215
2835.24	Potassium phosphates	1 105	1 120	542	634
2836.40	Potassium carbonates	1 555	1 065	1 522	1 087
2839.20	Potassium silicates	877	667	573	423
	Total potash chemicals	20 287	10 060	. .	7 747
EXPORTS, Fertilizer Potash[1]					
3104.20	Potassium chloride, in packages weighing more than 10 kg				
	United States	6 037 362	655 165	5 180 055	558 929
	People's Republic of China	1 366 177	168 269	550 835	68 927
	India	252 345	29 869	422 204	50 021
	Japan	481 035	65 715	362 348	46 890
	Malaysia	493 392	64 121	320 192	37 389
	South Korea	445 219	57 467	246 793	29 481
	Brazil	294 228	31 202	247 673	27 760
	Australia	140 177	18 077	172 758	21 092
	New Zealand	89 462	11 211	129 048	15 234
	Taiwan	210 631	27 076	115 936	14 418
	Belgium	133 428	14 866	94 046	11 515
	Indonesia	82 833	10 463	82 705	9 891
	Chile	85 032	10 960	66 283	8 627
	Bangladesh	66 357	6 238	53 320	4 968
	Netherlands	–	–	35 863	4 019
	Denmark	40 389	4 233	30 855	3 391
	Colombia	70 010	6 897	29 957	3 377
	Philippines	89 462	11 666	22 008	2 844
	Thailand	22 550	2 922	20 980	2 528
	Jamaica	16 556	2 555	13 487	2 079
	Nigeria	40 000	3 655	20 000	1 901
	Norway	16 000	1 582	16 000	1 804
	France	90	8	15 750	1 740

TABLE 1 (cont'd)

Item No.		1991 (tonnes)	1991 ($000)	Jan.-Sept. 1992p (tonnes)	Jan.-Sept. 1992p ($000)
EXPORTS (cont'd)					
	Venezuela	–	–	14 962	1 559
	Singapore	–	–	13 849	1 306
	Cuba	–	–	10 000	1 023
	Martinique	–	–	10 026	930
	Dominican Republic	6 105	613	5 800	602
	Guatemala	12 700	1 222	6 000	584
	Guyana	2 730	506	1 050	224
	United Kingdom	13 218	1 770	18	2
	Mexico	21 552	2 427	–	–
	Ivory Coast	20 602	2 177	–	–
	Other countries	7 906	1 041	17	17
	Total	10 557 548	1 213 973	8 310 818	935 072
3104.30	Potassium sulphate, in packages weighing more than 10 kg				
	United States	1 003	309	833	493
	Total	1 003	309	833	493

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available or not applicable; . . . Amount too small to be expressed; p Preliminary.
[1] Countries are ranked in descending order of value, based on nine-month 1992 data.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, POTASH PRODUCTION AND TRADE, FERTILIZER YEARS ENDED JUNE 30, 1977-92

	Production[2]	Imports[1,2]	Exports[1]
		(tonnes K_2O equivalent)	
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
1986	6 519 777	12 837	6 479 678
1987	7 031 586	12 122	7 100 135
1988	7 839 625	14 486	7 315 318
1989	8 088 748	18 604	7 075 122
1990	6 773 019	20 714	6 387 857
1991	7 520 235	23 714	6 727 678
1992	7 011 891	22 719	6 434 926

Sources: Potash and Phosphate Institute; Canadian Fertilizer Institute.
[1] Includes potassium chloride, potassium sulphate, potassium magnesium sulphate, except that contained in mixed fertilizers. [2] Change of data source; prior to 1978, figures were obtained from Statistics Canada.

TABLE 3. CANADA, POTASH PRODUCTION AND SALES IN 1991 AND BY QUARTERS, 1992

	Total (1991)	1992 1st Quarter	1992 2nd Quarter	1992 3rd Quarter	1992 4th Quarter	1992 Total
	(000 tonnes, K_2O equivalent)					
Production	7 396.2	1 969.0	1 797.8	1 601.9	1 878.7	7 247.4
Sales						
North America	3 930.2	1 173.9	1 405.0	954.9	779.9	4 313.7
Offshore	3 096.5	618.8	795.9	773.6	524.1	2 712.4
Total	7 026.7	1 792.7	2 200.9	1 728.5	1 304.0	7 026.1
Ending Inventories						
Mine site	775.1	813.8	668.7	579.8	957.0	n.a.
Off site	810.1	945.2	709.8	685.4	827.3	n.a.
Total	1 585.2	1 759.0	1 378.5	1 365.3	1 784.3	n.a.

Source: Potash and Phosphate Institute.
n.a. Not applicable.

TABLE 4. CANADA, POTASH SALES BY PRODUCT AND AREA, 1990 AND 1991

		Agricultural					Industrial			Total
		Standard	Coarse	Granular	Soluble	Total	Standard	Soluble	Total	Sales
		(tonnes, K_2O equivalent)								
British Columbia	1990	646	307	6 901	36	7 890	–	–	–	7 890
	1991	53	67	6 054	44	6 247	–	–	–	6 247
Alberta	1990	106	40	33 695	1 851	35 692	1 725	475	2 200	37 893
	1991	296	650	30 206	1 426	32 578	1 850	366	2 216	34 794
Saskatchewan	1990	11	2 258	9 512	104	11 885	2 761	1 437	4 198	16 083
	1991	–	–	–	–	–	2 324	992	3 316	–
Manitoba	1990	–	3 127	16 334	2 449	21 910	–	–	–	21 910
	1991	–	1 837	19 367	2 052	23 255	–	–	–	23 255
Ontario	1990	892	114 142	67 615	1 269	183 919	7 784	407	8 191	192 110
	1991	825	82 132	72 666	427	156 051	5 669	411	6 080	162 131
Quebec	1990	–	4 953	85 675	35	90 664	752	169	921	91 584
	1991	18	7 772	72 209	54	79 053	1 051	226	1 277	80 330
New Brunswick	1990	–	4 583	5 124	–	9 707	–	18	18	9 725
	1991	48	6 470	6 103	–	12 621	–	–	–	12 621
Nova Scotia	1990	–	3 486	1 412	–	4 898	–	–	–	4 898
	1991	–	3 488	1 295	–	4 785	–	14	14	4 797
Prince Edward Island	1990	–	1 395	9 484	–	10 879	–	–	–	10 879
	1991	351	–	12 414	24	12 789	3	241	244	13 033
Newfoundland	1990	–	–	–	–	–	–	–	–	–
	1991	–	–	782	–	–	–	–	–	782
Total	1990	1 655	134 291	235 753	5 745	377 444	13 022	2 506	15 528	392 972
	1991	1 699	103 020	228 389	4 359	327 467	10 897	2 250	13 147	350 614

Source: Potash and Phosphate Institute.
– Nil.

TABLE 5. CANADA, POTASH INVENTORY, PRODUCTION, DOMESTIC SALES AND EXPORT SALES, 1992

Month	Beginning Inventory	Production	Domestic Sales			Export Sales					Canadian Total Sales
						United States					
			Agriculture	Non-Agriculture	Total	Agriculture	Non-Agriculture	Total	Offshore Total	Exports Total	
						(000 tonnes K_2O)					
January	1 585.2	556.7	16.1	1.5	17.6	476.4	25.5	501.9	205.3	707.2	724.8
February	1 415.6	711.6	12.6	1.0	13.6	242.4	22.9	265.3	224.9	490.2	503.8
March	1 596.8	700.7	25.8	1.5	27.3	314.1	34.1	348.2	188.6	536.8	564.1
1st quarter subtotal		1 969.0	54.5	4.0	58.5	1 032.9	82.5	1 115.4	618.8	1 734.2	1 792.7
April	1 758.7	651.7	52.8	1.3	54.1	466.9	24.9	491.8	264.8	756.6	810.7
May	1 621.5	621.6	144.1	1.3	145.4	495.9	33.2	529.1	189.9	719.0	864.4
June	1 393.2	524.5	14.7	1.3	16.0	140.9	27.7	168.6	341.2	509.8	525.8
2nd quarter subtotal		1 797.8	211.6	3.9	215.5	1 103.7	85.8	1 189.5	795.9	1 985.4	2 200.9
July	1 398.7	289.3	25.4	1.5	26.9	153.3	27.5	180.8	360.6	541.4	568.3
August	1 104.7	615.9	9.9	1.1	11.0	438.6	30.4	469.0	246.6	715.6	726.6
September	989.6	696.7	8.6	1.0	9.6	231.1	26.5	257.6	166.4	424.0	433.6
3rd quarter subtotal		1 601.9	43.9	3.6	47.5	823.0	84.4	907.4	773.6	1 681.0	1 728.5
October	1 265.3	750.8	20.0	1.2	21.2	259.4	31.6	291.0	156.0	447.0	468.2
November	1 528.3	650.9	9.3	1.5	10.8	110.1	31.8	141.9	147.6	289.5	300.3
December	1 878.9	477.0	12.8	1.8	14.6	265.5	34.9	300.4	220.5	520.9	535.5
4th quarter subtotal		1 878.7	42.1	4.5	46.6	635.0	98.3	733.3	524.1	1 257.4	1 304.0
Total		7 247.4	352.1	16.0	368.1	3 594.6	351.0	3 945.6	2 712.4	6 658.0	7 026.1

Source: Potash and Phosphate Institute.

TABLE 6. WORLD POTASH PRODUCTION, 1987-92

	1987	1988	1989	1990	1991p	1992e
			(000 tonnes K_2O)			
Brazil	37	48	98	68	100	45
Canada	7 267	8 328	7 333	7 002	7 405	7 245
Chile	–	5	10	20	38	35
China	25	30	35	60	98	100
France	1 539	1 502	1 195	1 292	1 129	1 150
FSU	10 889	11 999	10 232	9 088	8 562	6 900
Germany	5 711	5 800	5 386	4 850	3 902	3 470
Israel	1 265	1 242	1 271	1 311	1 270	1 290
Italy	122	126	152	68	31	120
Jordan	722	786	792	842	818	790
Spain	740	766	742	686	585	580
United Kingdom	429	452	463	488	494	530
United States	1 262	1 461	1 595	1 654	1 692	1 650
Total	30 008	31 546	29 304	27 429	26 125	23 905

Sources: Energy Mines and Resources Canada; International Fertilizer Industry Association Ltd.; U.S. Bureau of Mines.
– Nil; e Estimated; p Preliminary.

TABLE 7. CANADA POTASH, CURRENT SITUATION AND FORECAST

	Actual						Forecast
	1987	1988	1989	1990	1991	1992p	1993e
				(000 tonnes K_2O)			
Capacity	11 020	11 430	11 550	11 800	11 800	12 000	12 000
Production	7 267	8 328	7 360	7 002	7 405	7 245	7 000
Capacity utilization (%)	66	73	64	59	63	60	58
Sales	7 837	8 030	7 124	7 190	7 056	7 025	7 050
of which: Domestic	480	420	315	396	350	370	350
United States	4 224	3 830	3 886	3 630	3 610	3 945	3 800
Offshore	3 114	3 780	2 923	3 164	3 096	2 710	2 950
Year-end stocks	1 135	1 360	1 596	1 272	1 585	1 785	1 735
World production	29 309	31 650	29 300	27 429	26 125	24 335	24 440
Canada/world production ratio (%)	24.7	26.3	25.1	25.5	28.3	29.8	28.6

e Estimated; p Preliminary.

TABLE 8. CANADA, POTASH MINES, CAPACITY PROJECTIONS, 1985-95

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	(000 tonnes K_2O equivalent)										
Potash Corporation of Saskatchewan Inc.											
Allan[1]	575	575	575	575	575	960	960	960	960	960	960
Cory	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
Lanigan	690	1 240	1 740	2 090	2 090	2 090	2 090	2 090	2 090	2 090	2 090
Rocanville	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160
Subtotal	3 835	4 385	4 885	5 235	5 235	5 620	5 620	5 620	5 620	5 620	5 620
Central Canada Potash	815	815	815	815	815	815	815	830	830	830	830
Cominco Ltd.	815	815	815	815	815	815	815	830	830	830	830
International Minerals & Chemical Corporation (75%)	1 745	1 745	1 745	1 745	1 745	1 745	1 745	1 745	1 745	1 745	1 745
Kalium Canada, Ltd.	1 055	1 055	1 245	1 245	1 245	1 245	1 245	1 245	1 245	1 245	1 245
Potash Company of America, Inc.	630	630	100	30	150	400	400	450	450	450	450
Saskaterra Fertilizers Ltd. (Allan)[1]	385	385	385	385	385	–	–	–	–	–	–
Subtotal	5 445	5 445	5 105	5 035	5 155	5 020	5 020	5 100	5 100	5 100	5 100
Total Saskatchewan	9 280	9 830	9 990	10 270	10 390	10 640	10 640	10 720	10 720	10 720	10 720
Potash Mining of Canada	200	450	650	780	780	780	780	810	810	810	810
Potash Company of America, Inc.	300	300	380	380	380	380	380	470	470	470	470
Total New Brunswick	500	750	1 030	1 160	1 160	1 160	1 160	1 280	1 280	1 280	1 280
Total Canada	9 780	10 580	11 020	11 430	11 550	11 800	11 800	12 000	12 000	12 000	12 000

– Nil.
[1] Potash Corporation of Saskatchewan Inc. increased its share of Allan mine from 60% to 100% in mid-1990.
Note: Capacity means "rated" capacity; under normal conditions, Canadian mines can operate comfortably at about 95% of rated capacity.

Primary Iron

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Primary iron is defined to include blast furnace iron, direct reduced iron (DRI) and, in Canada, electric smelted iron. It is the main raw material used to make steel and other iron products such as castings.

There are two technologies used to produce steel: basic oxygen furnaces, which are charged with blast furnace iron and ferrous scrap at the integrated steel mills; and electric furnaces, which are charged with scrap and/or DRI at the mini-mill plants. Approximately 50% of iron units used to make steel in Canada come from scrap.

CANADIAN DEVELOPMENTS

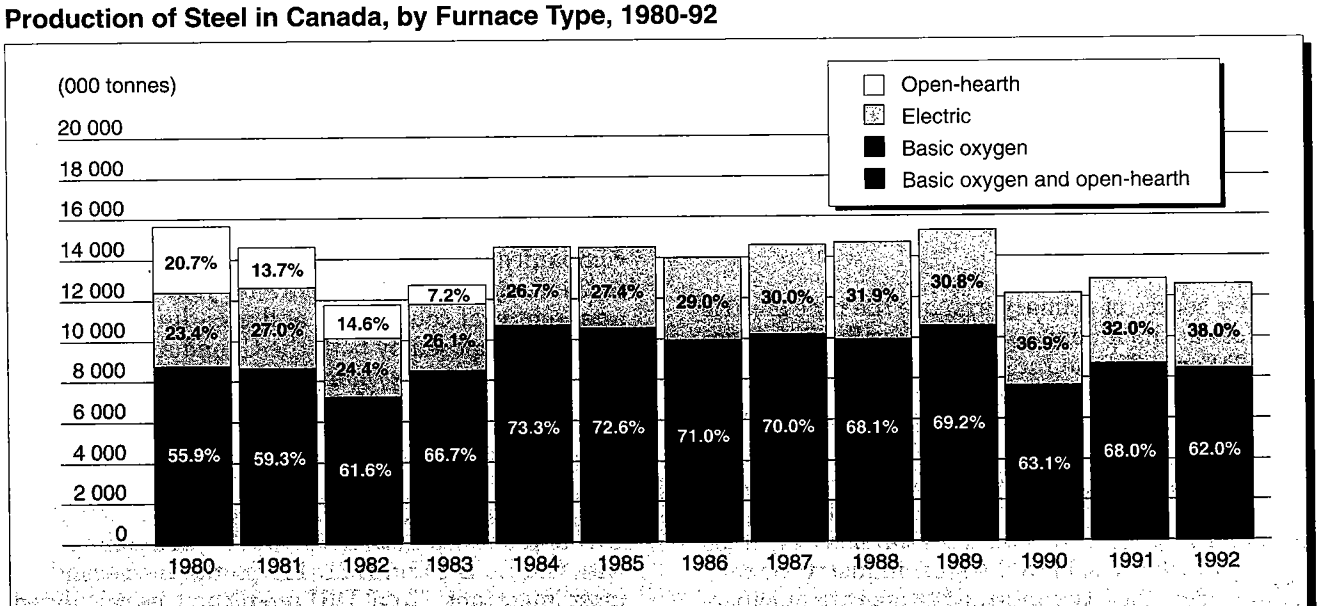
Since almost all of the primary iron produced in Canada is used in the production of steel, trends in steel production and in demand for steel mill products influence the production of primary iron. Therefore, this review will frequently refer to developments in the steel industry.

Steel

The weak domestic steel demand that characterized 1991 continued during the first half of 1992. The economy began to improve slightly in the third quarter; however, the steel industry continued to face a very competitive and difficult pricing environment. Although production increased, prices were very low, often close to the cost of production.

Under the Canada-U.S. Free Trade Agreement (FTA), bilateral steel shipments remained high even with the threat of trade actions by both countries. U.S. exports to Canada declined by 130 000 t, but were

Figure 1
Production of Steel in Canada, by Furnace Type, 1980-92



still high by historical standards at 1 180 000 t. Canadian exports of steel mill products to the United States increased by 790 000 t. These changes show that the dislocation in trade caused by the extended Canadian strikes of 1990 were much diminished. Total exports of steel mill products to all countries decreased by 228 000 t and total imports decreased by over 350 000 t. These figures emphasize the importance of the bilateral steel trade to the industries of both Canada and the United States.

Canadian steel production in 1992 increased to 13.8 Mt from 12.9 Mt in 1991. This increase was attributed partly to an improvement in the economy; however, the most significant factor was trade.

Blast Furnace Iron

Canadian production of blast furnace and foundry iron in 1992 increased to 8.62 Mt, compared to 8.17 Mt in 1991. This increase was due to higher steel production at integrated producers.

To some extent, ferrous scrap and primary iron are substitute materials in steel production. In 1992, the proportion of primary iron to scrap in steel production increased from 55% to 56%. This small increase occurred in spite of: the closure of the blast furnace at Sydney Steel Corporation, the start-up of an electric furnace at that plant, a 1% increase in electric furnace steel production, and the fact that the price of ferrous scrap was considerably lower than in 1991. The main factor in this increase was the return to full production of Stelco's E blast furnace at its Hilton works after its scheduled reline.

The Canadian steel industry has eight blast furnaces with a total capacity of 10.55 Mt/y. Associated with these furnaces are 780 coke ovens with a total capacity of 4.8 Mt/y.

Electric Smelted Iron

Another source of primary iron are the nine electric furnaces at the ilmenite smelting facility operated by QIT-Fer et Titane Inc. at Tracy, Quebec. These furnaces have the capacity to produce 900 000 t/y of iron as a co-product with titanium dioxide. The iron is used to produce three products: a range of specialty pig iron grades, which are sold mainly to the foundry industry; iron powder used by the powder metallurgy industry; and continuous cast steel billets, which are sold to the steel industry for rerolling. This facility continued to operate at capacity during 1992.

Direct Reduced Iron (DRI)

DRI is a semi-metallic product made by reducing iron ore in its solid state to approximately 95% metallics. Sidbec-Dosco Inc. has one operating Midrex DRI plant at Contrecoeur, Quebec. This plant, with a capacity to produce 750 000 t/y, operated at capacity during 1992. DRI, together with scrap, is used to produce steel at the company's electric furnace steel mill.

INTERNATIONAL DEVELOPMENTS

Primary Iron and Steel

World steel production, as calculated by the International Iron and Steel Institute, decreased 3.1% in the first 11 months of 1992 relative to the same period in the previous year. This continuing decrease in production was concentrated in the Western economies where production declined 2.6%, and in Eastern Europe where the decline totalled 15.5%. This decline in world demand was attributed to lower levels of demand for consumer durables, especially automobiles, brought about by recessionary pressures. The economic decline intensified during the year, especially in Europe and Japan. In Eastern Europe and the former U.S.S.R., the massive changes involved in the break-up of the U.S.S.R. continued to devastate the economy.

Worldwide, the greatest declines in steel production occurred in Japan (11.4%), the European Community (2.4%), Yugoslavia (38.4%), Romania (25.2%), Hungary (19.2%) and the C.I.S. (16.3%). Production increased 6.6% in Canada, 5.1% in the United States and 3.3% in Mexico, an indication that these economies were pulling out of the recession.

On the trade front, the year was characterized by petitions from the American industry to the U.S. government, which resulted in a series of investigations for dumping and subsidization. Canadian companies responded by making similar demands to the Canadian government. By year-end, it was apparent that countervail and anti-dumping duties would be imposed by both the Canadian and U.S. governments against many of their trading partners.

Direct Reduced Iron (DRI)

Midrex plants accounted for about 64% of world DRI and hot briquetted iron (HBI) production, with the HYL-1 and HYL-111 plants the second most important. Total DRI production, as calculated by the Midrex Corporation, was 20.7 Mt in 1992, an 8% increase over the 1991 level of 19.41 Mt, or about 3% of world crude steel. DRI's inherent advantages of high purity and controlled chemistry have always been valued, but low ferrous scrap prices limited the growth potential of the product. This situation has changed in recent years as electric furnace mills have moved into the market for such products as high-quality wire rod and special-quality forging grade bar. Another important factor is the technical success of the thin slab casting technology that allows electric furnace mills to produce flat products at very competitive prices. Trade in DRI and HBI continued to increase with 3.5 Mt shipped in 1992.

New DRI plants that came on stream in 1992 added over 3 Mt to capacity. Additional DRI capacity is under construction, and Midrex forecasts world production of 28 Mt by 1995 and 35 Mt by the year 2000.

OUTLOOK

Canadian production of iron and steel should increase slightly by year-end 1993 as significant economic growth is expected in both Canada and the United States. Canadian producers should capture a portion of the U.S. market lost by offshore producers due to U.S. trade actions. Both countries should benefit in their own domestic markets from reduced pressure from imported steel. At the same time, Canadian and U.S. companies will likely improve their sales levels in each other's domestic market.

In the medium term, annual growth of 2%-4% is expected in North America. This forecast assumes a considerable reduction in offshore imports to North America. Although the Canadian steel industry is well placed to benefit from a period of economic growth, additional improvements in productivity will be necessary to maintain a competitive position with the greatly improved U.S. steel industry.

There are a number of factors that could radically change this forecast. The future of Algoma Ltd. is still quite uncertain. Steelmaking capacity at Algoma represents about 25% of the Canadian total. Furthermore, a high percentage of Algoma's product line is not made by other Canadian producers. Therefore, imports of wide flange beams and large structurals, large seamless tubing, and wide plate and sheet would all increase.

Sydney Steel is also a company with an uncertain future, having been put up for sale by the provincial government. It is effectively a single-product mill making rails that no other Canadian company produces.

Perhaps of most importance, changes in the relative exchange rates between the currencies of Canada and its trading partners dramatically influence trade patterns and, consequently, Canadian production. The above forecast assumes that the Canadian dollar will also remain relatively low vis-à-vis the U.S. dollar and that the Canadian steel-consuming secondary manufacturing industry will create new business capable of competing in North American, if not world, markets.

In the medium term (three to five years), Canadian producers should see a period of slightly increasing sales at profitable prices as the economy enters a period of growth. Steel producers would therefore benefit from improved productivity and product quality. In the longer term (five to ten years), trade under the FTA should stabilize in North America, and the Canadian industry should find its place in the North American market. Assuming that the intent of existing and proposed free trade agreements becomes reality, barriers to trade that exist in the form of various trade laws will be eliminated. Because Mexico is not self-sufficient in steel, both Canadian and U.S. steel producers will have an opportunity to increase export sales to Mexico if a North American Free Trade Agreement is negotiated.

International Factors

The difference in the cost of producing steel anywhere in the world continues to narrow; therefore, the relative value of currencies and the cost of shipping are becoming more important factors in steel trade. The North American steel industry, of which Canada is an integral part, will continue to rationalize and improve its competitiveness. A very important factor is that North America does not have excess domestic supply. Furthermore, over the next 10 years, North American prices will not be significantly higher than world prices. Therefore, North American producers will have an opportunity to maintain relatively high levels of capacity utilization. Capacity utilization is a key factor in profitability and the ability to maintain the capital expenditures necessary to maintain or improve competitiveness. However, it is important to note that continuing high levels of capital spending will be required. The rate of technological change is not likely to slow but, rather, to accelerate as new processes, such as thin slab and near net shape casting, become the industry standard. Traditional steelmaking will have to be competitive, or it will be replaced by direct smelting or direct steelmaking processes. The impact of technological change should not be underestimated as it is an exceptionally important factor forming the nature of tomorrow's steel industry. All of the recently proven and advanced technologies have the significant characteristic of reducing barriers to entry into the steel industry, and dramatically decreasing both the capital and operating costs of steel production.

U.S. output of steel is expected to increase 5%-6% in 1993 and to average 2%-3% in the medium term. Prices in 1993 will likely increase quite dramatically for two reasons: the U.S. government has imposed tariffs on imported steel, and inventories held by steel users are at low levels.

The European steel industry will likely have minimal growth in 1993 because, in European economies, the recession is expected to persist well into the year. Also, it is likely that European producers will lose a portion of their U.S. market. In the medium term, growth in steel production should average 2%-3%/y. In the longer term, the European economy will likely be stimulated by the rebuilding of the economies of Eastern Europe with a great potential demand for consumer durables and the availability of relatively low-cost labour.

Japanese production is forecast to decrease, in the short term, as the recession that started in North America continues to affect the Japanese economy in 1993. In the medium term, a period of little or no growth is likely.

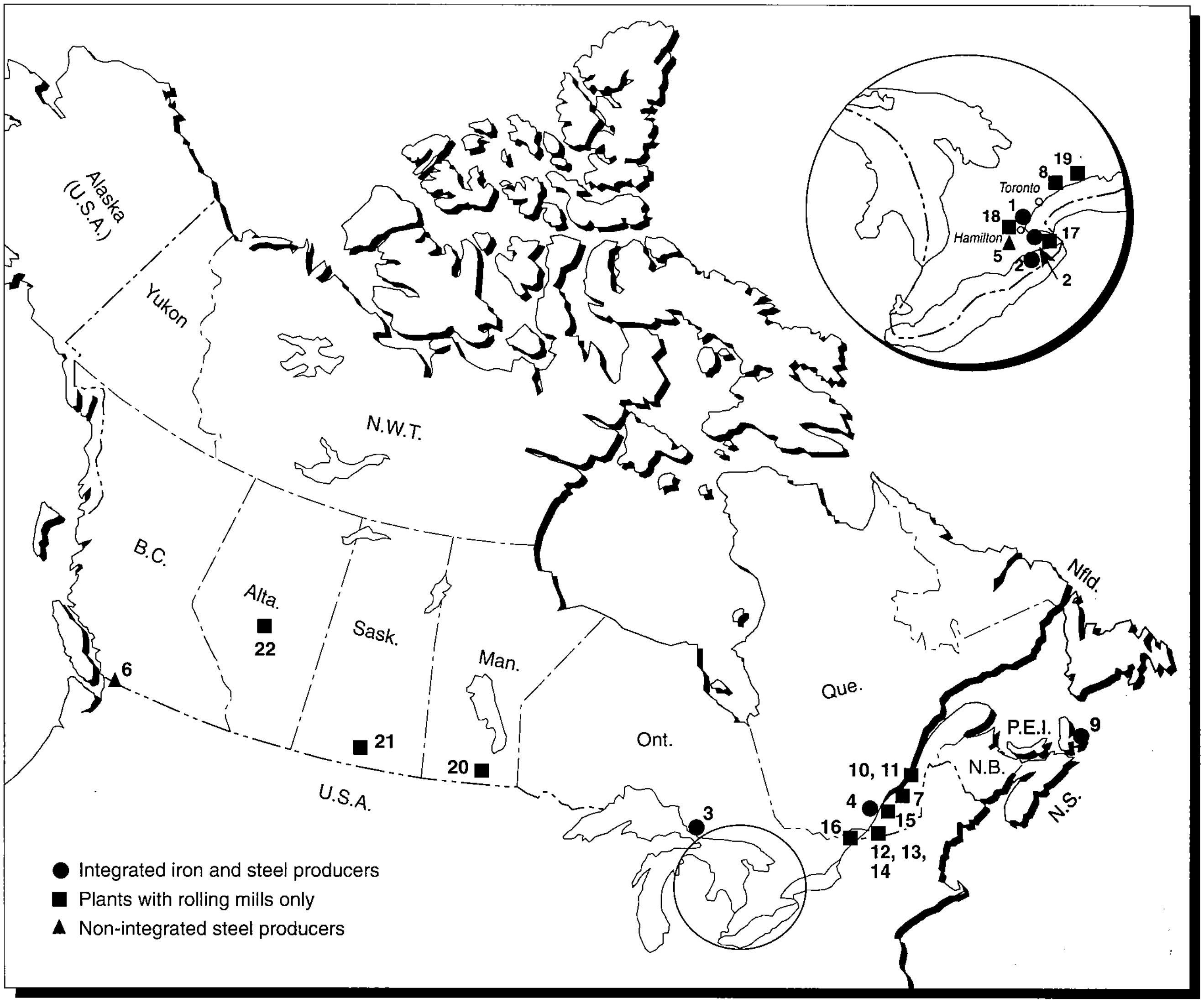
Steel production in the newly industrialized nations is expected to increase at over 2%/y throughout the decade.

Based on the above North American forecast for steel production, the overall outlook for Canadian production of primary iron is quite good in the short term. In fact, Canadian production could reach the industry's capability of 16.5 Mt. However, the industry must respond to the technological changes that are occurring, and that will continue to occur, if its long-term future is to be secure.

Note: Information in this review was current as of February 1, 1993.

Figure 2

Iron and Steel in Canada, 1992



Numbers refer to locations on map above.

INTEGRATED IRON AND STEEL PRODUCERS

1. Dofasco Inc. (Hamilton)
2. Stelco Inc. (Hamilton and Nanticoke)
3. Algoma Steel Ltd. (Sault Ste. Marie)
4. Sidbec-Dosco Inc. (Contrecœur)

PLANTS WITH ROLLING MILLS ONLY

5. Stanley Strip Steel, division of Stanley Canada Inc. (Hamilton)
6. Pacific Continuous Steel Limited (Delta)

NON-INTEGRATED STEEL PRODUCERS

7. QIT-Fer et Titane Inc. (Sorel)
8. Courtice Steel Inc. (Cambridge)
9. Sydney Steel Corporation (Sydney)
10. Stelco Inc. (Contrecœur)
11. Atlas Stainless Steels, division of Sammi Atlas Inc. (Tracy)
12. Sorel Forge, division of Slater Industries Inc.
13. Canadian Steel Foundries, division of Hawker Siddeley Canada Inc. (Montréal)
14. Canadian Steel Wheel Limited (Montréal)
15. Sidbec-Dosco Inc. (Montréal and Longueuil)
16. Ivaco Inc. (L'Orignal)
17. Atlas Specialty Steels, division of Sammi Atlas Inc. (Welland)
18. Hamilton Specialty Bar, division of Slater Industries Inc. (Hamilton)
19. Co-Steel Inc. (Whitby)
20. Manitoba Rolling Mills, subsidiary of The Canam Manac Group Inc.
21. IPSCO Inc. (Regina)
22. Stelco Inc. (Edmonton)

TABLE 1. CANADA, CRUDE STEEL PRODUCTION AND SHIPMENTS, 1990-92

	1990	1991	1992p
		(tonnes)	
FURNACE CAPACITY, JANUARY 1[1]			
Steel ingot			
Basic open-hearth	–	–	–
Basic oxygen converter	11 736 900	11 854 400	11 170 000
Electric	6 664 640	6 891 450	6 715 450
Total	18 401 540	18 745 850	17 885 450
Steel castings	631 600	322 590	315 590
Total furnace capacity	19 033 140	19 068 440	18 201 040
PRODUCTION			**(Jan.-Nov.)**
Steel ingot			
Basic open-hearth and basic oxygen	7 676 182	8 722 218	8 467 422
Electric	4 508 219	4 172 961	4 147 528
Total	12 184 401	12 895 179	12 614 950
Continuously cast, included in total above	9 423 667	10 851 706	10 961 422
Steel castings[2]	96 335	92 254	86 716
Total steel production	12 280 736	12 987 433	12 701 666
SHIPMENTS FROM PLANTS			
Steel castings	89 128	87 111	94 453
Rolled steel products	11 563 101	11 241 164	11 144 869
Total shipments	11 652 229	11 328 275	11 239 322

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil.
[1] The capacity figures, as of January 1 in each year, take into account both new and obsolete capacity anticipated for the year. [2] Produced mainly from electric furnaces.

TABLE 2. CANADA, PIG IRON PRODUCTION, SHIPMENTS, TRADE AND CONSUMPTION, 1990-92

	1990	1991	1992p
		(tonnes)	
Furnace capacity January 1[1]			
Blast	10 025 000	10 060 000	9 688 000
Electric	900 000	900 000	900 000
Total	10 925 000	10 960 000	10 588 000
Production			
Basic	w	w	w
Foundry iron[2]	w	w	w
Total	7 346 127	8 267 542	7 868 635a
Consumption of pig iron			
Steel furnaces[3]	7 441 171	8 176 021	8 046 923a
Consumption of iron and steel scrap			
Steel furnaces	6 554 358r	6 621 519	6 430 883a

Sources: Energy, Mines and Resources Canada; Statistics Canada; Primary Iron and Steel (monthly).
p Preliminary; r Revised; w Withheld to avoid disclosing company proprietary data.
a January to November.
[1] The capacity figures, as of January 1 in each year, take into account both new and obsolete capacity anticipated for the year. [2] Includes malleable iron. [3] Includes pre-reduced iron.

TABLE 3. CANADA, IMPORTS AND EXPORTS, 1990-92

		1990		1991		Jan.-Nov. 1992p	
		World	United States	World	United States	World	United States
IMPORTS							
Iron and steel	(000 t)	4 031	2 515	4 135	2 908	3 679	2 537
	($000)	2 884 602	1 678 924	2 673 842	1 615 545	2 374 521	1 489 293
Rolling mill products	(000 t)	2 480	1 396	2 097	1 314	1 862	990
	($000)	1 734 026	1 022 434	1 517 240	945 029	1 378 905	823 046
Steel mill products	(000 t)	2 915	1 660	2 564	1 586	2 212	1 255
	($000)	2 309 325	1 385 407	2 104 487	1 310 178	1 853 069	1 180 248
EXPORTS							
Iron and steel	(000 t)	4 352	3 037	4 879	2 961	4 616	3 729
	($000)	2 511 712	1 934 601	2 745 357	1 927 815	2 706 419	2 319 793
Rolling mill products	(000 t)	3 408	2 243	3 958	2 170	3 853	2 991
	($000)	1 690 937	1 206 021	1 851 457	1 154 749	1 936 950	1 583 908
Steel mill products	(000 t)	3 968	2 762	4 642	2 747	4 414	3 537
	($000)	2 183 003	1 661 839	2 468 366	1 677 064	2 417 471	2 045 396

Source: Statistics Canada.
p Preliminary.

TABLE 4. WORLD STEEL PRODUCTION FORECAST, 1991 AND 1992

	1991[r]	1992[e]
	(million tonnes)	
WESTERN EUROPE		
EEC		
Belgium-Luxembourg	14.7	13.4
Germany[1]	42.2	39.8
France	18.4	18.0
Italy	25.0	24.8
United Kingdom	16.5	16.1
Spain	12.9	12.6
Netherlands	5.2	5.4
Other EEC	2.5	2.5
Scandinavia	7.6	8.1
Turkey	9.3	10.2
Other	6.5	6.6
Subtotal	160.8	157.4
NORTH AMERICA		
United States	79.7	83.2
Canada	13.0	13.9
Subtotal	92.7	97.1
OTHER ADVANCED		
Japan	109.6	98.1
South Africa	9.4	9.2
Australia/New Zealand	6.9	7.6
Subtotal	125.9	114.9
Total, developed regions	379.4	369.4
LATIN AMERICA		
Brazil	22.6	23.9
Mexico	7.9	8.4
Other	8.6	8.8
Subtotal	39.1	41.1
DEVELOPING ASIA		
South Korea	26.0	27.8
India	17.1	18.1
Other	19.0	19.2
Subtotal	62.1	65.1
AFRICA-MIDDLE EAST		
Africa	5.2	5.1
Middle East	4.8	5.6
Subtotal	10.0	10.7
Total, developing regions	111.2	116.9
Total, market economies	490.6	486.3
EASTERN EUROPE/CPEs		
Former U.S.S.R.	132.8	111.2
Eastern Europe[2]	33.1	29.1
China	71.0	80.2
Other CPEs	7.3	7.2
Subtotal	244.2	227.7
Total, world	734.8	714.0
% Change	–5.2	–2.8

Source: International Iron and Steel Institute.
CPE Centrally Planned Economies.
[e] Estimated; [r] Revised.
[1] Includes East Germany beginning in 1990. [2] Excludes East Germany beginning in 1990.

Recycled Metals

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(This article provides an industry overview for recycled metals as it is the first time this topic is featured in the *Canadian Minerals Yearbook.*)

Successful recycling depends upon three conditions:

- a source of recyclable material;
- an infrastructure to collect the recyclable material; and
- markets for the recyclable material.

Metals possess the unique characteristic of retaining their elemental properties throughout use and re-use. Metal recycling is, in fact, the use and re-use of valuable raw materials. The value of metals and metal recycling is not a recent discovery. Biblical references to the beating of swords into plough-shares illustrate that the benefits of metal recycling and reclamation were as well recognized by early civilizations as they are today.

It is only in recent years that the concept of recycling has been brought to the fore. The realization that our natural resources are finite in nature, that our generation and disposal of solid waste is choking our landfills, and that future generations are entitled to a clean environment, have all contributed to an awareness of the requirements of, and the necessity for, recycling.

Because of their high value, metals are not discarded as waste. It is likely that the original copper forged to make cooking cauldrons in historical times is still in existence in some modern industrial application. The gold cast into jewellery for use by ancient kings may today very well form the coatings on electronic circuit board connectors to ensure the reliable transmission of energy.

Metal recycling is an economic activity in which products, whose designed usage has been served, now become raw material products in the recycling chain. Metal recycling embodies the spirit of sustainable development.

METAL-RECYCLING CHAIN

Sources of Scrap

Scrap metal arises from two main sources: new production materials and obsolete materials.

New production scrap arises from the manufacturing sectors, who generate unused or excess materials. These unused or excess materials may be recycled internally, in which case they are called "home" scrap. New production scrap that is not recycled within the same organization is referred to as "prompt" scrap. These materials are not considered as waste. Manufacturers fully realize that scrap metal is a valuable source of raw material to the recycling industry. Anticipated revenues that may be generated by the sale of these excess raw material products are included in pro forma financial accounting statements. Industrial manufacturing companies are the largest source of scrap metal.

Obsolete scrap metal arises primarily from consumer or industrial goods that have effectively served their useful life. The construction/demolition industry is one source of such scrap metal. A second source of obsolete metal scrap is public and private utilities. Through their activities of repairing, replacing and upgrading equipment, these utilities generate significant volumes of scrap metal. This scrap metal is generally sold into the metal-recycling industry via a tendering process. A third significant volume of scrap metal arises directly from the general public, whose house-cleaning and renovating activities may generate recyclables such as cast iron bathtubs, radiators, and aluminum siding. Many home renovators collect their metal recyclables and sell them directly to local scrap metal dealers. Larger, less-transportable consumer items may be picked up by smaller scrap collectors.

Scrap Peddlars

These small collectors, or "peddlars," serve an integral function within the recycling chain. They represent an important first step in the collection process. Peddlars are able to economically collect metal recyclables in quantities considered too small for sourcing, even by small scrap metal companies. Peddlars typically sell their scrap metal recyclables to small- or medium-sized scrap metal processors or "dealers."

Scrap Dealers

The scrap metal dealers may perform a variety of physical processing activities on these metals. These activities include sorting by quality, shearing of contaminating attachments, and bundling or baling into forms suitable for transportation. Scrap dealers purchase directly from smaller industrial manufacturers to supplement the quantity of metal recyclables purchased from both peddlars and the general public. After an economically transportable quantity of scrap metal has been collected, these recyclables are sold to a large processor or metal "wholesaler."

Scrap Wholesalers

A well-equipped wholesale scrap metal-recycling facility can easily require a capital investment in excess of $10 million. Standard material-handling equipment will include guillotine shears, high-speed automated balers, hydraulic cranes, front-end loaders, alligator shears, elemental analyzing equipment, and a variety of transportation vehicles. Metal-recyclable materials are crushed, sheared and compressed to produce products which conform to the purchasing specifications of particular consumers. Scrap metal wholesalers compete internationally. They buy and sell world-traded metal commodities. Freely traded commercial exchanges determine the prices for these recyclable metals. Two of the more well-known terminal markets are the London Metal Exchange (LME) and the New York Commodity Exchange (COMEX).

Scrap Brokers/Traders

Scrap brokers provide an invaluable service to the metal-recycling community. Brokers of scrap metal act as intermediaries between scrap dealers, scrap wholesalers and scrap consumers. They generally possess a wider range of industry contacts which enable them to effectively match companies wishing to purchase scrap with companies wishing to sell scrap. While scrap brokers may not take physical delivery of the materials, they are, in many instances, the legal owners of the scrap.

Scrap brokers may also perform a type of "flow control" for consumers. Consumers may often wish to purchase scrap material in the spot market, but may only wish to receive this material at some later date. The scrap broker may be in a position to directly purchase scrap material for the particular consumer and arrange for the deliveries at dates suitable to the individual consumer's needs. In this instance, the broker may act both as an intermediary and as a financier. Many industrial companies do not have the in-house expertise to efficiently market their scrap materials. In these cases, scrap metal brokers can provide experienced marketing services for the benefit of the company, the broker, and the ultimate scrap consumer.

Consumers of Scrap

Ingot-Makers/Smelters/Refiners

Ingot-makers, smelters and refiners represent an intermediate processing sector within the metal-recycling industry. Ingot-makers and refiners purchase scrap metal of a uniform alloy or metallic consistency. This metal is remelted to produce a semi-fabricated product for use in the manufacturing process. Automobile radiators and brass plumbing valves are examples of typical raw materials purchased by ingot-makers.

Smelters treat metal materials that are complex or contain many metallic impurities. Smelters can effectively separate alloyed metals into their component elements. Many metal products must conform to strict specifications. These may demand that an individual element be present in less than one part per million. Conformity to these strict specifications is possible through refining and alloying processes.

Foundries/Mills/Casters

Foundries, mills, die casters, extruders and other manufacturers purchase products directly from individual scrap dealers, smelters or ingot-makers. These specialized purchasers produce products such as steel beams, copper wire, aluminum window frames and brass valves.

Metals Identification

Scrap metals are initially identified by their magneticity or lack thereof. Metals that are magnetic are called "ferrous metals"; metals that are nonmagnetic are "nonferrous metals." There are more than 100 different grades of ferrous metal scrap and many times that number of nonferrous metal scrap grades. The recovery processes used to recycle ferrous and nonferrous metals are as numerous as the number of different metals and metal compounds.

While many of the more traditional labour-intensive activities have benefitted from modern technologies, the true expertise required in the scrap metal-recycling industry has remained unchanged. Material must be correctly identified before processing can occur. The scrap dealer must have a thorough knowledge of metals and metal compounds. The scrap dealer is often required to purchase materials on an immediate basis, and must be prepared to instantly identify and evaluate the quality of the offered material. Experienced "metals-men" can successfully identify the majority of scrap metal by simple visual means. With the use of a file or drill, the bare metal can be exposed. This bare metal will exhibit a particular colour, shading or texture which provides important clues on the metal's identity. If uncertainty still exists, the application of acidic spot tests can generally narrow down the number of potential metal candidates. Advancements in metal identification techniques include the use of spectrographs and highly advanced X-ray spectrometers.

CANADIAN SCRAP METAL-RECYCLING INDUSTRY

Canada has a well-established, effective metal-recycling industry. The Canadian scrap metal-recycling industry comprises over 1000 companies. The majority of these companies handle both ferrous and nonferrous metals. Collectively, Canadian recycling companies handle in excess of 10 Mt of metals annually valued at more than C$5.5 billion.

The size and composition of Canadian scrap metal companies vary from individual scrap collectors to sophisticated, capital-intensive metal-processing plants. The recycling infrastructure can be viewed in the form of a two-tiered pyramid. Approximately 1000 companies comprise the base of this pyramid. They include scrap peddlars and small- to medium-sized metal-recycling dealers. Large scrap metal companies comprise the uppermost layer of this recycling network. Large scrap recyclers or "wholesalers" are typically located in highly populated cities where there is an abundant source of raw metal material to be recycled. A large scrap metal-recycling company can typically process in excess of 6000 t/y of nonferrous metals and 40 000 t/y of ferrous metals. There are 43 metal-recycling wholesalers located in Canada.

The provincial distribution of Canadian scrap metal-recycling companies is shown in the following table.

CANADA, RECYCLING COMPANY DISTRIBUTION, BY PROVINCE

Province	No. of Scrap Companies	Percent
British Columbia	125	15
Alberta	75	12
Manitoba	50	10
Ontario	290	56
Quebec	200	35
New Brunswick	24	8
Nova Scotia	60	12
Prince Edward Island	8	3
Newfoundland	10	4
Total	1 074	100

The highest number of metal-recycling companies are located in the provinces of Ontario, Quebec and British Columbia. Not surprisingly, these three provinces also represent the largest concentration of population and manufacturing industries.

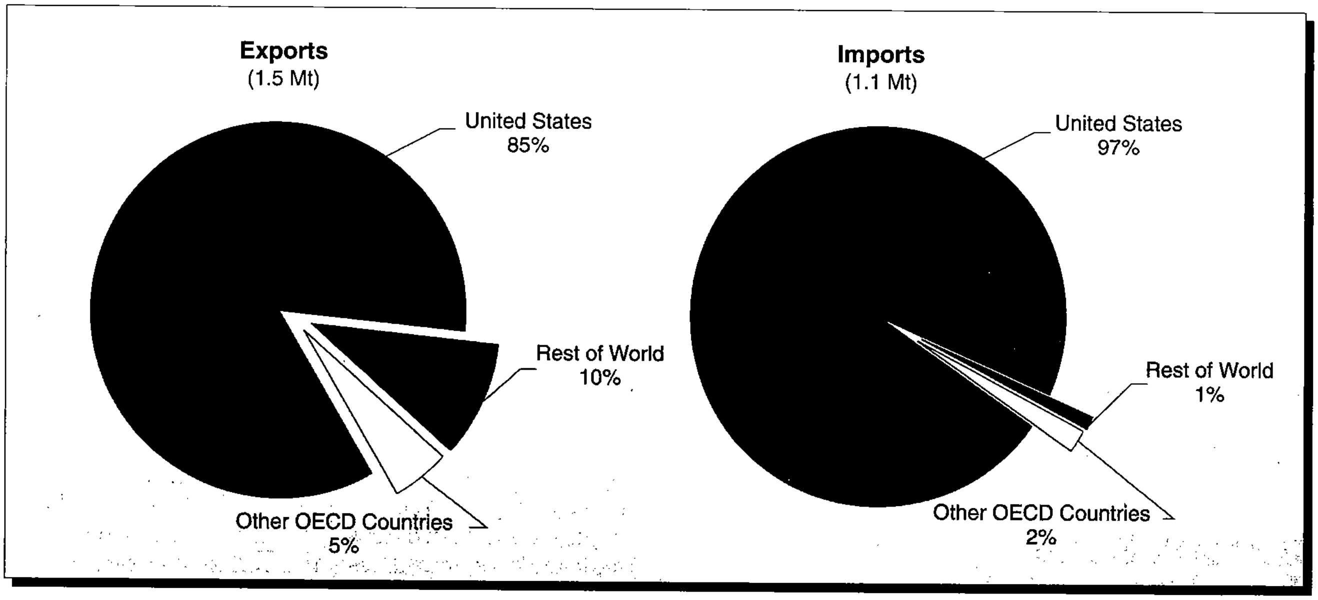
The Canadian scrap metal-recycling industry directly employs approximately 20 000 persons. This employment figure does not include employees of ingot-makers, foundries, steel mills, smelters or refiners. While ingot-makers, foundries, smelters and refiners certainly form an essential part of the total recycling industry, many consider themselves wholly integrated. It may be difficult to clearly differentiate between personnel who are strictly involved in scrap recycling operations and those whose activities are considered to be in manufacturing. Rough employment estimates indicate that an additional 60 000 jobs may be directly or indirectly involved in the Canadian metal-recycling industry.

International Trade of Recyclable Metals

Canada maintains a positive international scrap metal trade balance. Canadian international trade in recyclable metals during 1991 approached 3 Mt valued at $1.5 billion. As Illustrated in Figure 1, 85% of Canadian recyclable exports and 97% of Canadian recyclable imports are with the United States. Trade within the 24 Organization for Economic Cooperation and Development (OECD) countries (Table 1) accounts for 90% of Canadian recyclable exports and 99% of Canadian recyclable imports.

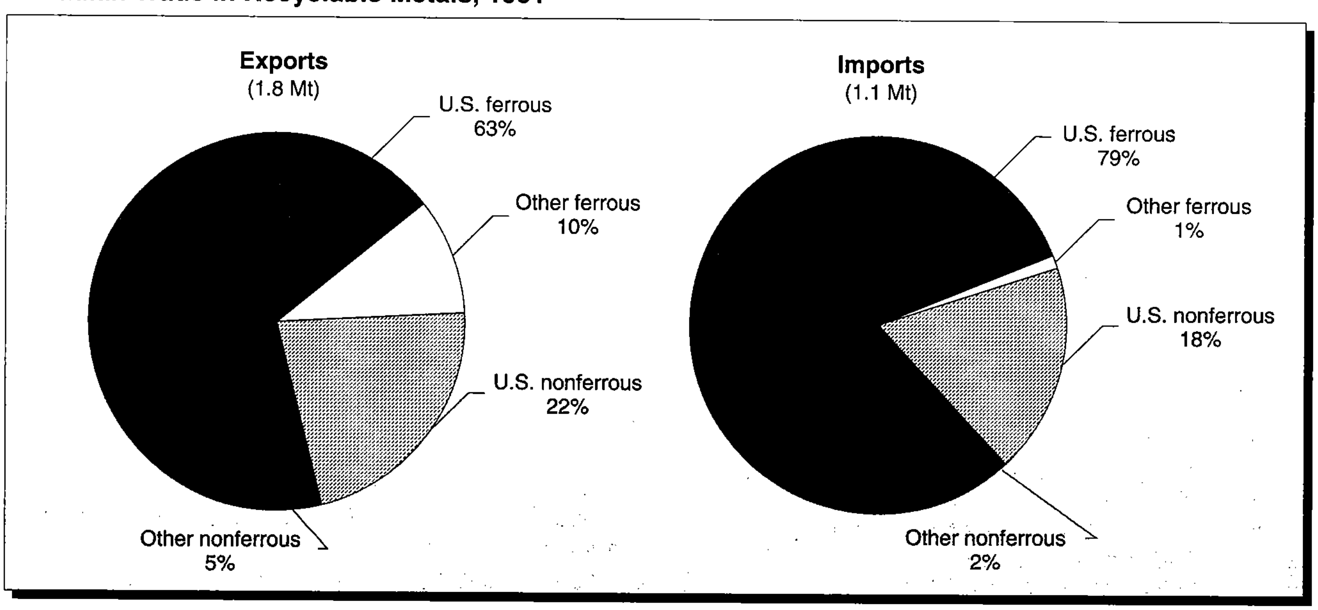
Steel scrap metal recycling represents the largest volume of recycled material in Canada. Figure 2 illustrates the component proportions of ferrous and nonferrous recyclables in Canada's international trade. Canada exported 1 334 000 t of steel scrap in 1991. This steel scrap export accounted for 73% of the total Canadian recyclable export volume. Canada imported 872 000 t of steel scrap in 1991. This import trade accounted for 78% of the total Canadian recyclable import volume.

Figure 1
Canadian Trade in Recyclable Metals, 1991



SOURCE: Statistics Canada, 1991.

Figure 2
Canadian Trade in Recyclable Metals, 1991



SOURCE: Statistics Canada, 1991.

Nonferrous scrap-metal recycling represents the majority of the value in Canada's international trade. Canada exported 488 000 t of nonferrous metal scrap valued at C$609 million in 1991. These nonferrous scrap metal exports accounted for 79% of the value of total Canadian recyclable exports. Canada imported 252 000 t of nonferrous scrap metals valued at C$586 million for the year 1991. These imports accounted for 87% of the value of Canada's total metal-recyclable imports. Table 2 provides a statistical summary of Canada's exports and imports by metal commodity group.

The province of Ontario is the major gateway for Canada's international trade in metal recyclables. More than 50% of both exports and imports cross Ontario borders. Table 3 provides a summary of Canada's recyclable exports and imports by province of lading.

ALUMINUM RECYCLING

Sources

Aluminum scrap arises in many different forms. New production aluminum stampings, door and window frames, aluminum venetian blinds, aluminum car and home radiators, aluminum siding, automobile transmissions, and aluminum electrical wires are all sources of scrap aluminum. Aluminum packaging and aluminum use in containers represent roughly 30% of aluminum consumption. Ninety-five percent of all beverage cans are made of aluminum.

Aluminum Scrap Classification

Aluminum scrap has traditionally been identified, segregated and sold using descriptive rather than elemental names. Accordingly, categories of scrap aluminum have names such as aluminum castings, aluminum siding, aluminum extrusions and painted aluminum. As most of these descriptors identify an application or usage, a number of different aluminum alloys can exist within each of these descriptive groupings.

The segregation of aluminum scrap by elemental alloy involves the testing of the aluminum scrap to determine the component elements contained within the alloy. As alloy identification technologies have improved and elemental analyzing equipment costs are being reduced, scrap metal recyclers are finding that classification by elemental alloy groupings is increasingly possible. Furthermore, this segregational upgrading of aluminum scrap is encouraged by consumers who are willing to pay premium prices for segregated aluminum alloys. While this elemental segregation is best suited to new production scrap arisings, many scrap dealers are now using these technologies to identify their entire scrap product purchases.

Used Aluminum Beverage Cans

Used aluminum beverage can (UABC) recycling represents a growing sector for the aluminum recycling industry. Prompted both by environmental concerns for waste reduction and the cost savings realized through the use of recycled scrap products, there is a strong incentive to increase and improve the collection network for UABCs.

Unlike the majority of recyclable products arising from the post-consumer sector, UABCs can be economically recycled. Post-consumer materials, such as newspapers, constitute 70% of the volume in the consumer waste stream yet offer very low recycled values. Aluminum, on the other hand, comprises less than 1% of the recyclable post-consumer waste volume yet contributes exceptionally high economic value. The average price paid by recyclers for UABCs in 1991 was C$1500/t. This compares to a value for newspapers of C$22/t. Aluminum materials collected in curbside recycling programs contribute an estimated 40% of the generated revenues.

The markets for post-consumer aluminum products are established and stable. The recycling technologies are both competitive and economical. The existing collection infrastructure for post-consumer aluminum packaging products is the weak point of the three requirements for successful recycling.

The growth of post-consumer curbside recycling programs, together with the support of the aluminum industry, has greatly contributed to increases in aluminum packaging recycling rates.

ALUMINUM CAN RECYCLING RATES IN REPORTING OECD COUNTRIES

Country	Consumption	Recycling Rate
	(million cans)	(%)
Sweden	850	83
Iceland	30	75
United States	86 513	64
Australia	2 523	62
Canada	2 968	60
Japan	8 346	42
Switzerland	95	40
Greece	480	25
Austria	190	24
Italy	1 510	10
Ireland	130	8
United Kingdom	4 250	6
France	950	5

Canada's UABC recycling rate for 1991 is estimated at 60%. With the exception of the provinces of Ontario and Manitoba, the sale of beverages and beverage alcohol in aluminum cans requires a deposit to be added to the price of the beverage. This nominal deposit is refunded when the used can is returned for recycling. The rationale of this deposit program is to encourage the recycling of aluminum beverage containers by emphasizing the value aspect of the aluminum product.

Province of Ontario – Environmental Tax

The province of Ontario does not require a deposit on soft drink beverage containers. However, there is a voluntary deposit on alcohol beverage containers. The estimated recycling rate of aluminum beverage containers in the province of Ontario is in excess of 88%.

The province of Ontario has stated that refillable beverage containers are environmentally preferable to non-refillable recyclable beverage containers. Accordingly, the Ontario government imposed an environmental tax on alcoholic beverages packaged in non-refillable recyclable containers. The Ontario provincial government has specifically targeted aluminum beer cans for this additional environmental tax; it maintains that re-usable glass bottles are environmentally superior to recyclable aluminum containers.

The aluminum industry maintains there is no environmental benefit to be gained in the province of Ontario through the use of refillable glass containers in preference to recyclable aluminum containers. In fact, the aluminum industry has demonstrated that there is a larger generation of waste using refillable glass containers compared to the use of recyclable aluminum cans. This waste generation is caused by the disposal of the steel twist-off cap which seals the glass bottles.

Environmental Benefits of Recycling Aluminum

Aluminum recycling is both economically and environmentally desirable. The table below quantitatively illustrates the environmental benefits gained through the production of aluminum using recycled materials versus the production of aluminum using virgin materials.

ENVIRONMENTAL BENEFITS OF ALUMINUM RECYCLING

Activity	Savings
	(%)
Energy conservation	95
Virgin material conservation	79
Reduction of emissions	95
Reduction of effluents	97

Source: U.S. Environmental Protection Agency.

Secondary Aluminum

Uses

The largest end use for secondary aluminum is the automotive industry, which accounts for approximately 80% of demand. Other uses for secondary aluminum include its use as a deoxidizing agent in steel production and in the production of aluminum beverage cans. An average of 77 lb of aluminum was used in each new car produced in 1971. This figure rose to 151 lb of aluminum per car by 1991. Auto industry experts anticipate that aluminum usage will more than double by the year 2000. The resistance to the wider use of aluminum in the automotive industry is caused by current fixed asset investments in steel-related production technologies. The aluminum industry claims that vehicle weights could be reduced by 35%-40% through the increased use of aluminum in body-frame components. Moreover, even though aluminum is present in less than one tenth of the unit weight of steel, the scrap value of aluminum in new cars closely approaches the value of steel scrap.

World Production

World production of secondary aluminum in 1991 is estimated at 5 570 000 t. This secondary aluminum production represents 33% of the total world refined aluminum production and 37% of the total world refined aluminum consumption. Table 4 illustrates the world production of secondary aluminum by geographic region.

LME Secondary Aluminum Contract

The establishment of a formal trading contract on the LME for secondary aluminum underlines the importance of secondary aluminum to world metal industries. The new LME contract began three-month trading on October 6, 1992, and cash trading on January 4, 1993. Twelve warehouses have been authorized by the LME to accept delivery of the secondary aluminum alloy. These warehouses are in Belgium, France, Germany, Holland, Italy, the United Kingdom and the United States. The LME has approved 47 brands of aluminum alloy, including the German DIN 226, the Japanese ADC12, and the U.S. 380-1. Alloy specifications for the secondary aluminum contract are presented in Table 5.

It should be noted that the production of secondary aluminum does not represent the sole use of recycled aluminum materials. Scrap aluminum is directly purchased by many manufacturers for use as a raw material. The new LME secondary aluminum contract enables producers, manufacturers, traders and scrap dealers to lock in forward prices, thereby offering some protection from price fluctuations. This LME contract provides a common sale reference price to all secondary producers. Accordingly, the value of scrap aluminum should be more transparent to all parties concerned. As with all terminally traded commodities, the success of this secondary aluminum contract will largely depend upon its acceptance as a suitable hedging vehicle.

Canadian Secondary/Scrap Aluminum Production and Consumption

Canada produced 67 660 t of secondary aluminum in 1991. Canadian manufacturing companies purchased 151 655 t of aluminum scrap and 74 998 t of secondary aluminum for consumption in 1991. These scrap and secondary aluminum purchases represent roughly 37% of the total Canadian consumer aluminum purchases. Table 6 presents Canada's purchases of scrap and secondary aluminum, together with the percentage of the total Canadian consumer aluminum purchases.

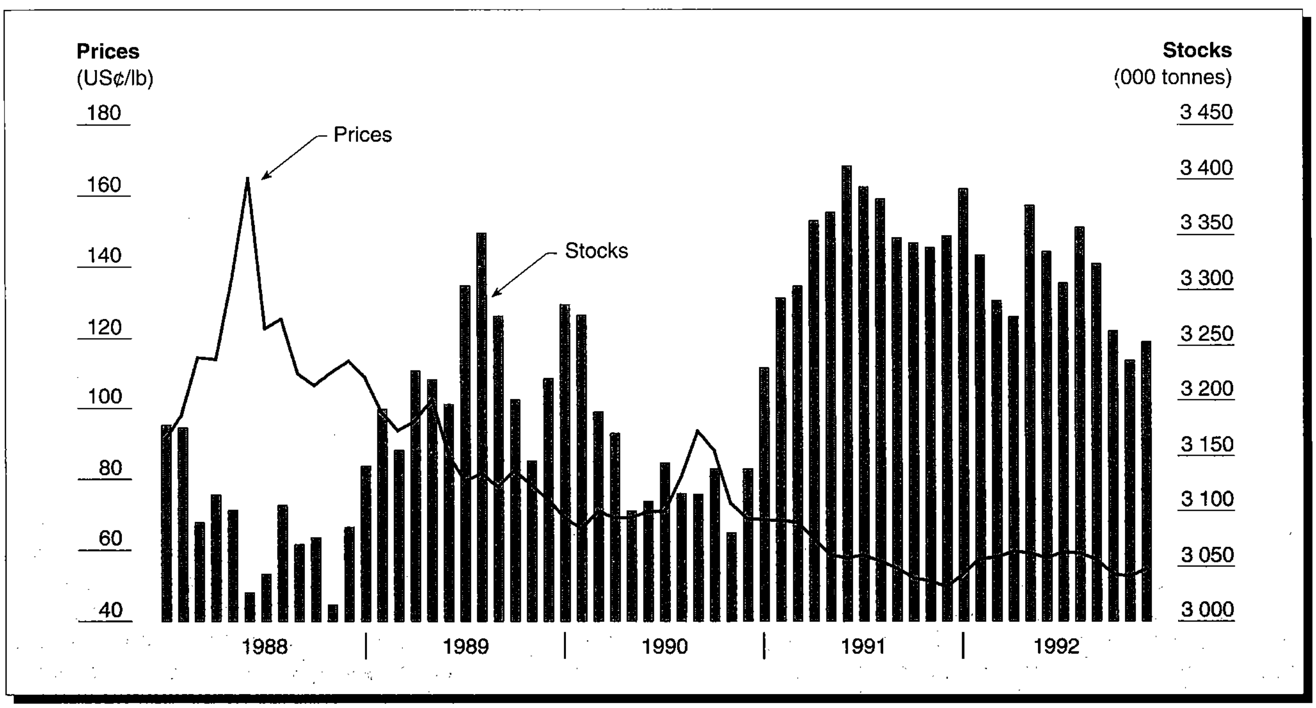
Canada recycled an estimated 437 300 t of scrap aluminum in 1991. Table 7 estimates the amount of scrap aluminum recycled in Canada.

Canada is a net exporter of recycled aluminum scrap. Canada exported 200 000 t and imported 47 000 t of scrap aluminum in 1991 (Tables 8 and 9). The United States received 87% of Canada's total scrap aluminum exports in 1991. Japan was the second largest recipient at 9% of the total aluminum export volume.

Prices

Prices for both primary aluminum and scrap aluminum (Figure 3) are expected to remain unchanged throughout 1993. There has been a large influx of

Figure 3
Aluminum Prices[1] and Stocks,[2] 1988-92



1 Average monthly London Metal Exchange (LME) prices.
2 International Primary Aluminium Institute (IPAI) stocks (all forms).
SOURCE: Energy, Mines and Resources Canada.

aluminum from the former Soviet Union, which has contributed to high stock levels on the LME and with producers.

Lead Recycling

Uses of Lead

Lead is one of the least recognized metals in our daily lives. It is used as a construction material in roofing, and it is used more and more as a partition sound barrier in multiple-dwelling complexes.

Lead is the metal of choice in the nuclear industry because of its resistance to gamma radiation and Xrays. Accordingly, it is used as a protective shielding around X-ray equipment and nuclear installations.

Lead is also used in a variety of other applications, including the production of crystal, light bulbs, television and computer screens, keels for pleasure boats, and protective wrappings for underwater electrical transmission cables.

More than 70% of all lead is used to produce lead-acid batteries. The average automotive lead-acid battery contains approximately 10 kg of lead. The electrical storage battery is by far the most successful battery ever developed and, in most of its applications, no viable substitute exists. The average useful life of an automotive lead-acid battery is estimated at four years. Contrary to popular opinion, hot weather reduces battery life more than cold weather does. Hot temperatures increase the evaporation of battery electrolytes which results in discharge failure in cold weather conditions. Accordingly, the battery failures experienced during the first cold snaps of winter are caused by the hot temperatures of both the preceding summer period and the vehicle's under-hood operating conditions.

Types of Scrap Lead

Lead is one of the most recycled and recyclable of metals. More than 90% of all the lead consumed in Canada can be effectively recycled. The principal types of lead scrap are batteries, battery plates, drosses, skimmings, and industrial scrap such as cables, solders and babbitts. While some lead is present in metallic form and needs only to be remelted and refined, the majority of lead scrap is present as a combination of metallic lead, oxides and sulphates. The recycling of these lead compounds requires complex metallurgical reduction processes.

Lead Recycling in Canada

There are seven lead smelters located in Canada. Table 10 provides a summary of their geographical location and processing capacities.

Canadian Production of Secondary Lead

Canada produced 107 000 t of recycled lead in 1991. This represents roughly 50% of total Canadian lead production. It is estimated that Canadian recycled lead production will increase to 60% of total lead production by the year 2000 (Figure 4). The principal reason for the anticipated increase is that Canadian primary lead smelters are using larger quantities of scrap lead-bearing materials to supplement their concentrate-based raw material feed. Lead scrap from spent lead-acid batteries is relatively homogeneous in elemental consistency when compared to many of the complex lead ores and concentrates typically processed by primary lead smelters.

There are 10 battery-breaking facilities in Canada. Table 11 summarizes their names and geographic locations in Canada.

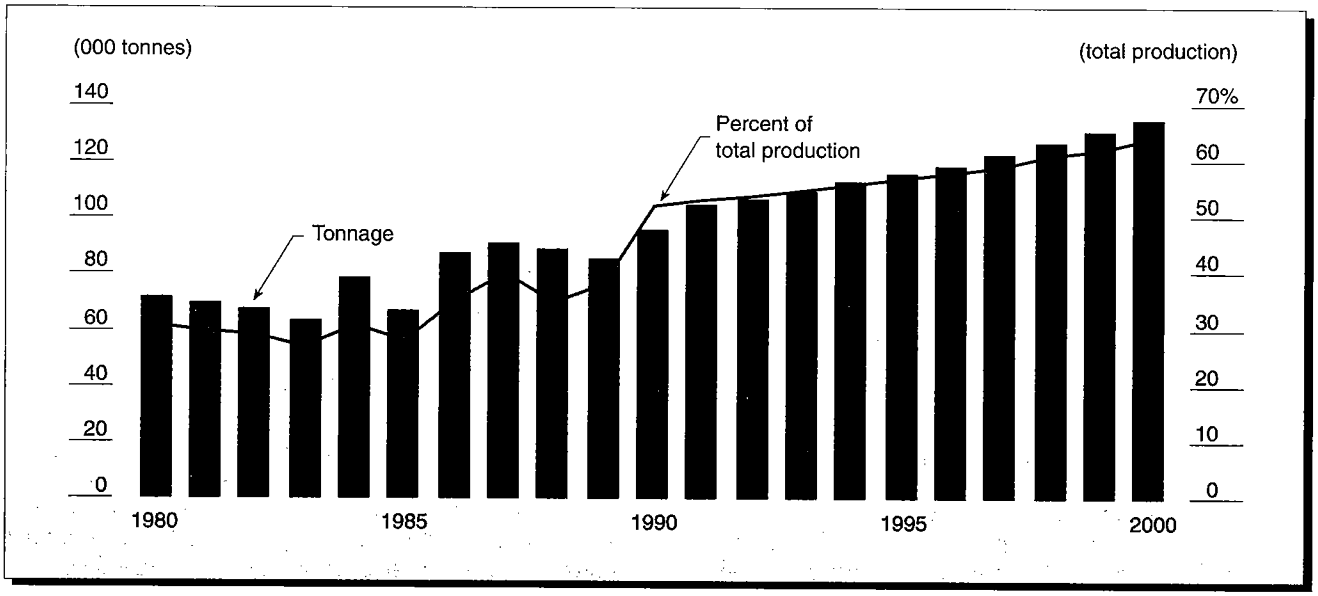
Lead-Acid Battery Recycling Rates

Energy, Mines and Resources Canada estimates that Canadian lead recyclers processed in excess of 119 000 t of Canadian-sourced spent lead-acid batteries in 1991, representing a 94% recycling rate. This compares favourably with a 97% recycling rate estimate in the United States for the same year. The European Community estimates its lead-acid battery recycling rate to be in excess of 60% for 1991.

Scrap Lead Recycling Chain

The lead recycling industry has developed an efficient and effective recycling chain for spent lead-acid batteries. The recycling chain begins with the individual consumer. The consumers' decisions about how their lead-acid batteries will be replaced play a major role in determining if, how, and how quickly the spent products will be recycled. Consumers can return their spent lead-acid batteries directly to the retailer from whom they purchase a new battery. Most consumers leave their spent product at their automotive garage. These spent lead-acid batteries are returned directly to the original manufacturer or, alternatively, they are purchased by peddlars. The peddlars may sell these batteries either to scrap dealers or directly to lead smelters.

Figure 4
Canadian Recycled Lead Production, 1980-2000



SOURCE: Energy, Mines and Resources Canada.

While the structure of the Canadian lead recycling industry typically mirrors that of the Canadian scrap metal industry, there are some exceptions. The province of British Columbia has recently introduced an initiative to encourage the recycling of spent lead-acid batteries. Provincial authorities have imposed a C$5.00 deposit on the sale of new lead-acid batteries. Battery retailers are further required to take back spent products at their retail outlets. The deposit fee is used to finance the costs for spent lead-acid batteries to be transported from remote provincial regions to centrally located battery breakers.

The province is divided into 12 sectors. Each sector is assigned a transport allocation fee which serves to subsidize the transportation freight charges. This sector-based allocation is calculated on a monthly basis. The calculation incorporates factors including the distance to the nearest breaking facility and the published price for lead.

This program is an attempt to ensure that spent lead-acid batteries always maintain a positive economic value. Preliminary results of the program are encouraging. Estimates for the provincial battery recycling rate exceed 100%. A recycling rate in excess of 100% can be explained by the influx of previously held lead-acid battery inventories. As these battery inventories are drawn down, the recycling rate estimate figures should normalize.

Similar programs, sponsored by the Battery Council International, have been successfully introduced in the United States. Typically, these programs all contain similar elements such as mandatory take-backs at retail outlets, bans on improper disposal and, in some states, deposits and/or charges on the sale of new products. The Battery Council International has determined that the essential elements for successful battery recycling include a mandatory take-back policy at the retail level and a ban on the improper disposal of spent lead-acid battery products.

Product Stewardship

Canadian battery manufacturers have recently developed their own product stewardship programs. These programs involve the return of spent lead-acid batteries collected from the retail outlets where new battery products are delivered. Pilot programs are continuing in eastern Canada, principally through Canadian Tire Corporation retail stores. The spent batteries collected from this program are returned directly to a secondary lead smelter for processing. The battery manufacturer can negotiate either a direct sale of this spent product with the smelter or a tolling arrangement. A tolling arrangement involves the return of lead to the battery manufacturer in exchange for spent lead-acid batteries plus a pre-determined conversion fee. This stewardship program will remove increasing percentages of lead-acid batteries from the traditional scrap metal dealer network.

Non-domestic battery manufacturers, such as Johnson Controls Inc., Exide Battery Inc., GNB Inc., and East Penn Manufacturing Co. Inc., are similarly involved in product stewardship spent lead-acid battery return programs in Canada.

World Secondary Lead Production

Secondary lead production accounts for a little over 50% (Table 12) of the total world refined lead production. Secondary lead smelters produced 2 236 200 t of secondary lead in 1991. The United States, as the dominant source for secondary lead, produced an estimated 848 800 t in 1991.

Economics, Prices and Outlook

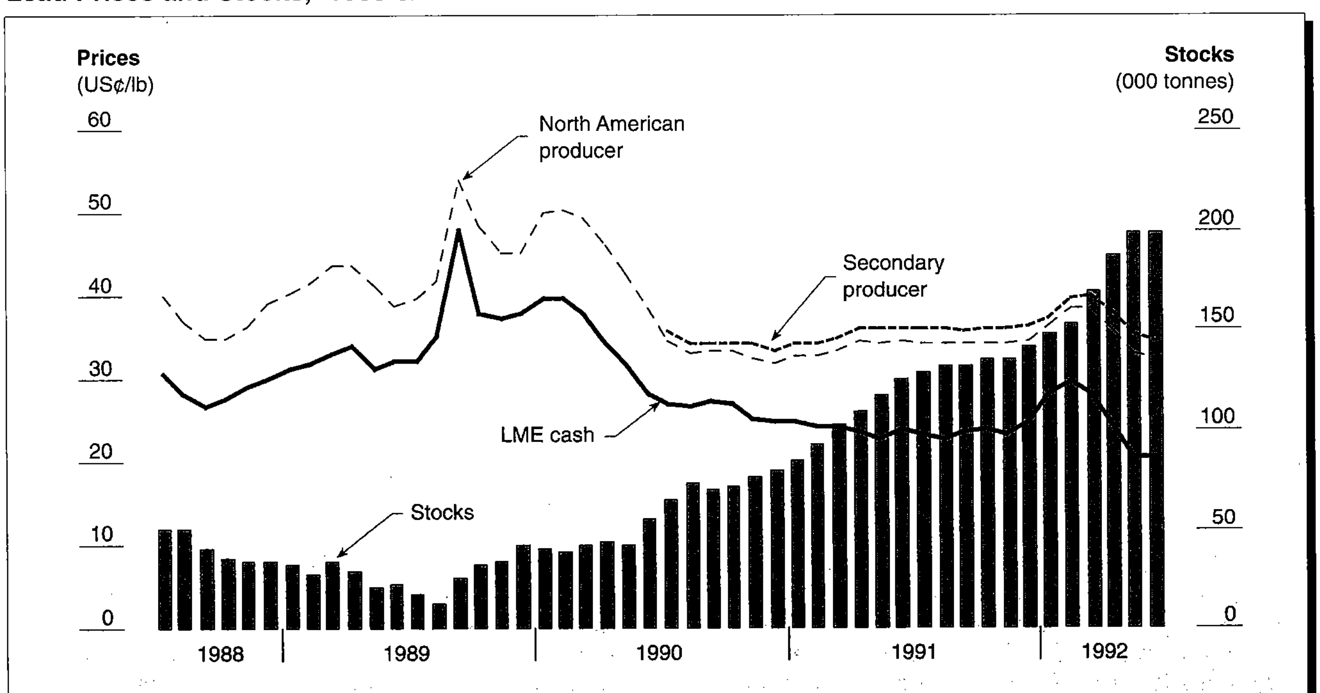
The current economics of secondary smelting and refining of lead are very poor. Transaction sale prices of lead in North America are chiefly based upon the LME plus a monthly premium established by ASARCO Incorporated. This monthly premium is calculated so as to preclude the shipment of European-produced lead to North America. The monthly Asarco premium in late 1992 was about US4¢/lb.

North American secondary production costs to convert spent lead-acid batteries to refined lead products are estimated to be US$13.25/lb. If the current purchase price for spent lead-acid batteries is estimated at US5¢/lb on a pick-up basis, then lead produced at the secondary smelter facility has a cost value of approximately US25.25¢/lb. The estimated sales price of lead to major North American consumers is US23-24¢/lb. It is clear that there exists very little, if any, profit margin for the direct sale of lead in the current market.

The price for spent lead-acid batteries at the end of 1992 was about US$5-6/lb on a pick-up basis. While battery prices generally tend to fluctuate with the LME price for lead, they do exhibit their own demand/supply curves. Many secondary smelters have annual supply commitments with their major lead-consuming clients. These product commitments must be honoured. In periods of reduced raw material supply, secondary smelters rely upon stored inventories or they are forced to offer higher prices to attract their essential raw material. Major tolling agreements can also force

Figure 5

Lead Prices and Stocks,[1] 1988-92



1 Average monthly London Metal Exchange (LME) prices and stocks.
SOURCE: Energy, Mines and Resources Canada.

lead producers into the raw material marketplace to replace lead units that were received from battery producers in seasonally high battery return periods.

The lead market is currently at its lowest level since the early 1980s. Figure 5 illustrates the historical prices for lead superimposed upon the published LME lead stock levels. Lead inventories on the LME are currently in excess of 200 000 t. It is unlikely that lead prices will increase substantially until much of this stock inventory overburden has been reduced.

COPPER AND BRASS RECYCLING

Sources of Scrap Copper and Brass

The production of copper wire accounts for 40% of the total consumption of refined copper. Accordingly, copper scrap arises principally in the form of scrap wire. Other major sources of scrap copper include copper tubing, electrical motors and copper sheeting. Copper scrap also arises in the form of residues. Consequently, copper will be recovered from metallurgical compounds, metallic dusts, electronic scrap, copper-containing ashes, and copper-containing sludges.

Bronze alloys contain varying percentages of copper and tin as their principal elements. They may also contain smaller proportions of both lead and zinc. Brass alloys contain copper and zinc as their principal elements and may also contain smaller proportions of both tin and lead. Brass and bronze scrap arises in forms such as water valves, plumbing fixtures, auto radiators, cast machinery, train brake linings, ship propellers, brass pipes, water condenser tubes, and lighting fixtures.

Classification of Scrap Copper

There are four general categories or grades of scrap copper: No. 1 copper, No. 2 copper, No. 3 copper, and copper-bearing material. The grades differentiate from each other in the percentage of contained copper content. No. 1-grade copper must contain a minimum of 98% copper. No. 2-grade copper contains a minimum of 94%, while No. 3-grade copper nominally contains a minimum of 92% copper. Copper-bearing materials do not contain a minimum copper content. The acceptability of copper-bearing materials by the refinery is more dependent upon the remaining trace elements present in the material.

No. 1 copper scrap is further differentiated between "bare bright" copper and "burnt" copper. This further differentiation reflects the type of processing method which has prepared the copper scrap for economic trade.

Scrap copper wire is initially segregated according to the gauge or thickness of the wire. Copper wire of one-sixteenth-inch gauge or greater in thickness generally passes for a No. 1 grade of scrap. Copper wire of less than one-sixteenth-inch gauge is generally categorized as a No. 2-grade scrap. Copper sheeting is generally considered a No. 3 grade of copper scrap. The copper tubing used in plumbing systems is accepted as a No. 2 grade of copper. New production copper tubing, however, will be equivalently accepted as a No. 1 grade of copper scrap.

Consumers of Copper and Brass Scrap

Most copper scrap is consumed by refineries. Scrap copper represents an important raw material which supplements the feed from mining operations. While copper wire can generally be directly consumed at the refinery level, copper-bearing materials must first be smelted. Mixed grades of brass also represent excellent raw material feed for the copper smelter.

The majority of brass and bronze scrap is purchased by ingot-makers. Ingot-makers produce brass and bronze alloys for sale to the foundry industry. They are also the preferred outlet for brass and bronze scrap because they can use the elemental components contained within these raw materials. Copper refiners are primarily interested in recovering the copper fraction of the material. Ingot-makers can generally pay a higher price for brass and bronze scrap than copper producers can because the value of the tin, lead and zinc is not lost to the ingot-maker.

World Copper Scrap Recovery

There were 4 129 000 t of scrap copper recovered in 1991 (Table 13). The United States is the largest source of scrap copper. It is estimated that the United States recovered 1 263 000 t of scrap copper in 1991.

Scrap in Production and Consumption

Scrap copper competes directly with both copper concentrates for production and primary copper for consumption. Scrap copper accounts for close to 40% (Table 14) of the raw material input of refined copper production and consumption (Table 15).

Exports of Copper Scrap

Canada exported a total of 88 160 t of scrap copper and scrap copper-tin alloys in 1991. The United States (Table 16) was the country of import for the majority of this exported product. Tables 16 and 17 illustrate the major scrap copper exports from, and imports to, Canada by selected countries.

Scrap Copper Pricing

Copper scrap is purchased principally by copper smelters, refiners, ingot-makers, brass foundries and industrial manufacturers. Scrap copper pricing (Figure 6) is based upon discounts off either the LME or the COMEX copper quotations. The size of the discount depends upon the demand and supply needs of copper consumers.

STEEL RECYCLING

Sources of Scrap Steel

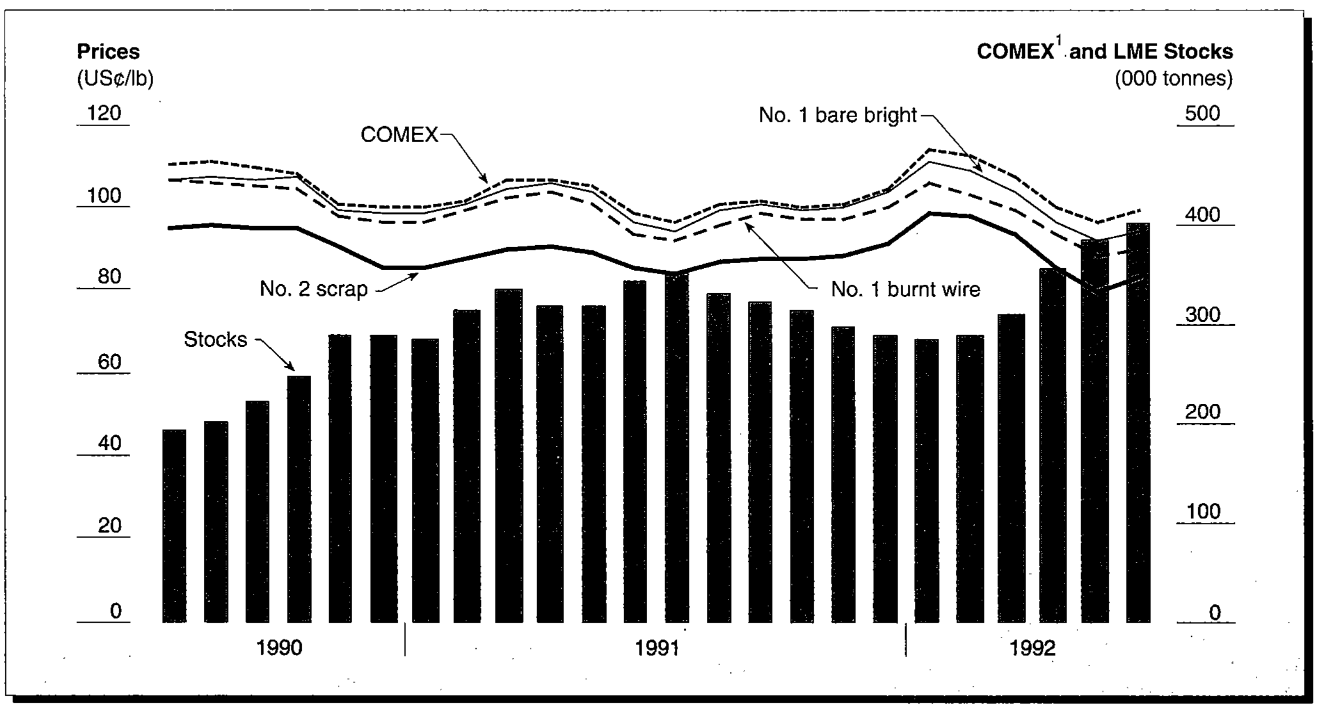
Iron and steel scrap represent by far the largest volume of recyclable material in Canada. Scrap steel arises via three principal channels: internally generated and consumed steel scrap, new production steel scrap, and obsolete steel scrap.

Scrap is generated in the steel production process. This form of scrap never leaves the steel-making production area. It is re-fed into the "heat" and, in essence, becomes a circulating load. It is called "home" scrap and accounts for approximately 25% of total scrap steel consumed by steel mills.

New production scrap steel arises from the manufacturing sector. As new products are produced from steel, the excess steel material generated by these processes forms new production scrap steel. This material is typically sold to the scrap metal industry which processes it for sale to steel mills and foundries.

Obsolete scrap steel arises when industrial and consumer steel products have served their useful life. It is impossible to directly estimate the generation of obsolete scrap steel. This material can be generated at any time from the moment of production to well beyond the end of a product's useful life.

Figure 6
Copper Prices and Stocks, 1990-92



1 New York Commodity Exchange.
SOURCES: Metals Week; Metals Bulletin.

Consumers of Scrap Steel

Steel mills and ferrous foundries consume the majority of scrap steel products. The Canadian iron and steel industry consumed more than 7 Mt of scrap iron and steel in 1991 (Table 18). This consumption tonnage of scrap steel represents more than 50% of the raw material requirements of Canadian steel-making producers. There are 16 electric arc iron and steel mills and 255 iron and steel foundries in Canada. The apparent Canadian recycling figures for iron and steel scrap are presented in Table 19.

Steel-Producing Methods

There are two principal steel producing methods: the integrated or basic oxygen furnace process, and the electric arc furnace (EAF) process. The integrated furnace method of steel production uses smaller quantities of scrap steel to begin the melting process and for the adsorption of heat in the blast furnace. While some of this scrap steel is purchased on the open market, the majority is internally generated and is referred to as "home scrap."

EAF steel mills, commonly referred to as mini-mills, use 100% recycled steel as their raw material input. The scrap steel is melted by passing electricity through carbon electrodes. EAF mills typically depend upon local indigenous scrap for their raw material input. Typically, 25% of the steel consumption by EAF steel mills arises from home scrap. This percentage of self-generated scrap is continually being reduced because of improvements to the steel-producing recovery processes.

Scrap Steel Processing

The scrap steel purchased by steel mills must be of high quality, easily identifiable and readily loaded into charging baskets. The charging baskets need to be easily and quickly emptied into the furnace to prevent heat loss as the furnace roof is removed. The scrap must be prepared in such a manner that the carbon electrodes, upon being lowered into the furnace, will not be damaged by oversized steel pieces. The scrap steel must also fall into the furnace with the least opportunity of damaging the refractory linings.

There are generally four basic methods of processing and preparing scrap steel for commercial sale. The first and simplest method is that of hand torching the product. Gaseous mixtures of acetylene and oxygen, when ignited, produce a high-intensity flame capable of cutting steel pieces into manageable sizes. While technology has produced hydraulic shear heads capable of preparing oversized scrap steel, the hand torch still represents a widely used economical means of material preparation.

The second processing method is the hydraulic press or baler. This baling process is no longer used for processing automobiles due to the inefficiency of consuming up to 30% of nonmetallic components in the steel mill furnace. Hydraulic balers are used for compacting light-gauge steel into dense bundles, which represent a preferred raw material product in the steel-making industry.

The third steel-processing method is the hydraulic guillotine shear. Scrap steel is charged into a long horizontal loading box by magnetic cranes. A side ram effectively closes the loading door compacting the contained scrap steel into the form of a log. This contained-steel log-shaped scrap is then pushed forward by another hydraulic ram into the throat of a guillotine shear. The hydraulic shear can exert a downward force of 2000 t. The shear knife edge effectively cuts the scrap steel log into predetermined uniform lengths.

The fourth steel-processing method is the car shredder or fragmentizer. Scrap cars are prepared or stripped for shredding by removing batteries, tires, gas tanks, radiators and catalytic converters. These removed materials contain problematic elements which could contaminate the prepared scrap steel. The stripped car hulks are charged onto a conveyor which advances them into the shredder. The heart of the shredder is a rotor fitted with fixed or swing hammers. Motors of up to 6000 horsepower literally beat the car hulk into uniform-sized two-inch steel fragments. Modern automobile shredders can reduce a car into "frag" pieces within 20 seconds.

Once the car is successfully fragmentized, a magnet is passed over the pieces and ferrous metal is removed. The remaining nonferrous metal fraction, together with the organic waste materials, are separated from each other by utilizing the differing specific densities of these materials in either a liquid medium or an updraft chamber. Figure 7 illustrates the component fractions recycled from used automobiles.

Car Shredders

There are 19 car shredders in Canada representing a total estimated annual production capacity of 1 800 000 t (Table 20). There are 5 car shredders located in the province of Quebec whose combined annual production capacity exceeds 750 000 t.

Figure 7
Automobile Shredder Components
Component Fractions by Weight

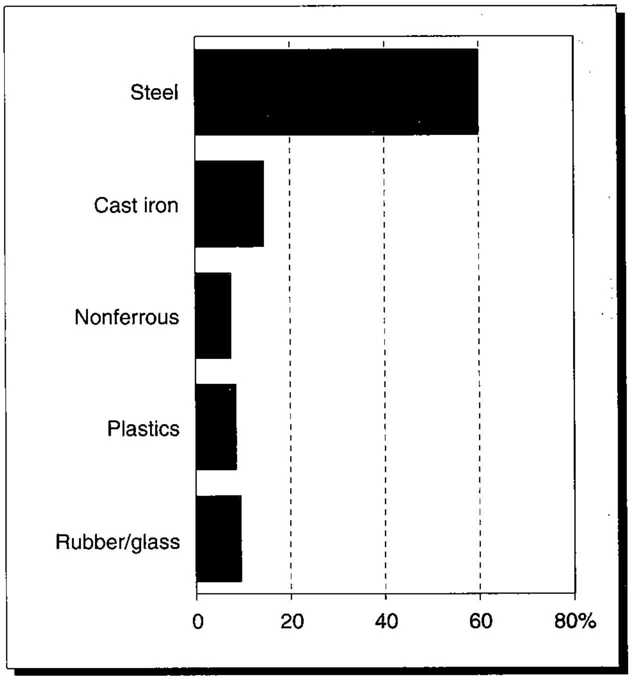
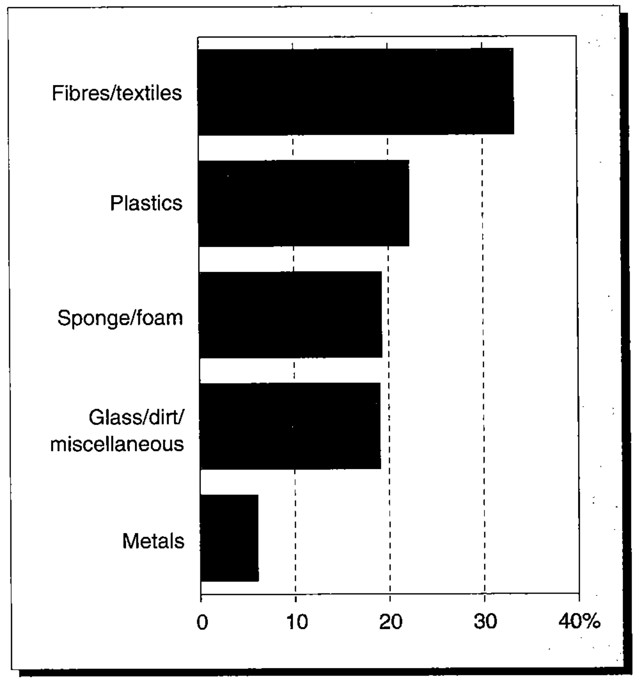


Figure 8
Automobile Shredder Residue Components
Component Fractions by Weight



Clearly, there is an insufficient local supply of scrap cars to satisfy the needs of this equipment. Oversized grades of scrap steel are used to supplement the supply feed of scrapped automobiles.

Automobile Shredder Residue

The organic waste fraction of the shredded car is comprised of plastic, glass, rubber, fibre and dirt, including iron oxide and other materials. Figure 8 illustrates the percentage component fraction of the shredder "fluff" residue. This waste material, or fluff, is disposed of in municipal or specialized landfills. It has been shown that this material serves as an excellent landfill cover for unsegregated municipal/industrial wastes. The fluff does not easily disperse; it provides good cover for degrading organic matter and allows valuable topsoil to be used in more efficient and economical applications.

The province of Quebec classifies this shredder fluff as a hazardous waste. Using the Quebec leachate test, fluff has been shown to leach both copper and zinc in quantities exceeding the provincial limits of 10 parts per million. Studies have indicated that shredder fluff has sponge-like qualities and, accordingly, the leachate will not migrate far from the landfill placement sites. The Quebec government has nonetheless insisted that automobile-shredding companies identify alternative disposal means for this waste material. Studies are being conducted to evaluate the applicability of shredder fluff as an alternate fuel for use in cement kilns.

Internationally, this shredder fluff is not considered to be environmentally hazardous; it is generally acknowledged that efforts to recycle larger percentages of automobile components must continue. The major considerations for this initiative are the increasing shortage of suitable landfill space and the ever-rising costs to use available landfills.

Technology currently exists to separate the plastic fraction contained in vehicles. The problem is the 30-40 different plastic resins used in manufacturing various automotive components. The resultant resin mixture renders this plastic material worthless for recycling. The three major automobile manufacturers have proposed that plastic companies label their products with symbols that would enable identification of different resin compounds. This may be a suitable solution for manual automobile dismantling; however, it is not currently economically feasible. Perhaps the solution lies in the use of one or two compatible plastic resins for all plastic automotive applications. The basic problem is that there are insufficient markets for mixed post-consumer plastics to support a viable, large-scale, post-consumer plastic-recycling activity. In the majority of cases, plastics can be more cheaply produced using virgin resin.

Scrap Steel Pricing

In general, steel consumers purchase their raw material in the last days of the preceding month or in the first days of the current month. Scrap steel, being a relatively low-priced commodity, is sensitive to transportation costs. There is a limited distance over which scrap steel can be shipped economically. To a large extent, the steel market is fairly transparent. Consumers know from which dealers each purchases raw material. Similarly, the steel consumers are well known to the scrap steel dealer network. Small purchase price variations may exist among local scrap steel dealers. These minor price variations reflect differing scrap qualities, dedicated supply lines and different raw material supply capabilities. In general, there is marginally little difference in the selling price between major suppliers of scrap steel.

As the final outlets for scrap steel are both well known and established, there are few new outlet markets to be found. Invariably, supplying scrap steel to a new market involves accepting a lower price for the scrap material at the expense of a previous supplier. Unless the new supplier's processing costs are significantly lower than those of his competitor, the economic feasibility of supplying this new market is disappointing.

Figure 9 illustrates the estimated Canadian consumer buying prices for selected scrap steel commodities.

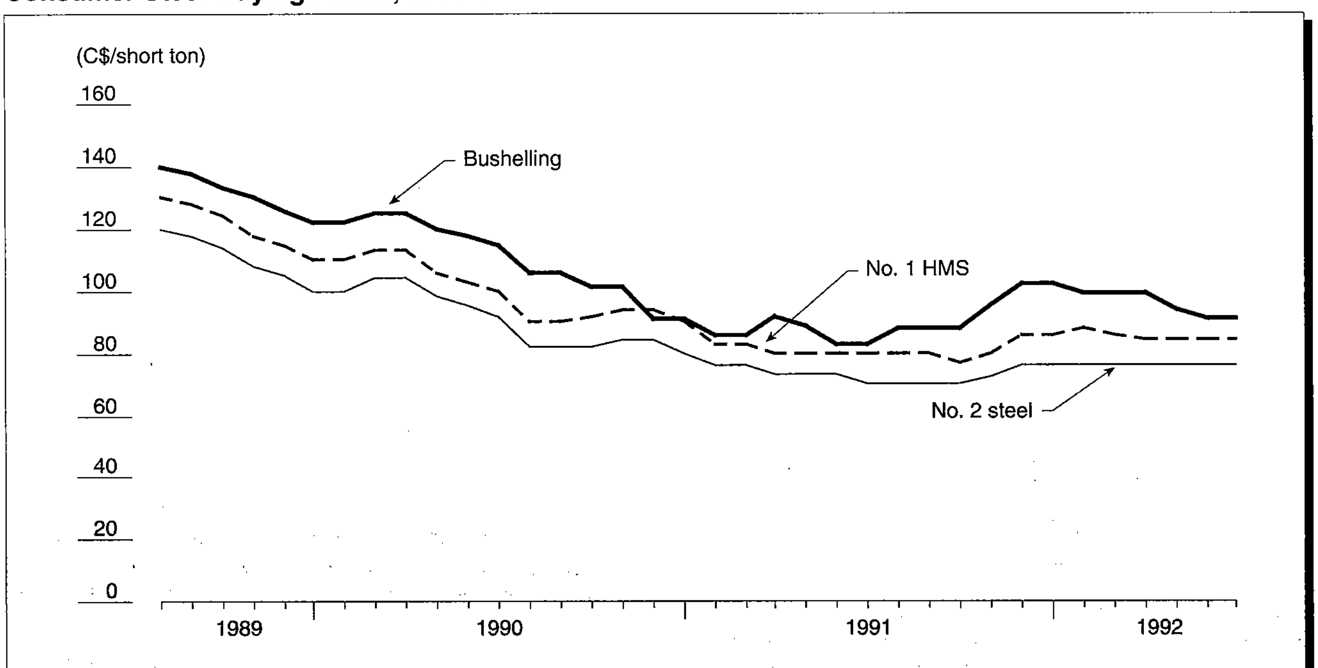
Ferrous Scrap Futures

The Chicago Board of Trade attempted to put into place a futures trading contract for scrap steel in October of 1992. The proposed steel futures contract would have applied to Shredded Scrap and No. 1 Bundles. The unit of trade was to be 100 short-ton lots with price increments of US25¢/t, or US$25 per contract.

This proposed futures contract could have established a greater transparency in the scrap steel commodity market. The exchange would have enabled shippers to increase the liquidity of unsold inventories, participate in arbitrage trading, hedge industrial contracts, and provide a clear pricing mechanism for market transactions.

Figure 9

Consumer Steel-Buying Prices, 1989-92



SOURCE: Energy, Mines and Resources Canada.

The requirements for registration, however, included furnishing audited financial statements. This has seemingly created great hesitancy as many scrap operations are privately owned and are under no obligation to disclose financial information.

The Chicago Board of Trade has delayed commencement of this ferrous scrap futures contract in hopes of overcoming the reluctance of industry participants to provide financial assurances of liquidity. It is unfortunate that this financial trading instrument has been unable to be instated successfully. Within the international scope of environmental regulations, metal recyclables have been classified as waste materials. The legitimacy endowed on scrap steel through its acceptance as a formally traded exchange commodity would have provided irrefutable evidence that **scrap is not waste.**

Environmental Benefits to Steel Recycling

Scrap steel recycling conserves energy, preserves mineral resources and eases the burden on municipal landfills. The table below quantitatively illustrates the environmental benefits gained through the production of steel using recycled materials versus the production of steel using virgin materials.

ENVIRONMENTAL BENEFITS OF STEEL RECYCLING

Benefit	Savings
	(%)
Energy savings	74
Virgin materials savings	90
Emission reduction	86
Effluent reduction	40
Water pollution reduction	76
Mining waste reduction	97

CANADIAN FEDERAL REGULATIONS IMPACTING ON METAL RECYCLING

Export and Import of Hazardous Waste Regulations

The Canadian *Export and Import of Hazardous Wastes Regulations* (EIR) is the major piece of federal legislation affecting the Canadian metal-recycling industry. The EIR establish the legal requirements for the international trade of hazardous metal recyclables. A metal recyclable is considered hazardous if it exhibits any one of nine hazard characteristics as defined under the *Transport of Dangerous Goods Regulations* (TDGR). These hazard characteristics are listed below.

HAZARD CHARACTERISTICS

Class 1	– Explosives
Class 2	– Gases: compressed, deeply refrigerated, liquefied, or dissolved under pressure
Class 3	– Flammable and combustible liquids
Class 4	– Flammable solids
Class 5	– Oxidizing substances
Class 6	– Poisonous (toxic) and infectious substances
Class 7	– Radioactive materials
Class 8	– Corrosives
Class 9	– Miscellaneous substances considered to be dangerous to life, health, property, or the environment, including leachable toxic waste

Prior to the EIR, the TDGR were formally used to control the transboundary movements of hazardous metal recyclables. An amendment in 1989 to the TDGR redefined wastes to include all recyclable materials. Prior to this amendment, recyclable metals were rightly considered as raw material products.

The EIR was drafted to allow Canada to assume its international responsibilities for the control of hazardous wastes as defined in the Basel Convention. The Basel Convention, ratified by Canada in 1992, is an international convention designed to aid the protection of the environment by requiring controls on the import and export of hazardous wastes.

The key regulatory elements of Canada's EIR include:

- the requirement of prior notification to, and acceptance from, the competent environmental authority of the importing country;
- the prohibition of exports to those countries that have banned imports;
- the requirement to return wastes to the country of origin or find acceptable disposal alternatives should the original disposal activities prove not to be possible in accordance with the contractual agreement;
- the requirement to obtain insurance sufficient to cover either the return of the exported hazardous

wastes or the clean-up activity of these wastes in the event of an accident; and

- the requirement to use an authorized tracking document in the shipment of these hazardous wastes.

Unresolved Issues

Although the EIR is in force, there still exist several issues which have yet to be finalized. The most contentious of these issues surrounds the applicability of the leachate test to recyclable materials.

The Canadian leachate test is a provisional standard which was designed by the Canadian General Standards Board at the request of Transport Canada. This standard was devised to provide Transport Canada with a means to control wastes destined for final disposal which could cause environmental damage. The scope of the TDGR was broadened in 1986 to include protection of the environment. This extended the definition of dangerous goods to include those dangerous goods that became a waste. In 1989, the TDGR were amended and waste was redefined to include recyclable materials. Accordingly, eco-toxicity is one of the hazard characteristics applicable to recyclable materials. The test to determine eco-toxicity is the leachate test.

The EIR recognizes that solid recyclable materials pose limited risks to the environment. In cases of accidental spillage, clean-up procedures are typically simple and relatively inexpensive. The risk of environmental damage may increase if the recyclable material is readily dispersible. A highly dispersible powder may prove impossible to recover in the event of accidental spillage. The EIR specifies that, in the case of recyclables, the leachate test is to be applied only to those wastes that are of a dispersible nature.

The term "dispersible" has yet to be defined. Definitions for the word dispersible must incorporate the concepts of size, shape and specific density. Risk is another element which should merit consideration. The risk of "sham" recycling is greatly reduced if there is a positive economic value for the recyclable material. Certainly no one will indiscriminately dispose of valuable raw materials.

While the implications of this issue are severe, this definitional quandary impacts on only a very small percentage of Canada's total metal recyclables.

International Regulations Impacting on Metal Recyclables

Canada-U.S. Agreement on the Transboundary Movement of Hazardous Wastes

This agreement seeks to ensure that the treatment, storage and disposal of hazardous waste are conducted in a manner that reduces the risks to public health, property and environmental quality. The Canada-U.S. agreement controls and monitors the flow of hazardous wastes between the two countries. This bilateral agreement was negotiated in 1986 and automatically renewed itself in 1992.

Under the provisions of the agreement, all hazardous wastes destined for a transboundary movement between Canada and the United States are subject to the requirements of:

- notification and consent prior to shipment;
- re-admission of any shipment of hazardous waste that may be returned by the country of import or transit;
- maintenance of insurance or other financial guarantee in respect of damage during the entire movement; and
- utilization of an authorized manifest or tracking document.

Basel Convention

The Basel Convention was designed to restrict the transboundary movement of hazardous wastes to protect countries (particularly developing) that may not have the capability and technology to properly handle the wastes. The Basel Convention defines recycling as a "disposal" activity, and recyclable materials as "wastes." Recyclables that exhibit a hazardous characteristic are classified as hazardous wastes and are subject to strict Basel Convention control procedures. The Basel Convention does not adequately distinguish between wastes destined for disposal and recyclables destined for recovery operations. The Basel Convention prohibits trade in hazardous wastes between ratified and non-ratified countries unless there exists a bilateral agreement between them that does not detract from the spirit of the Convention.

The Basel Convention came into force on May 5, 1992, and Canada ratified it on August 28, 1992. Canada was an active participant at the first meeting of contracting parties to the Basel Convention, which was held in Piriapolis, Uruguay, on November 30, 1992. Twenty-eight of thirty-five contracting countries participated in the meeting. There were active discussions among participants over a full range of environmental-related issues. The major issues which could affect the metal-recycling industry are presented below.

Proposed Ban on the Export of Hazardous Waste

Developing countries called for an immediate and complete ban on exports of hazardous wastes destined for disposal and recovery/recycling operations from OECD countries to developing countries. There were no objections raised by developing countries of being shut out of trade in recyclables that are considered hazardous. The final decision requests industrialized countries to prohibit the movement to developing countries of hazardous wastes destined for final disposal. Hazardous wastes (recyclables) destined for recovery/recycling operations will continue until a technical working group completes further studies. These studies involve assessing whether environmentally sound recycling is occurring in developing countries.

Protocol on Liability and Compensation

The Basel Convention recommends the establishment of protocols on liability and compensation which will offer protection to the environment and legal recourse to third parties in the event of damage caused by the transboundary movement of hazardous wastes. The scope of this protocol could include any damages occurring to the environment up to and including 30 years after the completion of "disposal" operations. Recycling is defined as a disposal operation.

It was recommended that a working group of legal and technical experts be established to advise on both issues of liability and compensation. The recommendations of this working group will be presented at the next meeting of the Basel contracting parties.

Decision on the Status of Recyclable Material

The Basel secretariat acknowledged that there were differences of opinion with respect to the identification of hazardous wastes containing recyclable or reusable materials. The secretariat has requested that an ad-hoc committee review the issue and develop specific guidelines and criteria for the identification of the level of recyclable or reusable material in a hazardous waste that would allow it to be considered a tradeable material. This committee is further instructed to recommend handling, processing and shipping procedures which should apply to the movement of such wastes. These recommendations will be presented for review and consideration at the second meeting of the Conference of Parties to the Basel Convention, which is scheduled for February/March 1994.

OECD Decision

The OECD Decision C(92)39/FINAL concerning the control of the transfrontier movement of wastes destined for recovery operations is a multilateral agreement, recognized under the Basel Convention, to allow the continuation of trade in recyclable materials among the OECD member countries. The Decision was adopted on March 30, 1992, by 23 of the 24 OECD member countries. Japan abstained from the adoption of this Decision.

The Decision fully recognizes a difference between wastes destined for final disposal and wastes destined for recovery/recycling operations. Furthermore, the Decision recognizes that there exists differing levels of perceived risk in the transfrontier movement of recyclable materials.

The OECD Decision divides recyclable materials into three lists: green, amber and red. These three lists are to be considered finite lists. If a material is not on one of these lists, then the transfrontier movement of the material must conform to the movement control procedures governing hazardous wastes destined for final disposal as prescribed under the Basel Convention.

The green OECD list contains recyclable non-hazardous materials of a non-dispersible nature. Table 21 provides a list of the major metal recyclables contained on the green OECD list. These green-list metal recyclables can freely move under normal commercial control mechanisms.

The amber OECD list of wastes includes metals which exhibit one or more hazardous characteristics. These metals have been reviewed by an experts committee who have determined that the risk posed by the movement of these hazardous metals is limited. Accordingly, they are permitted to move internationally under more reduced transportation control mechanisms than those prescribed under the Basel Convention.

Two control system procedures are provided under the amber control mechanism. These procedures relate to cases where transactions require consent for specific shipments to a recovery facility, and where transactions involve shipments to specific pre-consented recovery facilities. The control procedures for specific shipments to a recovery facility include:

- prior notification of the intended shipment with a 30-day tacit consent provision;
- required use of an authorized tracking document;
- recovery facility to provide signed copy of receipt of waste;
- minimum $1 000 000 insurance requirement; and
- movement may occur only under terms of valid written contract.

The control procedures for shipments to specific pre-authorized recovery facilities include a seven-day tacit consent for the notification of the intended shipment. This effectively reduces the time delay between material purchases and actual shipment.

Table 22 provides a summary of the major metal recyclables on the amber OECD list.

The red OECD list does not specifically include any metals or metal compounds. It includes materials contaminated with polychlorinated biphenyls (PCB), polychlorinated terphenyls (PCT), or polybrominated biphenyls (PBB) at a concentration level of 50 mg/kg or more.

It is important to realize that, while OECD countries have agreed to these three lists of recyclable materials, individual countries have the authority to determine whether a material is, or is not, considered hazardous under their own national regulations. Accordingly, stricter transportation control procedures may be required by individual countries for specifically identified materials.

Note: Information in this review was current as of February 1, 1993.

TABLE 1. CANADA, EXPORTS AND IMPORTS OF METAL RECYCLABLES, 1990-92

	1990		1991		1992p	
	Quantity	Value	Quantity	Value	Quantity	Value
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
RECYCLABLE EXPORTS						
Exports to United States	1 947 911	855 086	1 549 000	628 566	1 022 078	521 453
% of total exports	76.04	80.77	85.04	81.68	88.48	85.70
Ferrous exports to United States	1 517 056	221 161	1 153 095	150 230	658 818	95 618
% of total ferrous exports	83.20	78.43	84.89	82.84	78.67	73.33
Nonferrous exports to United States	430 855	633 925	395 905	478 336	280 280	408 680
% of total nonferrous exports	58.36	81.62	85.46	81.32	88.23	85.49
Exports to OECD countries	2 341 904	991 236	1 644 055	715 429	1 083 128	578 862
% of total exports	91.42	93.63	90.25	92.97	93.76	95.14
Exports to non-OECD countries	219 851	67 445	177 531	54 116	72 029	29 592
% of total exports	8.58	6.37	9.75	7.03	6.24	4.86
Exports to EC countries	35 197	76 142	31 837	48 622	11 744	28 004
% of total exports	1.37	7.19	1.75	6.32	1.02	4.60
Total exports	2 561 755	1 058 681	1 821 586	769 545	1 155 157	608 454
RECYCLABLE IMPORTS						
Imports from United States	1 434 667	630 029	1 089 447	585 193	1 066 295	481 228
% of total imports	96.72	88.93	96.83	87.27	93.71	72.45
Ferrous imports from United States	1 235 222	127 820	884 956	104 699	904 347	103 698
% of total ferrous imports	98.93	97.97	99.07	99.14	98.40	98.53
Nonferrous imports from United States	199 445	502 209	204 927	480 494	161 948	377 570
% of total nonferrous imports	84.96	86.88	88.38	85.05	74.02	67.55
Imports from OECD countries	1 459 695	675 504	1 113 715	646 896	1 087 136	536 668
% of total imports	98.40	95.34	98.98	96.47	95.54	80.80
Imports from non-OECD countries	23 688	32 987	11 424	23 639	50 733	127 555
% of total imports	1.60	4.66	1.02	3.53	4.46	19.20
Imports from EC countries	16 021	33 372	21 187	50 341	3 275	12 172
% of total imports	1.08	4.71	1.88	7.51	0.29	1.83
Total imports	1 483 383	708 491	1 125 139	670 535	1 137 869	664 223

Source: Statistics Canada.
p Preliminary.

TABLE 2. CANADA, EXPORTS AND IMPORTS BY COMMODITY GROUP, 1990-92

	1990		1991		1992p	
	Quantity	Value	Quantity	Value	Quantity	Value
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
METAL RECYCLABLE EXPORTS						
Aluminum ash and residues	49 546	6 181	25 820	4 640	5 323	1 118
Aluminum scrap	185 971	278 527	173 675	227 539	151 039	203 171
Total aluminum	235 517	284 708	199 494	232 179	156 363	204 289
% total recyclable	10.48	34.04	10.95	30.17	13.54	33.58
Copper ash and residues	5 847	5 605	1 792	2 151	1 005	1 069
Copper scrap	18 298	37 167	86 368	178 682	72 766	148 850
Total copper recyclable	24 145	42 772	88 160	180 833	73 771	149 919
% total recyclable	1.07	5.11	4.84	23.50	6.39	24.64
Lead ash and residues	741	352	216	151	808	184
Lead scrap	17 382	6 398	5 237	2 675	4 066	1 518
Total lead recyclable	18 123	8 750	5 453	2 825	4 873	1 702
% total recyclable	0.81	0.81	0.30	0.37	0.42	0.28
Zinc ash and residues	9 007	8 624	9 723	6 322	10 256	8 601
Zinc scrap	38 118	22 925	33 327	18 497	23 024	13 513
Total zinc recyclable	47 125	31 549	43 050	24 819	33 280	22 114
% total recyclable	2.10	3.77	2.36	3.23	2.88	3.63
Nickel ash and residues	–	–	–	–	–	–
Nickel scrap	7 748	39 385	4 232	19 866	2 814	12 111
Total nickel recyclable	7 748	39 385	4 232	19 866	2 814	12 111
% total recyclable	0.34	4.71	0.23	2.58	0.24	1.99
Vanadium ash and residues	1 085	1 426	680	622	1 170	983
Vanadium scrap	–	–	–	–	–	–
Total vanadium recyclable	1 085	1 426	680	622	1 170	983
% total recyclable	0.05	0.17	0.04	0.08	0.10	0.16
Magnesium ash and residues	–	–	–	–	–	–
Magnesium scrap	3 358	8 569	3 035	4 051	636	666
Total magnesium recyclable	3 358	8 569	3 035	4 051	636	666
% total recyclable	0.15	1.02	0.17	0.53	0.06	0.11
Tin ash and residues	–	–	–	–	–	–
Tin scrap	529	449	460	490	347	409
Total tin recyclable	529	449	460	490	347	409
% total recyclable	0.02	0.05	0.03	0.06	0.03	0.07
Precious metal ash and residues	–	–	–	–	–	–
Precious metal scrap	204	97 997	300	87 960	130	60 652
Total precious metal recyclable	204	97 997	300	87 960	130	60 652
% total recyclable	0.01	11.72	0.02	11.43	0.01	9.97
N.e.s. ash and residues	85 785	40 913	118 377	34 543	44 295	25 220
N.e.s. scrap	–	–	–	–	–	–
Total n.e.s. recyclable	85 785	40 913	118 377	34 543	44 295	25 220
% total recyclable	3.82	4.89	6.50	4.49	3.83	4.14
Stainless steel ash and residues	–	–	–	–	–	–
Stainless steel scrap	36 878	41 282	24 041	20 719	17 015	15 151
Total stainless steel recyclable	36 878	41 282	24 041	20 719	17 015	15 151
% total recyclable	1.64	4.94	1.32	2.69	1.47	2.49
Ferrous slags	522 176	61 428	281 795	28 355	81 980	17 155
Ferrous scrap	1 264 404	179 227	1 052 508	132 282	738 483	98 083
Total ferrous recyclable	1 786 580	240 855	1 334 303	160 638	820 463	115 238
% total recyclable	79.51	28.77	73.25	20.87	71.03	18.94
Total recyclable exports	2 247 077	836 455	1 821 586	769 545	1 155 157	608 454

TABLE 2 (cont'd)

	1990		1991		1992p	
	Quantity	Value	Quantity	Value	Quantity	Value
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
METAL RECYCLABLE IMPORTS						
Aluminum ash and residues	1 750	709	1 923	1 293	2 668	1 246
Aluminum scrap	52 603	73 271	46 433	52 717	39 862	47 172
Total aluminum	54 353	73 980	48 357	54 010	42 530	48 418
% total recyclable	3.66	10.23	4.30	8.05	3.74	7.29
Copper ash and residues	37 248	30 136	19 269	13 191	6 721	6 942
Copper scrap	65 540	109 673	47 687	65 512	31 537	40 152
Total copper recyclable	102 788	139 809	66 957	78 703	38 258	47 094
% total recyclable	6.92	19.34	5.95	11.74	3.36	7.09
Lead ash and residues	1 764	4	95	110	22	99
Lead scrap	34 831	12 496	58 044	10 640	38 486	7 141
Total lead recyclable	36 595	12 500	58 139	10 750	38 508	7 240
% total recyclable	2.46	1.73	5.17	1.60	3.38	1.09
Zinc ash and residues	567	439	472	255	807	592
Zinc scrap	1 615	1 890	655	670	1 049	1 084
Total zinc recyclable	2 182	2 329	1 127	925	1 856	1 676
% total recyclable	0.15	0.32	0.10	0.14	0.16	0.25
Nickel ash and residues	–	–	–	–	–	–
Nickel scrap	9 314	22 978	14 811	35 145	14 617	30 613
Total nickel recyclable	9 314	22 978	14 811	35 145	14 617	30 613
% total recyclable	0.63	3.18	1.32	5.24	1.28	4.61
Magnesium ash and residues	–	–	–	–	–	–
Magnesium scrap	41	116	260	688	1 525	3 968
Total magnesium recyclable	41	116	260	688	1 525	3 968
% total recyclable	0.003	0.02	0.02	0.10	0.13	0.60
Tin ash and residues	–	–	–	–	–	–
Tin scrap	94	545	167	846	396	1 349
Total tin recyclable	94	545	167	846	396	1 349
% total recyclable	0.01	0.08	0.01	0.13	0.03	0.20
Precious metal ash and residues	–	–	–	–	–	–
Precious metal scrap	14 144	287 888	9 702	288 044	3 047	223 557
Total precious metal recyclable	14 144	287 888	9 702	288 044	3 047	223 557
% total recyclable	0.95	39.82	0.86	42.96	0.27	33.66
N.e.s. ash and residues	17 372	37 873	31 589	80 177	72 608	72 764
N.e.s. scrap	964	14 447	757	15 640	5 436	122 300
Total n.e.s. recyclable	18 336	52 320	32 346	95 817	78 044	195 064
% total recyclable	1.23	7.24	2.87	14.29	6.86	29.37
Stainless steel ash and residues	–	–	–	–	–	–
Stainless steel scrap	20 337	20 962	20 508	20 972	15 510	13 551
Total stainless steel recyclable	20 337	20 962	20 508	20 972	15 510	13 551
% total recyclable	1.37	2.90	1.82	3.13	1.36	2.04
Ferrous slags	245 750	6 754	83 546	2 561	32 355	1 237
Ferrous scrap	981 979	102 717	789 220	82 073	871 223	90 456
Total ferrous recyclable	1 227 729	109 471	872 766	84 634	903 578	91 693
% total recyclable	82.62	15.14	77.57	12.62	79.41	13.80
Total recyclable imports	1 485 913	722 898	1 125 139	670 535	1 137 869	664 223

Source: Statistics Canada.
– Nil; n.e.s. Not elsewhere specified; p Preliminary.

TABLE 3. CANADA, RECYCLABLE METAL EXPORTS AND IMPORTS, BY PROVINCE OF LADING, 1991 AND 1992

	1991		Jan.-Sept. 1992p	
	(tonnes)	(%)	(tonnes)	(%)
EXPORTS				
British Columbia	348 834	19.85	296 747	25.71
Alberta	18 864	1.07	14 325	1.24
Saskatchewan	562	0.03	1 570	0.14
Manitoba	16 474	0.94	10 623	0.92
Ontario	886 164	50.42	557 706	48.32
Quebec	452 002	25.72	278 943	24.17
New Brunswick	8 533	0.49	3 541	0.31
Nova Scotia	25 402	1.45	3 540	0.31
Newfoundland	229	0.01	807	0.07
Prince Edward Island	1	–	–	–
Northwest Territories	523	0.03	–	–
Total	1 757 587		1 167 802	
IMPORTS				
British Columbia	17 201	1.53	7 060	0.67
Alberta	16 973	1.51	17 562	1.66
Saskatchewan	309 660	27.52	196 783	18.63
Manitoba	21 004	1.87	42 581	4.03
Ontario	633 038	56.27	636 645	60.27
Quebec	123 493	10.98	149 855	14.19
New Brunswick	1 098	0.10	782	0.07
Nova Scotia	2 583	0.23	5 133	0.49
Newfoundland	–	–	3	–
Prince Edward Island	–	–	–	–
Northwest Territories	–	–	–	–
Total	1 125 050		1 056 404	

Source: Statistics Canada.
– Nil; p Preliminary.

TABLE 4. ALUMINUM, WORLD SECONDARY PRODUCTION, PERCENTAGE OF TOTAL PRODUCTION, 1989-91

	1989		1990		1991	
	(000 tonnes)	(%)	(000 tonnes)	(%)	(000 tonnes)	(%)
Europe	1 676	30.0	1 655	30.0	1 641	30.2
Africa	27	4.3	27	4.3	27	4.3
Asia	1 396	55.8	1 536	56.6	1 539	54.5
America	1 998	21.5	2 027	21.5	2 336	22.7
Oceania	53	3.7	38	2.5	27	1.8
Total	5 149	33.3	5 282	34.2	5 570	33.5

Source: World Bureau of Metal Statistics.

TABLE 5. ALLOY SPECIFICATIONS FOR SECONDARY ALUMINUM CONTRACT

Element	ADC 12 (Japan)	DIN 226 (Europe)	A 380-1 (U.S.)
Copper	1.3 - 3.5	2.0 - 3.5	3.0 - 4.0
Silicon	9.6 - 12.0	8.0 - 11.0	7.5 - 9.5
Magnesium	0.3[a]	0.1-0.5[a]	0.1
Zinc	1.0[a]	1.2	2.9
Iron	0.9[a]	1.2	1.0
Manganese	0.5[a]	0.1-0.5	0.5
Nickel	0.5[a]	0.3	0.5
Tin	0.3[a]	0.1	0.35
Titanium	–	0.15	–
Lead	–	0.2	–

– Nil.
[a] Maximum.

TABLE 6. CANADA, CONSUMER PURCHASES OF SCRAP AND SECONDARY ALUMINUM, 1989-91

	1989	1990	1991
		(000 tonnes)	
Secondary aluminum purchases	74.4	82.7	75.0
Scrap aluminum purchases	141.5	153.7	151.7
Total secondary and scrap purchases	215.9	236.4	226.7
% of total consumer purchases	34.4	38.2	37.1

Source: Energy, Mines and Resources Canada.

TABLE 7. CANADA, QUANTITY OF ALUMINUM RECYCLED, 1989-92

	1989	1990	1991	1992p
		(000 tonnes)		
Secondary production	60.4	67.7	67.7	50.7
Secondary consumption	102.1	137.0	134.5	100.9
Scrap consumption	141.5	153.7	151.7	113.8
Scrap imports	60.4	54.4	48.4	42.5
Scrap exports	166.5	235.5	199.5	156.4
Scrap recycled	349.7	471.8	437.3	328.6

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

TABLE 8. ALUMINUM, EXPORTS TO SELECTED COUNTRIES, 1991 AND 1992

	1991		1992p	
	(tonnes)	($000)	(tonnes)	($000)
United States	150 588	196 116	129 022	173 751
Japan	16 368	23 423	15 366	22 527
Korea	1 757	2 066	1 235	1 351
Taiwan	1 742	1 917	2 292	2 035
Pakistan	945	945	408	311
Germany	709	709	–	–
United Kingdom	221	332	1 142	1 280

Source: Statistics Canada.
– Nil; p Preliminary.

TABLE 9. ALUMINUM, IMPORTS FROM SELECTED COUNTRIES, 1991 AND 1992

	1991		1992p	
	(tonnes)	($000)	(tonnes)	($000)
United States	45 971	52 215	39 038	46 406
United Kingdom	463	502	710	721
C.I.S.	–	–	114	45

Statistics Canada.
– Nil; p Preliminary.

TABLE 10. CANADA, LEAD SMELTERS

	Location	Capacity
		(t/y)
Cominco Ltd.	Trail, British Columbia	135 000
Metalex Products Ltd.[1]	Burnaby, British Columbia	6 000
Canada Metal Company	Winnipeg, Manitoba	10 000
Canada Metal Company	Toronto, Ontario	12 000
Tonolli Canada Ltd.[1]	Mississauga, Ontario	50 000
Nova Lead Inc.[1]	Ville Ste-Catherine, Quebec	60 000
Brunswick Mining & Smelting	Belledune, New Brunswick	72 000
Total		345 000

1 Fully integrated (breaking, smelting, refining) smelters.

TABLE 11. CANADIAN BATTERY-BREAKING FACILITIES

Lead Smelter	Location
K.C. Recycling Inc.	Trail, British Columbia
Metallex Products Ltd.	Burnaby, British Columbia
Wild Rose Recycling Inc.	Wetaskewan, Alberta
Chisick Metals Ltd.[1]	Winnipeg, Manitoba
Holt Metals Inc.	Winnipeg, Manitoba
Erie Battery Inc.[1]	Port Colbourne, Ontario
Regional Battery Breaker Inc.[1]	Hamilton, Ontario
Tonolli Canada Ltd.	Mississauga, Ontario
Nova Pb Inc.	Ville Ste-Catherine, Quebec
Bathurst Steel Inc.[1]	Bathurst, New Brunswick

1 Not currently in operation.

TABLE 12. WORLD, PRODUCTION OF SECONDARY REFINED LEAD AND PERCENTAGE OF TOTAL REGIONAL LEAD PRODUCTION, 1989-91

	1989		1990		1991	
	(000 tonnes)	(%)	(000 tonnes)	(%)	(000 tonnes)	(%)
Europe	852.5	52.2	854.2	53.8	820.3	50.2
Africa	49.6	30.6	46.1	30.6	46.3	30.7
Asia	323.9	52.4	277.3	49.4	257.5	46.3
America	1 103.4	56.6	1 128.4	59.5	1 087.7	59.7
Oceania	20.4	9.7	22.0	9.4	24.4	10.0
Total	2 349.8	53.5	2 328.0	55.2	2 236.2	53.5

Source: World Bureau of Metal Statistics.

TABLE 13. WORLD, COPPER SCRAP RECOVERY, 1989-91

	1989		1990		1991	
	(000 tonnes)	(%)	(000 tonnes)	(%)	(000 tonnes)	(%)
EUROPE						
Secondary production	615	14.4	650	15.2	628	15.2
Direct scrap use	997	23.4	950	22.3	921	22.3
Total Europe	1 612	37.8	1 600	37.5	1 549	37.5
ASIA						
Secondary production	115	2.7	122	2.9	116	2.8
Direct scrap use	787	18.4	805	18.9	834	20.2
Total Asia	902	21.1	924	21.8	950	23.0
AMERICA						
Secondary production	548	12.8	531	12.4	518	12.6
Direct scrap use	1 101	25.8	1 116	26.2	1 015	24.6
Total America	1 619	37.9	1 647	38.6	1 533	37.2
OCEANIA						
Secondary production	35	0.8	24	0.6	35	0.9
Direct scrap use	41	1.0	40	0.9	34	0.8
Total Oceania	76	1.8	64	1.5	69	1.7
Total world	4 270		4 268		4 129	

Source: World Bureau of Metal Statistics.

TABLE 14. WORLD, SCRAP AND SECONDARY COPPER AS A PERCENTAGE OF TOTAL REFINED PRODUCTION, 1989-91

	1989		1990		1991	
	(000 tonnes)	(%)	(000 tonnes)	(%)	(000 tonnes)	(%)
Europe	1 612	100.5	1 600	97.9	1 549	96.5
Africa	31	3.7	30	3.7	28	3.9
Asia	902	59.1	927	61.2	950	59.0
America	1 649	40.4	1 647	39.0	1 533	35.5
Oceania	76	29.8	64	23.4	69	24.7
Total	4 270	39.6[a]	4 268	39.5[a]	4 129	39.6[a]

Source: World Bureau of Metal Statistics.
[a] Final percentage calculation includes refined copper from other countries.

TABLE 15. WORLD, COPPER[1] SCRAP RECOVERY AS A PERCENTAGE OF REFINED COPPER CONSUMPTION, 1989-91

	1989		1990		1991	
	(000 tonnes)	(%)	(000 tonnes)	(%)	(000 tonnes)	(%)
Europe	1 612	52.6	1 600	51.0	1 549	49.2
Africa	31	31.2	30	31.3	28	30.2
Asia	902	36.3	927	34.3	950	32.2
America	1 568	54.9	1 647	60.9	1 533	57.4
Oceania	76	58.2	64	51.3	69	66.5
Total	4 270	38.9[a]	4 268	39.5[a]	4 129	38.2[a]

[a] Final percentage calculation includes refined copper from other countries.
[1] Secondary production plus direct use of scrap.

TABLE 16. CANADA, EXPORTS OF COPPER SCRAP BY SELECTED COUNTRIES, 1990-92

Country	1990		1991		Jan.-Sept. 1992[p]	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
United States	85 738	214 292	73 564	153 155	65 425	138 811
Korea	3 077	7 642	4 361	10 371	827	1 687
People's Republic of China	478	875	2 155	3 072	3 151	2 857
Japan	1 413	3 472	2 076	4 861	355	764
India	3 778	6 643	1 260	1 874	806	1 347
Hong Kong	574	348	1 005	1 013	1 111	1 753
Taiwan	235	331	613	1 055	124	204
Italy	1 607	2 477	279	350	450	884
Belgium	1 426	2 768	75	119	–	–
Germany	4 495	10 619	29	78	103	62
Netherlands	458	744	19	30	29	55

Source: Statistics Canada.
– Nil; [p] Preliminary.

TABLE 17. CANADA, IMPORTS OF COPPER SCRAP BY SELECTED COUNTRIES, 1990-92

Country	1990		1991		1992p	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
United States	60 977	93 918	47 420	65 023	31 118	39 344
Chile	3 577	13 283	–	–	–	–
C.I.S.	–	–	163	273	152	214

Source: Statistics Canada.
– Nil; p Preliminary.

TABLE 18. CANADA, SCRAP STEEL CONSUMPTION AS A PERCENT OF TOTAL STEEL PRODUCTION, 1989-91

	1989		1990		1991	
	(000 tonnes)	(%)	(000 tonnes)	(%)	(000 tonnes)	(%)
Home scrap	2 827	16.7	2 152	16.0	2 381	16.8
Purchase scrap	5 760	34.1	5 072	37.8	4 918	34.6
Total	8 587	50.8	7 224	53.8	7 299	51.4

Source: Statistics Canada; Canadian Steel Producers Association.

TABLE 19. CANADA, APPARENT IRON AND STEEL RECYCLING TONNAGE, 1988-92

	1988	1989	1990	1991	1992p
			(000 tonnes)		
Steel consumed (1)	7 649	8 587	7 224	7 299	5 213
Iron consumed (2)	684	740	568	508	382
Ferrous imports (3)	1 208	1 540	1 249	893	919
Ferrous exports (4)	2 569	1 808	2 031	1 358	838
Tonnes recycled (1) + (2) – (3) + (4)	9 694	9 595	8 574	8 272	5 514

Sources: Statistics Canada; Canadian Steel Producers Association; Canadian Foundry Association.
p Preliminary.

TABLE 20. CANADIAN AUTOMOBILE SHREDDERS

Company	Location	Total Annual Capacity[1]
		(000 t/y)
Cyclomet Inc.[2]	Scoudouc, New Brunswick	140
Québec Métal Recyclé Inc.	Laval, Quebec	140
Capitale Métal Recyclé Inc.	St-Augustine, Quebec	140
Associées de L"Acier Ltée	Ste-Catherine, Quebec	140
Fers & Métaux Recyclés Ltée[2]	La Prairie, Quebec	140
Sidbec Ferruni Inc.	Contrecoeur, Quebec	140
Bakermet Inc.	Ottawa, Ontario	140
Lake Ontario Steel Company	Whitby, Ontario	140
Triple M Metals Inc.	Brampton, Ontario	140
Intermetco Ltd.	Hamilton, Ontario	140
Zalev Brothers Ltd.	Windsor, Ontario	80
Lakehead Scrap Metals Inc.	Thunder Bay, Ontario	40
Wheat City Metals Inc.	Regina, Saskatchewan	40
General Scrap & Car Shredder Ltd.	Winnipeg, Manitoba	40
Mandak Metal Processors Ltd.	Selkirk, Manitoba	40
Navajo Metals Inc.	Calgary, Alberta	40
Alta Steel Inc.	Edmonton, Alberta	40
Richmond Steel Recycling Inc.	Burnaby, British Columbia	40
Budget Steel Inc.	Victoria, British Columbia	40
Total		1 800

[1] Eight-hour shift, five-day week. [2] Operated by Intermetco Ltd.

TABLE 21. OECD GREEN LIST OF WASTE METAL RECYCLABLES, METAL AND METAL-ALLOY WASTES IN METALLIC, NON-DISPERSIBLE FORM

WASTE AND SCRAP OF PRECIOUS METALS AND THEIR ALLOYS

Gold waste and scrap
Platinum group metals waste and scrap
Other precious metals, e.g., silver
Waste and scrap of cast iron[1]
Waste and scrap of stainless steels[1]
Waste and scrap of other alloy steels[1]
Waste and scrap of tinned iron or steel[1]
Turnings, shavings, chips, milling waste, fillings, trimmings and stampings, whether or not in bundles[1]
Other ferrous waste and scrap[1]
Remelting scrap ingots[1]
Used iron and steel rails[1]

WASTE AND SCRAP OF NONFERROUS METALS AND THEIR ALLOYS

Aluminum
Antimony
Beryllium
Bismuth
Cadmium
Chromium
Cobalt
Copper
Germanium
Lead
Magnesium
Manganese
Molybdenum
Nickel
Tantalum
Tin
Titanium
Tungsten
Vanadium
Zinc
Zirconium

WASTE AND SCRAP

Gallium
Hafnium
Indium
Niobium
Rhenium
Selenium
Tellurium
Thallium
Thorium and rare earths

OTHER METAL-BEARING WASTES ARISING FROM MELTING, SMELTING AND REFINING OF METALS

Hard zinc spelter
- Galvanizing slab zinc top dross (90% Zn)
- Galvanizing slab zinc bottom dross (92% Zn)
- Zinc die cast dross (85% Zn)
- Hot dip galvanizers slab zinc dross (batch) (92% Zn)
- Zinc skimmings

Aluminum skimmings
Slags from precious metals and copper processing for further refining

OTHER WASTES

Electrical assemblies
Spent catalysts
- Fluid catalytic cracking catalysts
- Precious metal-bearing catalyst
- Transition metal catalysts

Slag from iron or steel
Granulate slag from iron/steel
Electronic scrap
Vessels and floating structures
Motor vehicle wrecks, drained of liquids
Basic slag from iron/steel
Slag from copper production
Neutralized red mud

[1] Mercury is specifically excluded as a contaminant of these metals or alloys.

TABLE 22. OECD AMBER LIST OF WASTE METAL RECYCLABLES

Dross, scalings and other wastes from the manufacture of iron and steel
Zinc ash and residues
Lead ash and residues
Copper ash and residues
Aluminum ash and residues
Vanadium ash and residues
Ash and residues containing metals or metal compound not otherwise specified
Residues from alumina production not otherwise specified
Lead-acid batteries, whole or crushed
Zinc slags containing up to 18% zinc
Liquors from the pickling of metals
Precious metal-bearing residues in solid form which contain traces of inorganic cyanides
Thallium waste and residues
Galvanic sludges
Mercury waste and residues
Precious metal ash, sludge, dust and other residues
    Ash from incineration of printed circuit boards
    Film ash

WASTE CATALYSTS NOT ON GREEN LIST

Leaching residues from zinc processing
Waste hydrates of aluminum
Waste alumina
Wastes that contain, consist or are contaminated with any of the following:
    Inorganic cyanides, excepting precious metal-bearing residues in solid form containing traces of inorganic cyanides
Arsenic waste and residues
Used batteries, other than lead-acid batteries

Salt

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DOMESTIC PRODUCTION AND DEVELOPMENTS

In 1992, Canadian salt production was estimated at 11.15 Mt, a 7% decrease over 1991. The decrease is mainly due to the recession coupled with relatively mild winter conditions. Canadian shipments in 1992 of all types of salt were 11.10 Mt, a 6.5% decrease over 1991 shipments of 11.87 Mt. In 1992, shipments from Ontario accounted for 60% of all shipments, the same proportion as in 1991. Rock salt shipments accounted for 72% of total shipments, followed by salt in brines (21%) and evaporated salt (7%). The average unit value of salt shipments was estimated at $22.86/t, a 4.7% increase over 1991. Salt production capacity in Canada increased slightly to 13.55 Mt, of which rock salt accounted for 70%, followed by captive brines (23%) and evaporated salt (7%). In 1992, rock salt mines operated at 86% of capacity; captive brining plants and evaporated salt facilities operated at 82% and 77% respectively. Salt operations overall ran at an average of 83% of capacity, compared to 90% in 1991. Sales of salt products for de-icing purposes were soft across the country in 1992 due to the recession and relatively mild winter conditions both at the beginning and the end of the year.

The chloralkali sector is still under significant pressure, mainly for environmental reasons, and sales continued to slow down in 1992. A major chloralkali complex in Sarnia, Ontario, closed down. Chloralkali plants also closed in British Columbia where the paper industry is being forced to phase out the use of chlorine as a bleaching agent. In 1992, the Canadian pulp and paper industry, which is one of the largest end users for chloralkali, experienced a worse year than in 1991. The British Columbia industry was affected by a five-week strike, which forced the closure of most of the province's chloralkali facilities. Pulp mills experienced an operating rate of 87% in 1992; a rate of 91% is expected in 1993. Canadian production of wood pulp rose 2.4% to 25 490 000 t in 1992, while pulp exports increased only 1.2% over 1991.

The Canadian pulp and paper industry continued its conversion to bleaching processes other than chlorine. However, the effect of this conversion on the chloralkali sector is expected to be minimal as the bulk of the conversion is now completed. Only some of the oldest chloralkali plants may close due to environmental concerns. Chlorine continued to be under scrutiny with respect to its use in solvents (chlorofluorocarbons), in drinking water disinfection, and in pulp bleaching. The Canadian market for PVC and its feedstocks (ethylene dichloride-EDC and vinyl chloride monomer-VCM) was affected by the recession due to the weakness of the construction sector. In North America in 1989, caustic soda was the major bleaching chemical used, accounting for 49.5%, followed by chlorine at 34.8% and sodium chlorate at 12.2%. By 1995, caustic soda is forecast to represent 49.0% of bleaching chemical usage; chlorine will be reduced to 22.5% and sodium chlorate will account for 20.9%. The imbalance between chlorine and caustic soda, two co-products from the same electrolysis process, continued. However, in 1992, prices for caustic soda remained relatively stable while chlorine prices improved slightly, especially towards the end of 1992. Producers of natural soda ash are also penetrating the caustic soda market, which could result in a much reduced imbalance between chlorine and caustic soda.

Sodium chlorate is considered to be the primary substitute for chlorine bleaching in pulp mills as it is the feedstock for the production of chlorine dioxide. Several sodium chlorate companies in Canada completed expansion and modernization projects during the year and new production units became operational in western Canada. As it closely follows the performance of the pulp and paper industry, the production of sodium chlorate in Canada decreased by about 6.5% in 1992 as producers operated at well below capacity.

Atlantic Region

Salt production in the Atlantic provinces was 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 Nappan, Nova Scotia.

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 1.2 Mt/y. Most of the salt from this mine is used for snow and ice control. At the evaporated salt plant, saturated brine is fed to a quadruple effect vacuum pan, rated at 13 t/h, where brine solution is evaporated to produce high-quality salt crystals for use in the chemical and food industries. Development work is continuing on the 300-m level, and a crusher and access ramp have been installed. Surface development included the installation of a new truck-loading facility and a new evaporator pan. An environmental study funded under a Mineral Development Agreement to examine the effect of saline tailings washing through the breached dam wall was successfully completed. The basic conclusion was that the saline levels were quickly reduced to normal levels within about 300 m of the breached dam. It is planned to repair the dam wall early next year. Production in 1992 was slightly below capacity due to a relatively mild winter. The bagging operation bought in 1989 by The Canadian Salt Company Limited from Avalon Salt of Newfoundland, and located at Shelbourne and North Sydney, is used at capacity for the bagging of solar salt supplied from its facility in the Bahamas.

In New Brunswick, Potash Company of America, a division of Rio Algom Limited, produced potash and salt at its underground mine near Sussex. Salt is extracted at a rate of 400 000-500 000 t/y and is sold mainly to the eastern United States and eastern Canada under a sales contract with Akzo Salt Limited. Reserves are estimated to be large enough to operate for as long as potash is extracted, which is for at least 20 years. In 1992, about 95% of the production was used in road de-icing and the remainder was for chemical use.

The main development during 1992 was the continuation of the integrated method of utilizing salt tailings underground as fill to support the salt and potash mining operation. Approximately 1.5 Mt of processed salt tailings and rock-salt screen rejects are sent directly to active cut-and-fill potash stopes to be used as backfill. Clay slimes and excess brine slurries from the processing plant are also piped underground to be discharged into large cavities created by the extraction of rock salt. After the solids have settled out, the clear brine solution is re-pumped to the surface for re-use. The entire operation results in a closed circuit or "zero effluent" system.

Sifto Canada Inc., a division of North American Salt Co., has a brining operation at Nappan in Cumberland County, Nova Scotia. Evaporated salt products are sold for table salt, fisheries and water conditioning.

Quebec

There is only one operating producer in Quebec, Seleine Mines Inc., located on the Magdelen Islands. The 173-m level is almost mined out and is expected to last until the end of 1993; development work has started on the 255-m and 268-m levels. A new crusher will be installed on the 255-m level next year. Each level contains reserves of about 8 Mt, which are sufficient to last about five years. The replacement of the secondary and tertiary impact crushers by rolling bar crushers was completed this year. The crushing circuit is still being optimized and, when completed, is expected to increase the recovery by about 5% (to 85%). Seleine Mines Inc. is now owned by The Canadian Salt Company Limited.

Ontario

In 1992, salt was produced from two underground rock salt mines, Goderich and Ojibway, and from brining operations at Goderich, Sarnia, Windsor and Amherstburg. Salt is extracted from the Salina formation.

At Goderich, Sifto Canada Inc. operated an underground rock salt mine. Mining is currently conducted approximately 537 m below surface, 2.5 km offshore Lake Huron. Reserves are estimated to be 240 Mt and the mine has an annual capacity of 3.3 Mt of salt products. Sifto's salt is marketed mainly for ice control and is sold primarily in eastern Canada, the north-central United States (Great Lakes Basin), and regions accessible through the Mississippi River system. Salt produced at Goderich is also used by the chemical and water treatment industries. Evaporated salt is produced at the Sifto brining operation located near Goderich and is used mainly for the water-softening market.

The Canadian Salt Company Limited produced both rock salt from the Ojibway underground mine and vacuum salt products from brine wells near

Windsor. The mine capacity is 2.5 Mt/y and current estimated reserves are 100 Mt. Rock salt is extracted using room-and-pillar mining methods from a 7.5-m unit of the Salina formation about 297 m below surface. Brine is pumped from the 427-m and 457-m levels. Production is now being moved to the southwest portion of the 297-m level, within about 600 m of the shaft. Salt products include de-icing road salt, accounting for two thirds of production, and water softening, agricultural and chemical fine salt. The main markets are Canada and the midwest United States for all salt products except chemical fine salt, which is marketed in Quebec for the manufacture of caustic soda and chlorine. The company reports that it has acquired the mineral rights to Fighting Island in the Detroit River; therefore, it now has enough reserves for at least 40 years.

In the vicinity of Amherstburg, General Chemical Canada Ltd. has operated a brining operation for the manufacture of sodium carbonate and by-product calcium chloride. At Sarnia, Dow Chemical Canada Inc. has extracted brines from wells for the production of caustic soda and chlorine. Dow Chemical Canada Inc. announced the closure of its last chloralkali unit for the end of June 1993 due to market conditions.

Prairie Provinces

In Saskatchewan, four companies produced salt from the Middle Devonian Prairies formation. International Minerals & Chemical Corporation (Canada) Limited (IMCC) supplied by-product rock salt from its potash operation at Esterhazy. Its salt is distributed locally for road de-icing. Sifto Canada Inc. operated a brining operation near Unity for the production of fine vacuum pan salt. Since the closure of its fused salt plant, the company has adopted the compaction method to produce water-softener salt. Other uses of its salt include agriculture and food processing. Sifto also has an operation at Patience Lake where salt is recovered by processing waste salt from nearby PCA's potash operation. Production capacity is reported to be in the range of 50 000-60 000 t/y. Most of the production is sold for agricultural purpose. The Canadian Salt Company Limited at Belle-Plaine produced evaporated salt from by-product brines sourced from an adjacent potash solution mine operated by Kalium Chemicals, a division of Kalium Canada, Ltd. Most of the production goes towards water softening; others uses include agriculture, food processing and ice control. Saskatoon Chemicals, a division of Weyerhaeuser Canada Ltd., produced brines from wells near Saskatoon for the manufacture of caustic soda and chlorine to be used internally by its pulp and paper sector.

Nusalt Corporation processed salt-rich potash tailings from Potash Corporation of Saskatchewan's Rocanville operation. The potash tailings are dried and bulk delivered to local distributors for road de-icing.

Central Canada Potash Limited began salt production in September 1992. Salt is recovered from its potash tailings and the operation has a reported capacity of 100 000 t/y. The main product is de-icing salt, which accounts for 90% of production; 5% is for domestic salt and 5% is agricultural grade. Products are all sold locally within the province.

In Alberta, four producers operated brining operations. At Fort Saskatchewan near Edmonton, Dow Chemical Canada Inc. extracted salt brines for the manufacture of chloralkali and, at Lindberg, The Canadian Salt Company Limited produced fine vacuum pan salt. Near Bruderheim, two companies, Canadian Oxy Ltd. and Albchem Industries, operated solution mines to produce sodium chlorate used mostly for pulp bleaching in the prairies and western Canada.

British Columbia

There was no production of salt in this province where three companies operated four chloralkali plants. These operations used solar salt imported from Mexico, the United States and Chile.

CONSUMPTION

In Canada, the apparent consumption of salt has averaged 9.0 Mt/y since the mid-1980s, a 30% increase compared to the early 1980s. In 1991, the apparent consumption of salt in Canada was estimated at 10.3 Mt, a 9.6% decrease over 1990. In 1991, imports, mainly in British Columbia and Ontario, accounted for about 12% of total domestic consumption. Chemical and de-icing uses accounted for between 90% and 95% of Canadian consumption, with the remainder being used for water conditioning, food processing, fisheries, and other industrial usages. Most of the salt used as a de-icing agent is consumed in Ontario, Quebec and Atlantic Canada. Average yearly ice and snow control consumption of salt in Canada ranges between 3.2 Mt and 4.5 Mt.

Some 60% of world salt consumption is as a chemical raw material, followed by table salt (20%) and road de-icing salt (10%); the remaining 10% is used in animal feed and water treatment. The consumption pattern differs in North America where the chemical industry consumes about 56% of total production, followed by highway usage (24%) and the food industry (7%).

The industrial chemicals industry consumes salt for the manufacture of chloralkali such as caustic soda (sodium hydroxide), chlorine, and sodium chlorate. Salt for four caustic soda and chlorine plants in Canada is obtained from on-site brining and natural brines; other plants use mined rock salt or imported solar or evaporated salt. Other industrial chemicals that require significant quantities of salt include sodium bicarbonate, sodium chlorite, sodium hypochlorite, sodium carbonate (soda ash), and calcium chloride.

Chlorine, which is a major market for salt, is currently under investigation as the principal pulp-bleaching agent responsible for the presence of traces of dioxin (2, 3, 7, 8,-TCDD (tetrachlorodibenzo-p-dioxin)) and furan (2, 3, 7, 8,-TCDF (tetrachlorodibenzo-p-furan)) in certain pulp and paper mill effluents in North America. These chlorinated compounds have been identified as carcinogenic to some animals; however, their effect in small dosages on humans is the focus of controversy.

By 1994, the release of furans and dioxins will be banned in pulp mill effluents. An announcement on the required compliance of pulp and paper mills with new amendments to regulations under the *Fisheries Act* was issued in February 1991. These amendments establish new procedures for effluent measurement and, for the first time, make **all** mills in Canada, new and old, subject to reguations governing the discharge of suspended solids and oxygen-depleting substances. To obtain an extension beyond the December 31, 1993, deadline, a company will have to demonstrate that it made all reasonable efforts to comply with these regulations. An extension will be subject to public consultation and ministerial approval. No extensions will be granted after December 31, 1995. The national average of dioxin and furan discharges from kraft pulp mills was estimated at 6 kg/t of pulp produced.

It is also worth noting that there is currently a debate, not only in the United States, but also in Canada, about the toxicity of dioxins. In summary, the U.S. Environmental Protection Agency and the Centers for Disease Control in Atlanta are now stating that there is new evidence suggesting that dioxin is not as potent a carcinogen as originally believed. In Canada, a new study by the National Water Research Institute in Burlington found that there is no link between chronic biological changes in fish and effluents from all types of kraft mills, whether using chlorine as a bleaching agent or not. However, these findings are unlikely to change policies in Canada on dioxin as a study by Environment Canada found that pulp mill effluents are toxic and will endanger human life as long as chlorine is used, even if all dioxins were to be removed. In fact, in early 1992, the province of British Columbia issued a regulation calling for the elimination of chlorine-compounds pollution from pulp mills by the year 2002. The Ontario government has also indicated that its intends to follow the lead of British Columbia and plans to introduce a law to phase out organochlorines.

Many mills in North America have already started the conversion of their bleaching process away from chlorine technology. A limit of 2.0 kg/t for absorbable organic halides (AOX), which include furans and dioxins, could be readily achieved; however, a cap could be legislated at 1.5 kg/t and would require a substitution level of up to 80%-90% in older mills, and up to 60%-70% in more recent mills.

Most mills in Canada have carried out extensive process modifications and improvements in effluent treatment. Several opted for reducing chlorine usage by installing other bleaching processes such as extended lignification, oxygen delignification, sodium chlorate bleachng, integrated chlorine dioxide with hydrochloric acid recycling, and ozone and hydrogen peroxide bleaching processes.

Sodium chloride, or salt, remains the primary de-icing agent. Different de-icers are used in accordance with site requirements. On streets and highways, rock salt, calcium chloride-salt mixtures, salt brines, and mechanical measures (plowing and blowing) are mostly used. On bridges, salt, sand-salt mixtures, and salt alternative methods are used; pavement heating and non-corrosive chemicals with corosion inhibitors are under investigation. On runways and airways, non-corrosive compounds are used and comprise urea, formamide, and glycols. In residential and commercial areas, rock salt, potassium chloride (potash), calcium chloride, and various combinations of these materials with abrasives are regularly used. Calcium chloride is the second most used de-icer, being effective at temperatures ranging between –10° and –20°C; this chemical is usually mixed with salt at a 2%-4% rate. The use of abrasives is mostly limited to highways and residential areas; a mixture of coarse sand and small crushed stone is spread to improve the skid resistance of slippery roads.

Growing concerns over degradation of the environment and the corrosion of infrastructure, such as bridge decks and parking lots, have led to numerous experiments with de-icing salt substitutes. Research on alternatives has focused on abrasive mixes, magnesium chloride, ammonium compounds, tetrapotassium pyrophosphates, calcium magnesium acetate (CMA), sodium formate, isopropyl alcohol, ethylene glycol, and technical urea. Studies have also been conducted on non-chemical treatments, including a series of measures that are mainly used in Europe such as ice-retardant pavement surfacing and roadway heating. The effects of salt-spreading on the environment depend on a variety of factors such as weather conditions, road characteristics, traffic loads, winter maintenance methods, and local topography. Environmental effects may include adverse impacts on plant growth and crop productivity in the immediate vicinity of highways, and higher salinity levels in streams and groundwater systems. For many years, provincial and regional agencies in charge of road maintenance have pursued the objective of optimizing the use and selection of ice and snow control methods. Cost, operational reliability, public safety, and environmental considerations have all resulted in improvements to existing methods and better road safety and rideability.

Tests by the Ontario Ministry of Transportation indicate that CMA is only effective at temperatures around –6° and –7°C. Although CMA has proven to be effective and environmentally safe, its temperature limitation and its price, which is about 30 times that of salt, will continue to limit its application. In 1991, the Research and Development Branch of the Ontario Ministry of Transportation published a paper presenting results on research on highway de-icers. Several de-icers were compared but, in the conclusion, salt is still acknowledged as the most efficient and the least expensive de-icer for use in the province of Ontario.

Since mid-1987, the Transportation Association of Canada (TAC) has been coordinating an extensive project to evaluate the degradation of highways and related infrastructure. The Canadian Strategic Highway Research Program (C-SHRP) is a $5 million project funded by provincial and federal governments over a five-year period. In 1990, the SHRP program in the United States initiated an $800 000 project to evaluate the testing procedure for de-icing chemicals and to develop improved sodium chloride products. The two-year program comprises two phases: field observations being carried out during the winter of 1991/92, and investigations of the effectiveness of salt and non-chloride chemicals. The full report should be available sometime in the first half of 1993.

Other sectors that consume salt include water softening, food processing, and the fisheries industry, which together account for close to 5% of total consumption in Canada. Salt consumption in Canada for water softeners is estimated at 150 000-200 000 t/y. All Canadian production is consumed in the domestic market; trade in conditioning salt is estimated to be small. A typical annual consumption per household in Canada ranged between 350 kg/y and 450 kg/y of salt. The bulk of the market is reported to be located in suburban and rural areas where hard water is seldom treated on a large-scale basis. Some major municipalities in western Canada, such as Regina and Calgary, use water softeners extensively as the local water carries high calcium and magnesium concentrations. In 1991, the water treatment market in Canada was evaluated at $700 million, an 8% increase over 1990. The residential water-softening market was evaluated at $60 million, a 33% increase compared to 1990, and salt sales in this market segment remained flat at $20 million. Canadians still seem to prefer bottled water as this market grew by 7% over 1990 to reach a value of $203 million. Fused salt, which was a popular product for water softening, has been replaced by compacted salt pellets, nuggets and crystals; in some instances, coarse salt is used. Growth in this market is tied to housing starts and local water characterstics. New water treatment devices that do not use salt, such as electromagnetic equipment and catalytic units, have not yet been approved in Canada.

TRADE

Imports of salt in 1991 were 1.20 Mt valued at $25.8 million, which represented a decrease of 42.6% in volume and 28.2% in value from 1990 figures. A similar downward trend is observed when comparing the first nine months of 1992 with the same period for 1991; imports are down by 20.6% from 955 380 t to 758 671 t. The unit price, however, increased from $21.47/t in 1991 to $27.25/t in 1992, an increase of 27%. This decline in imports is due to a reduced demand in the chloralkali sector of British Columbia where several plants have closed over the past couple of years. Imports in 1992 were in the form of table salt, brine and solar salt; over 90% originated from solar salt. The origin of imports was from 18 countries, but mainly from the United States (60%), Mexico (23%), Chile (10%) and the Bahamas (6%), for deliveries in Ontario (39%), British Columbia (35%), Quebec (18%) and the Atlantic provinces (5%).

Exports of salt in 1991 were 2.8 Mt valued at $50.43 million which, when compared to 1990 figures of 2.10 Mt valued at $35.97 million, represent an increase of 32.8% in volume and 40% in value. The first nine months of 1992 indicate exports of 1.67 Mt, which are down slightly from the 1.77 Mt reported for the same period in 1991. The unit value, however, shows an increase of 24% from $18.09/t in 1991 to $22.47/t in 1992. Exports of salt products in 1992 were to 16 countries, but principally to the United States, which accounted for 99.8%. Deliveries were shipped mainly from Ontario (78%) and Quebec (20%).

WORLD PRODUCTION IN REVIEW

The total world production of salt in 1991 was 184 Mt, which represented a similar level to 1990. Salt is produced in numerous countries, but the bulk of the production is from 12 countries of which the United States is the principal producer. The United States accounted for 20%, while China accounted for 14%, the C.I.S. for 8% and Germany for 8%; Canada again ranked fifth with 6%.

Provisional production figures for 1992 are 186 Mt, which represents an increase of 1.1% over 1991 figures. The 1992 production pattern for the major-producing countries is similar to 1991.

United States

Domestic salt production decreased slightly to 36.1 Mt in 1992 from the 1991 level of 36.3 Mt; the total value increased from US$765 million to US$780 million. Thirty-one companies operated seventy plants in fourteen states. U.S. salt production capacity in 1991 was reported at 43.1 Mt; for 1992, it was estimated at 43.2 Mt. Salt producers operated at 84.3% of capacity during 1991 and at 83.6% in 1992. Apparent consumption at 40.3 Mt was virtually unchanged from the 40.2-Mt level of 1990; the 1992 figure is estimated to be 41.5 Mt. The distribution of salt sold or used by type, in 1992, was brine sales (47%), rock salt (35%), evaporated salt (10%), and solar salt (8%). The chemical industry consumed about 49% of total salt sold; road and ice control usage accounted for 23%, food and agricultural sectors for 7%; and general industrial for 4%. The average unit value of salt from brine in 1992 decreased by about 9% to US$4.96/t, while the average unit value for rock salt shipments rose by about 3% to US$19.84/t.

Imports in 1992 were estimated at 6.1 Mt, which remained unchanged from 1991 levels. The major exporting country was Canada (41%) followed by Mexico (24%) and the Bahamas (12%). The net import reliance of the United States for 1992 was estimated at 12% of apparent consumption. Exports decreased almost 50% to 0.9 Mt.

A major salt company announced plans to take waste-coal fly ash and cement kiln dust mixed with Portland cement to use as backfill in its New York underground rock salt mine. The material will harden in place and provide structural support for the mine. The project will also provide an economical and environmentally acceptable method of disposal for the unwanted solid waste.

Australia

The A$23 million expansion program of Dampier Salt Pty Ltd., at Dampier, Western Australia, was completed in 1992. Investments made in upgrading equipment have resulted in an increase in capacity of 227 000 t for a total capacity of 4.5 Mt/y. This expansion strengthens the company's position as Australia's largest producer, and is directed towards the growing demand from the chemical industry in north and southeast Asia. Salt consumption in Asia is forecast to grow at an annual rate of 2% to reach 12 Mt/y by the year 2000. Japan is the main importing country, but it is expected that Korea, Taiwan and Indonesia will become significant customers.

Gulf Holdings Pty Ltd. has obtained environmental clearance for a new solar salt project on the east coast of the Exmouth Gulf in Western Australia. This project, which was first conceived in the late 1960s, will have a capacity of 2.5 Mt/y and employ about 60 people.

China

The world's largest salt-producing company, Akzo N.V., which is based in the Netherlands, began a feasibility study to produce salt in Jiangsu, China. The study evaluated the quantity and quality of salt available, energy sources, and markets in southeast Asia. Approval was granted for the construction of two 1-Mt/y salt plants at Laizhou Bay, Shandong. Construction is also progressing on a 3-Mt/y solar salt facility along the coast of Shandong Province.

Japan

In 1991, Japan produced about 1.37 Mt of salt, which is roughly the same level as in 1990. Japan imported close to 8 Mt, mostly from Australia (51%) and Mexico (44%). In 1991, Japan consumed

9.3 Mt of salt with the three main consuming sectors being the chloralkali industry (64%), the soda ash industry (16%), and the food-processing industry (11%).

INTERNATIONAL TRADE

Salt is a widespread, low-value bulk commodity. It is relatively easy to extract and transportation represents a significant proportion of the total delivered price. As a consequence, international trade in salt is small relative to world production, i.e., about 20% of total world production. Trade in the Pacific area currently accounts for one half of seaborne moveents, followed by North America (24%) and northwestern Europe (20%). Australia is expected to remain the major supplier to Japan, while Mexico will continue to export mainly to Japan and North America. Imports to the European Community are expected to remain minimal as this region is essentially self-sufficient.

PRICE

The price of salt depends on factors such as production methods, purity, scale of operations, transportation costs, and product availability. During those periods when a shortage occurs for reasons of strikes or technical problems, prices for salt will likely rise until alternative sources are found. In peak periods of demand, de-icing rock salt prices may increase if harsh winter conditions persist. Most likely, the replenishment of stocks during such periods will be at higher prices.

The prices of salt products for 1992 were variable for some products when compared to 1991 prices. Rock-salt de-icing grades in bulk delivery sold for $25-$94/t, or $4 per 40-kg bag. Fine-evaporated salt sold for $79-$120/t, or $6-$8 per 40-kg bag, and coarse-evaporated salt sold for $86-$100/t, or $5-$7 per 40-kg bag. Water-conditioning grades varied between $5 and $10 per 40-kg bag, while domestic salt varied between $15 and $16 per 25-kg bale. Agricultural grades were $3-$8 per 20-kg lick-block, and $4-$11 per 25-kg paper bag.

The price differential between eastern and western Canada was highest for agricultural products; 20-kg lick-blocks were 20%-30% higher, and 25-kg stock paper bags were 33%-45% higher in the eastern provinces. Fine-evaporated salt in bulk tonnage lots was 23%-33% higher, water-conditioning grades were 10% higher, and domestic salt was 2%-7% higher, also in the eastern provinces.

OUTLOOK

In 1993, domestic production and consumption of salt is forecast to remain stable. Imports of salt are likely to decline, mainly due to the continued downsizing of the chloralkali sector. Rock salt prices are expected to remain stable, while value-added products should achieve a marginal, inflation-like increase in 1993.

Despite environmental pressures, de-icing salt will continue to be the major de-icing agent because of its low price. The optimization of spreading rates, in combination with the search for adequate abrasive mixtures, will continue to be evaluated. A mild winter in 1992/93 will affect the demand for de-icing salt across Canada in the beginning of 1993. The loss of sales may be offset by more favourable winter conditions in early 1993/94.

As part of its restructuring, the pulp and paper sector is expected to continue its conversion away from the use of chlorine in its bleaching process, but at a slower rate. About one third of Canadian mills are still using chlorine and, so far, about 30% have converted to the chlorate process. This latter figure is expected to be 50% by 1995. In 1993, salt consumption in chemicals is forecast to decrease significantly due to the closure of several plants in 1992. The pulp and paper industry, the major consumer of chloralkali, is also expected to recover from the 1992 recession with operating rates in the 85%-90% range. During the 1990-94 period, demand is forecast to grow at a marginal rate of up to 1%/y, while consumption is expected to decline in the pulp and paper sector at a rate of 8%-9%/y, and in the chlorinated chemicals sector at a rate of 1.5%/y. These declines will be offset by an anticipated growth in the PVC sector, in which sales of chlorine will register an annual increase of 4%-5% up to 1994. Despite the recession, PVC output grew by a healthy 33% in 1992, mainly because of the strength in the export market.

Demand for chlorine's co-product, caustic soda or sodium hydroxide, is forecast to be strong in the pulp and paper, detergents, and the pH control sectors. Consumption of caustic soda is projected to increase 1.0%-2.5%/y up to 1994. The market will likely remain firm as new capacities are installed in the growing bleach chemothermomechanical pulp (BCTMP) segment of Canada. A serious imbalance between caustic soda and chlorine demands should force many caustic soda consumers to look for alternatives, such as calcined trona or sodium carbonate, for use in BCTMP mills, or to reduce its consumption rate, as in kraft mills.

In North America, the consumption of sodium chlorate is forecast to grow at a rate of 11%/y up to 1994. In Canada, the sodium chlorate industry is expected to experience strong growth after a very deceiving year in 1992, which was the result of the poor performance of the pulp and paper industry coupled with the strike in British Columbia that forced the closure of most of the province's chemical sector. However, no new facility is planned for 1993.

As the construction sector regains strength while Canada is pulling itself out of the recession in 1993, demand for salt in water treatment should regain strength. However, consumers are still turning to bottled water for their own consumption, probably at the expense of the water-softening industry, thereby limiting the potential growth of this sector. Sales of salt in the fisheries and food industries are expected to decline, but for different reasons. The current state of Canadian fisheries is such that demand for salt in this sector is for all purposes reduced to the minimum, with probably even further reductions. In the food industry, demand for salt is also expected to diminish as this industry will continue to reduce its salt requirements due to increasng public concern about sodium intake. Salt substitutes are expected to make sustained gains in this market.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2501.00	Salt (including table salt and denatured salt) and pure sodium chloride, whether or not in aqueous solution; seawater				
2501.00.10	Table salt made by an admixture of other ingredients when containing 90% or more of pure sodium chloride	4%	2.5%	Free	Free
2501.00.90	Other	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992.

TABLE 1. CANADA, SALT SHIPMENTS AND TRADE, 1991 AND 1992

Item No.		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)
SHIPMENTS					
	By type				
	Mined rock salt	8 615 755	167 101	7 934 511	161 716
	Fine vacuum salt	799 563	79 297	795 273	79 713
	Salt content of brines used or shipped	2 455 541	12 768	2 370 641	12 373
	Total	11 870 859	259 166	11 100 425	253 802
	By province				
	Nova Scotia	x	x	x	x
	New Brunswick	x	x	x	x
	Quebec	x	x	x	x
	Ontario	7 182 255	136 305	6 648 378	140 544
	Saskatchewan	566 236	27 032	543 891	25 173
	Alberta	1 245 244	15 335	1 244 783	15 324
	Total	11 870 859	259 166	11 100 425	253 802
IMPORTS				(Jan.-Sept.)	
2501.00	Salt[1]				
	United States	771 894	19 460	451 516	16 061
	Mexico	311 601	4 780	175 557	2 758
	Bahamas	29 066	497	45 264	755
	Chile	74 311	715	78 831	744
	France	4 919	134	1 446	76
	United Kingdom	3 573	77	897	61
	Belgium	1 185	40	78	52
	Japan	3 280	37	32	4
	Other countries	3 050	87	5 050	161
	Total	1 202 879	25 827	758 671	20 672
	By province of clearance				
	Newfoundland	11 707	264	18 843	372
	Prince Edward Island	–	–	22	3
	Nova Scotia	17 516	238	22 024	320
	New Brunswick	1 269	49	44	5
	Quebec	94 264	2 212	132 901	3 000
	Ontario	403 280	11 204	292 666	11 219
	Manitoba	12 625	288	4 841	187
	Saskatchewan	6 810	289	2 226	260
	Alberta	47 409	1 407	20 986	1 071
	British Columbia	607 999	9 872	264 117	4 220
	Total	1 202 879	25 827	758 671	20 672
EXPORTS					
2501.00	Salt[1]				
	United States	2 778 831	49 929	1 663 255	36 994
	St. Pierre and Miquelon	2 216	186	1 406	118
	Dominica	276	23	21	5
	Other countries	1 698	204	1 606	302
	Total	2 783 021	50 342	1 666 288	37 419

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil or not reported; p Preliminary; x Confidential.
[1] Includes table salt, pure sodium chloride and seawater salt.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADIAN SALIENT STATISTICS ON SALT

Company	Location/ Initial Production	Employment		Annual Production Capacity					Remarks
		1990	1991	1988	1989	1990	1991	1992	
				(000 t/y)					
Albchem Industries Ltd.	Bruderheim, Alta./1991	–	10a	–	–	–	29	29	Brining to produce sodium chlorate.
Canadian Occidental Petroleum Ltd.	Bruderheim, Alta./1991	–	5a	–	–	–	26	26	Brining to produce sodium chlorate.
Canadian Salt Company Limited, The	Pugwash, N.S./1959	225b	214b	1 200	1 200	1 200	1 200	1 200	Rock salt mining to a depth of 305 m.
	Pugwash, N.S./1962			110	110	110	110	110	Dissolving rock salt fines for vacuum pan evaporation.
	Îles-de-la-Madeleine, Que./1982	182	177	1 200	1 500	1 500	1 500	1 500	Rock salt mining to a depth of up to 273 m.
	Ojibway, Ont./1955	241	239	2 500	2 500	2 500	2 500	2 500	Rock salt mining at a depth of 300 m.
	Windsor, Ont./1892	86	108	150	150	150	150	150	Brining, vacuum pan evaporation.
	Belle Plaine, Sask./1969	28	28	170	170	170	170	170	Producing fine salt from by-product brine from nearby potash operation.
	Lindbergh, Alta./1968	66	65	140	140	140	140	140	Brining, vacuum pan evaporation.
Subtotal		828	831						
Central Canada Potash Ltd.	Colonsay, Sask./1992	–	–	–	–	–	–	100	By-product rock salt from potash operation.
Dow Chemical Canada Inc.	Sarnia, Ont./1950	4a	4a	830	900	900	900	900	Brining to produce caustic soda and chlorine.
	Fort Sask., Alta./1968	3a	3a	1 400	1 400	1 400	1 400	1 400	Brining to produce caustic soda and chlorine.
Subtotal		7a	7a						
General Chemical Canada Ltd.	Amherstburg, Ont./1919	8a	6a	690	690	690	690	690	Brining to produce sodium carbonate.
International Minerals & Chemical Corporation (Canada) Limited	Esterhazy, Sask./1962	3	3	120	120	120	120	120	By-product rock salt from potash mine for use in snow and ice control.
Nusalt	Rocanville, Sask./1990	. .	12	–	–	100	100	140	By-product rock salt from potash tailings.
Potash Company of America, a division of Rio Algom Limited	Sussex, N.B./1980	29	27	450	450	450	500	500	Rock salt produced in association with potash for use in snow and ice control.

Saskatoon Chemicals - a division of Weyerhaeuser Canada Ltd.	Saskatoon, Sask./1968	5[a]	5[a]	70	70	70	70	70	Brining to produce caustic soda, chlorine and sodium chlorate.
Sifto Canada Inc.	Nappan, N.S./1947	73	76	100	100	100	100	100	Brining for vacuum pan evaporation.
	Goderich, Ont./1959	330	339	2 800	2 800	3 300	3 300	3 300	Rock salt mining at a depth of 536 m.
	Goderich, Ont./1880	66	65	120	120	120	120	120	Brining for vacuum pan evaporation.
	Unity, Sask./1949	82	77	180	180	180	180	180	Brining vacuum pan evaporation. Fusion plant closed in 1991.
	Patience Lake, Sask./ 1987	4	5	–	–	–	100	100	By-product rock salt from potash mine.
Subtotal		555	562						
Total		1 435	1 468	12 230	12 600	13 200	13 405	13 545	

Sources: Mineral Policy Sector, Energy, Mines and Resources Canada, 1990; company surveys.
– Nil; . . Not available.
[a] Employment part of chemical complex. [b] Includes employment in brining operations at Pugwash.

TABLE 3. CANADA, SALT SHIPMENTS AND TRADE, 1980-92

	Producers' Shipments					
	Mined Rock	Fine Vacuum	In Brine and Recovered in Chemical Operations	Total	Imports	Exports
	(tonnes)					
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
1985	6 608 739	805 209	2 670 749	10 084 697	1 255 518	2 263 076
1986	6 867 287	815 044	2 649 515	10 331 846	1 328 298	2 502 518
1987	6 670 863	866 475	2 591 715	10 129 053	1 112 102	1 924 686
1988	7 126 762	783 368	2 777 050	10 687 180	1 202 219	3 030 124
1989	7 548 732	821 284	2 788 395	11 158 411	2 360 432	2 137 321
1990	7 704 499	778 428	2 708 458	11 191 385	2 095 321	1 897 816
1991	8 615 755	799 563	2 455 541	11 870 859	1 202 879	2 783 021
1992p	7 934 511	795 273	2 370 641	11 100 425	758 671a	1 666 288a

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary.
a January to September 1992.

TABLE 4. CANADIAN CHEMICAL PLANTS USING SALT AS A MAJOR RAW MATERIAL: DEVELOPMENTS AND PROJECTS IN 1992

Company	Location	Parent Company	Plant Location	Type of Cells	Products	Annual Capacity	Remarks
						(tonnes)	
Albchem Industries Ltd.	Bruderheim, Alberta	Sherritt Gordon Limited, Vencap Equities Alberta Ltd., Alberta	Bruderheim, Alberta	Metal	Sodium chlorate	55 000	
B.C. Chemicals Ltd.	Prince George, British Columbia	B.C. Chemicals Ltd., Prince George, B.C.	Prince George, British Columbia	Metal	Sodium chlorate	77 000	Production down due to strike in 1992.
Canadian Occidental Petroleum Ltd.	Calgary, Alberta	Occidental Petroleum Corporation, Los Angeles, CA, U.S.A.	Amherstburg, Ontario	Metal	Sodium chlorate	50 000	
			Brandon, Manitoba	Metal	Sodium chlorate	85 000	Expansion in 1992.
			Bruderheim, Alberta	Metal	Sodium chlorate	50 000	
			Nanaimo, British Columbia	Metal	Sodium chlorate	16 000	Production down due to strike in 1992.
			North Vancouver, British Columbia	Diaphragm	Caustic soda Chlorine	155 000 141 000	Production down due to strike in 1992.
			Squamish, British Columbia	Metal	Sodium chlorate	11 000	Production down due to strike in 1992. Closed at the end of 1992.
Canso Chemicals Limited	Abercrombie Point, Nova Scotia	ICI Inc., North York, Ontario	Abercrombie Point, Nova Scotia	Mercury	Caustic soda Chlorine	20 000 18 000	Closed in 1992.
Domtar Inc.			Lebel-sur-Quévillon, Quebec		Sodium chlorate	. .	
Dow Chemical Canada Inc.	Sarnia, Ontario	The Dow Chemical Company, Michigan, U.S.A.	Fort Saskatchewan, Alberta	Diaphragm	Caustic soda Chlorine	524 000 476 000	
			Sarnia, Ontario	Diaphragm	Caustic soda Chlorine	401 000 365 000	Will close at the end of June 1993.
Eka Nobel Canada Inc.	Magog, Quebec	Nobel Industries AB, Sweden	Magog, Quebec	Metal	Sodium chlorate	122 000	
	Valleyfield, Quebec		Valleyfield, Quebec	Metal	Sodium chlorate	105 000	
General Chemical Canada Ltd.	Amherstburg, Ontario	General Chemical Corporation, Morristown, New Jersey, U.S.A.	Amherstburg, Ontario	Metal	Calcium chloride Sodium carbonate	450 000 400 000	
Great Lakes Forest Products Limited	Thunder Bay, Ontario	Canadian Pacific Securities Limited Montreal, Quebec	Dryden, Ontario	Membrane	Caustic soda Chlorine	16 000 14 500	
ICI Canada Inc.	Montréal, Quebec	Imperial Chemical Industries plc (ICI), England	Bécancour, Quebec	Diaphragm	Caustic soda Chlorine	325 000 295 000	
			Cornwall, Ontario	Mercury	Caustic soda Chlorine	38 500 35 000	
			Dalhousie, New Brunswick	Metal	Sodium chlorate	22 000	
				Mercury	Caustic soda Chlorine	31 000 28 000	

TABLE 4 (cont'd)

Company	Location	Parent Company	Plant Location	Type of Cells	Products	Annual Capacity[r]	Remarks
						(tonnes)	
PPG Canada Inc. Industrial Chemical Division	Beauharnois, Quebec	PPG Industries, Inc. Pittsburgh, Penn., U.S.A.	Beauharnois, Quebec	Metal	Sodium chlorate	40 000	
				Membrane	Caustic soda Chlorine	80 000 73 000	
St. Anne Chemicals Company Ltd.	Nackawic, New Brunswick	Parsons & Whittemore, Inc. New York, U.S.A.	Nackawic, New Brunswick	Metal	Sodium chlorate	12 500	Captive production. A 25% expansion in 1992.
				Membrane	Caustic soda Chlorine	10 000 9 000	Captive production.
Saskatoon Chemicals	Saskatoon, Saskatchewan	Weyerhaeuser Canada Ltd. Kamloops, B.C.	Saskatoon, Saskatchewan	Metal	Sodium chlorate	44 000	
				Membrane	Caustic soda Chlorine	36 000 33 000	
Sterling Pulp Chemicals	Islington, Ontario	Sterling Chemical Inc. Texas, U.S.A.	Buckingham, Quebec	Metal	Sodium chlorate	132 000	
			Grande Prairie, Alberta	Metal	Sodium chlorate	45 000	New capacity in April 1992.
			Thunder Bay, Ontario	Metal	Sodium chlorate	53 000	
			North Vancouver, British Columbia	Metal	Sodium chlorate	92 000	Production down due to strike in 1992.

Sources: Mineral Policy Sector, Energy, Mines and Resources Canada, December 1992; Chemicals Directorate and Investments, Industry, Science and Technology Canada, December 1992.
. . Not available; r Revised.

India	9 900	9 205	9 600	9 500	9 500	9 525
France	7 840	7 560	7 490	7 540	6 500	6 440
United Kingdom	7 080	6 130	5 700	5 700	5 195	5 170
Mexico	6 395	6 790	6 940	7 135	7 595	7 620
Australia	6 485	7 165	7 350	7 440	7 790	7 800
Poland	6 175	6 180	4 665	4 810	3 900	3 720
Romania	5 395	5 400	6 770	6 530	6 500	n.r.
Italy	4 265	4 290	4 215	4 080	4 000	3 990
Other	31 815	32 810	32 140	33 075	38 980	38 640
Total	177 670	183 880	190 460	183 560	190 120	185 940

Sources: Energy, Mines and Resources Canada; U.S. Bureau of Mines, 1991.
[e] Estimated; n.r. Not reported; [p] Preliminary; [r] Revised.
[1] Includes data from the former East and West Germany.

Silica

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SUMMARY

Demand for silica was weak in nearly all markets during 1992 as a result of the recession. Major developments during the year included the following: Consumers Glass closed its Candiac, Quebec, glass container plant in March 1992; the construction of a sodium silicates plant in Alberta was delayed due to poor markets in the pulp and paper industry; and Baskatong Quartz Inc. started the development of a high-purity quartz deposit at Ste-Edwidge, Quebec.

SUPPLY

Nova Scotia

Nova Scotia Sand and Gravel Limited produces a high-purity silica from sand deposits located near Shubenacadie. The silica is used mainly in sandblasting, as foundry sand and as fracturing sand. In addition, fines from their silica operation are beneficiated to glass-grade material.

New Brunswick

Sussex Silica Inc. mines a high-grade (+99% SiO_2) silica deposit near Sussex. The company produces lump silica and sand of various sizes. The lump silica and coarse-grained sand are used in the manufacture of silicon metal and silicon carbide. Fine sand products are used in sandblasting, in glass-making, as filter sand and decorative sand in the Maritimes, and as a flux for base-metal smelters.

Quebec

Unimin Canada Ltd., a subsidiary of Unimin Corp. of the United States, is the largest producer of silica east of Ontario. Silica is mined from a quartzite deposit at Saint Donat and from a sandstone deposit at Saint Canut. Silica from Saint Donat (100 000-t/y capacity) is refined at the Saint Canut plant near Montréal. Most of the silica produced by Unimin Limited originates from Saint Canut where the ore is crushed, screened and beneficiated by attrition scrubbing, flotation and magnetic separation. The production capacity of the Saint Canut plant is about 550 000 t/y of finished products. The major markets for Unimin products are glass containers, flat glass, fibreglass, and the silicon carbide industries.

Baskatong Quartz Inc. produces high-purity lump silica from a quartzite deposit north of Saint Urbain. The silica is used mainly by SKW Canada Inc. at Bécancour for the production of ferrosilicon and silicon metal, and by Elkem Métal Canada Inc. at Chicoutimi. Baskatong also produces high-purity silica from quartz vein deposits located at Lac Bouchette south of Lac Saint-Jean where reserves will last about two more years at the current rate of production; the silica is sold almost exclusively to SKW for the production of ferrosilicon. During the year, Baskatong started the development of a high-purity quartz vein deposit at Ste-Edwidge in the Eastern Townships of Quebec.

Armand Sicotte & Sons Limited mines Potsdam sandstone at Sainte-Clothilde, south of Montréal. The company's lump silica is used mainly in the production of ferrosilicon and glass, as a fluxing agent, and in the cement industry.

The Good Sand Company Ltd. mines silica sand and gravel at Saint-Joseph-du-Lac and at Ormstown. The material is used mainly for sandblasting, but also for fibreglass and foundries.

Temisca Exploration Inc. of Saint-Bruno-de-Guigues produces silica for use in sylviculture, filtration, sandblasting, foundries, and as traction sand.

Syquartz Inc. is scheduled to begin production of synthetic quartz in mid-1993 at its plant in Trois-Rivières, Quebec. The plant has a production capacity of 40 t/y of standard-quality synthetic quartz. Initially, high-purity quartz (lasca) will be imported. Synthetic quartz is used to manufacture oscillators, resonators and filters in communications equipment, computers, lasers, optical equipment, etc.

Consumers Packaging Inc. permanently closed its Candiac container glass plant at the end of March 1992, leaving some 380 employees out of work. The company cited reduced sales as the reason for the plant closure. The lower sales were the result of increased competition from U.S. and Mexican producers, the recession in Canada and the United States, and competition from plastics. The company consumed approximately 15 000 t/y of silica.

Ontario

Unimin Canada Ltd. is the largest producer of silica west of Quebec, with a reported total capacity of about 550 000 t/y. Lump quartzite from Badgeley Island (150 000-t/y capacity), 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 Unimin's plant at Midland (400 000-t/y capacity), south of Georgian Bay, where it is further processed to a glass-grade silica sand and silica flour for ceramic and other uses.

Manitoba

Marine Transport Limited of Selkirk produces high-purity silica sand from a quarry on Black Island on Lake Winnipeg, some 130 km north of Selkirk. The silica sand, mined from a poorly consolidated white sandstone, is well rounded and therefore suitable for use as foundry sand. The silica is also used in the glass and fibreglass industries, in construction, and as traction sand. The ore is washed, screened and dewatered at a plant on the island, and then shipped by barge to a processing plant at Selkirk on the Red River. Due to poor sales the quarry has been inactive for the past few years and, unless markets improve, the company is planning to completely close its operation at the end of 1993.

Inco Limited produces a low-grade silica from an impure quartzite at a quarry in Manasan; the silica is used at its Thompson nickel smelter. Production varies from year to year depending on nickel production.

Dow Corning Corp. completed the construction of a $26 million research and commercial development pilot plant near Winnipeg for the production of silicon metal.

Saskatchewan

Hudson Bay Mining and Smelting Co., Limited (HBMS) produces silica sand from two pits in the Amisk Lake area of northern Saskatchewan. The silica is used by HBMS as a smelting flux at its copper-zinc smelter in Flin Flon, Manitoba.

Red Deer Silica Inc. produces a small amount of silica northeast of Hudson Bay. The main market is for golf course bunkers.

Alberta

Sil Silica, a wholly owned subsidiary of The Warren Paving and Materials Group Ltd., produces silica sand from local sand dunes in the Bruderheim area. The silica is sold mainly for the manufacture of fibreglass and as sandblasting material. It is also sold as foundry sand, filtration sand, fracturing sand, and railway traction sand.

National Silicates, a consumer of silica in the production of sodium silicates, delayed the construction of its sodium silicates plant at Exshaw, Alberta, due to poor markets in the pulp and paper industry.

British Columbia

Mountain Minerals Co. Ltd. mines a high-purity, friable sandstone deposit near Golden. The ore is crushed, screened, washed, dried and separated into several sizes. These different sizes are sold mainly as glass sand, but also as sandblasting sand, foundry sand, filter media sand and golf course sand.

Bert Miller Inc. mines the Nicholson silica deposit, which is located about 11 km from Golden. The property is owned by Silicon Metaltech of Seattle, Washington. The ore, which consists of a massive quartzite, is sold as lump material for use by the ferrosilicon and silicon industries in the state of Washington.

TRADE

Most silica sand imported into Canada comes from loosely consolidated and easily processed sandstones or lake sand deposits located near the Great Lakes region. Major U.S. operations are located in the states of 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. In 1991, imports of foundry sand were 445 963 t valued at $6.87 million, and imports of sand for use in glassmaking were 136 327 t valued at $1.30 million; in 1990, imports were 589 162 t and 152 028 t respectively.

OUTLOOK

Not much improvement is expected in 1993 in most silica markets in Canada. In the longer term, environmental concerns and the disposal problems posed by plastic containers should encourage a greater use of glass containers, which are easier to recycle. However, the glass container industry is under growing pressure to increase recycling, which will likely mean a reduction in the consumption of silica and other industrial minerals used in glass-making. Markets for flat glass and fibreglass are not expected to improve as long as the economy remains weak. Producers of silicon carbide and silicon metal will continue to suffer from strong overseas competition.

In the long 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 Great Lakes region. Also, due to reduced North American car production and the recycling of silica sand at foundries, no growth can be expected in the foundry sand industry in Canada. Competition from substitutes for glass containers, such as paper, plastics and aluminum, will continue. Sandblasting will continue to decline as a result of tighter environmental controls and substitution from minerals such as garnet, olivine, staurolite and feldspar. The filler market is still small, but its growth will continue to be strong. On balance, silica producers will continue to suffer from low capacity utilization and low prices.

OPPORTUNITIES

Higher value silica products could be produced in Canada because of the low cost of electricity in certain parts of the country. Such products include:

- cultured quartz for the production of oscillators used in electronics, in optical instruments and other applications;
- fused silica (minimum 99.8% SiO_2) in the form of ingots, rods, tubes, and powder for the chemical and electronic industries;
- refined silicon carbide for advanced ceramics;
- monocrystalline silicon for the production of silicon chips;
- high-purity ground silica (minimum 99.5% SiO_2, 2 to 20 microns) for use as an abrasive for metal polishes and cleansers, and fillers in plastics and rubber; and
- chemical-grade silicon metal for the production of silicones.

With the exception of a cultured quartz facility being built in Quebec, none of these products are currently manufactured in Canada.

In addition, there are opportunities for:

- an integrated silicon carbide plant in western Canada, based on local raw materials and inexpensive electricity;
- a new reinforcement fibreglass plant (in Canada there is only one plant in Ontario);
- the production of silicones[1] by reacting silicon metal powder with methyl chloride;
- the production of amorphous silica[1] from the hydrolysis of silicon tetrachloride[2] in a flame of hydrogen and oxygen for use as a thickening agent in inks, paints, cosmetics, rubber, etc., and specialty coatings such as powder coatings;
- precipitated silica and silica gel[1] by reacting sodium silicate with sulphuric acid. (These products are used for reinforcing rubber and as extenders in paints, fillers in inks, and thickening and polishing agents in toothpastes).

REFERENCES

[1] No production facility yet exists in Canada, although most raw materials are available.

[2] Produced through the chlorination of silicon metal or silica.

Note: Information in this review was current as of February 1, 1993.

TABLE 1. CANADA, SILICA PRODUCTION AND TRADE, 1991 AND 1992

Item No.		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)
PRODUCTION	(shipments)				
	By province				
	Newfoundland	–	–	. .	. .
	Prince Edward Island	–	–	. .	. .
	Nova Scotia	x	x	. .	. .
	New Brunswick	x	x	. .	. .
	Quebec	525 096	13 215	. .	. .
	Ontario	583 412	5 459	. .	. .
	Manitoba	–	–	. .	. .
	Saskatchewan	x	x	. .	. .
	Alberta	x	x	. .	. .
	British Columbia	x	x	. .	. .
	Total	1 495 146	25 327	. .	. .
IMPORTS[1]				**(Jan.-Sept.)**	
2505.10	Silica sands and quartz sands				
	United States	759 207	14 628	505 721	10 502
	Germany	210	146	41	35
	South Africa	43	11	40	12
	Japan	–	–	2	1
	Other countries	533	33	–	–
	Total	759 993	14 821	505 805	10 551
2506.10	Quartz (other than natural sands)				
	United States	3 075	180	1 506	100
	Brazil	408	26	625	39
	Japan	–	–	107	7
	South Africa	–	–	1	. .
	Spain	33 060	1 148	–	–
	Total	36 543	1 356	2 239	148
2506.21	Quartzite crude or roughly trimmed				
	United States	1 353	149	1 753	176
	Total	1 353	149	1 753	176
2506.29	Quartzite n.e.s.				
	United States	1 328	165	1 005	101
	Brazil	–	–	14	2
	Total	1 328	165	1 019	103
2811.22	Silicon dioxide				
	United States	8 742	18 723	7 894	14 546
	Germany	916	2 444	699	1 867
	France	329	378	393	444
	United Kingdom	101	193	10	59
	Japan	9	61	7	51
	Sweden	–	–	3	31
	Switzerland	. . .	4	1	8
	Netherlands	11	11	. . .	. .
	Other countries	1	3	–	–
	Total	10 109	21 819	9 008	17 008
EXPORTS					
2505.10	Silica sands and quartz sands				
	United States	177 032	842	135 743	588
	Venezuela	–	–	187	85
	South Africa	72	21	29	11
	France	80	21	50	11
	Singapore	–	–	35	9
	Philippines	28	4	24	4
	St. Pierre-Miquelon	–	–	19	2
	Other countries	7 911	289	–	–
	Total	185 123	1 177	136 087	712

TABLE 1 (cont'd)

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
2506.10	Quartz (other than natural sands)				
	United States	3 237	137	64	19
	Total	3 237	137	64	19
2506.21	Quartzite crude or roughly trimmed				
	United States	73	11	66	11
	Total	73	11	66	11
2506.29	Quartzite n.e.s.				
	United States	75	13	–	–
	Total	75	13	–	–
2811.22	Silicon dioxide				
	United States	92	51	23	15
	Belgium	–	–	...	..
	Taiwan	8	3	–	–
	Total	100	54	23	15

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified; p Preliminary; x Confidential.
[1] Includes sand for use in foundries and glass manufacturing, ground and flour sand, and volatized and silica flue dust.
Note: Numbers may not add to totals due to rounding.

TABLE 2. IMPORTS OF SILICA SAND (FROM THE UNITED STATES) BY PROVINCE AND BY USE, 1991

	Foundry		Glass Manufacturing	
	(tonnes)	($000)	(tonnes)	($000)
Newfoundland	–	–	–	–
Prince Edward Island	–	–	–	–
Nova Scotia	600	7	–	–
New Brunswick	91	12	–	–
Quebec	17 601	319	28 934	260
Ontario	225 870	3 768	107 393	1 041
Manitoba	1 503	140	–	–
Saskatchewan	81	13	–	–
Alberta	48	13	–	–
British Columbia	199 597	2 552	–	–
Total	445 391	6 828	136 327	1 302

Source: Statistics Canada.
– Nil.
Note: Numbers may not add to totals due to rounding.

TABLE 3. CANADA, SILICA CONSUMPTION,[1] 1990 AND 1991

	1990r	1991p
	(tonnes)	
Lump	1 042 784	909 147
Sand	1 590 795	1 254 879
Flour	49 018	48 896
Total	2 682 597	2 212 922

Source: Energy, Mines and Resources Canada.
p Preliminary; r Revised.
1 Available data, as reported by consumers.

TABLE 4. CANADA, REPORTED CONSUMPTION[1] OF SILICA, BY INDUSTRY, 1990 AND 1991

	1990r	1991p
	(tonnes)	
Nonferrous smelting and refining	842 665	590 446
Primary glass and glass containers, and glass fibre wool	597 500	492 036
Foundries	331 051	333 658
Chemicals	41 381	64 771
Abrasives	93 905	64 296
Other products[2]	776 095	667 715
Total	2 682 597	2 212 922

Source: Energy, Mines and Resources Canada.
p Preliminary; r Revised.
1 Available data, as reported by consumers. 2 Includes asbestos products, asphalt roofing products, cement, ceramic products, structural clay products, cleansers, fertilizers, paint and varnish, pulp and paper products, refractory brick, rubber products, ferroalloys, primary steel, and other miscellaneous products.

TABLE 5. FLAT GLASS- AND CONTAINER GLASS-MANUFACTURING PLANTS IN CANADA

Company	Plant Location	Type of Glass
PPG Canada Inc.	Owen Sound, Ontario	Flat
AFG Glass Inc.	Scarborough, Ontario	Flat
Glaverbec Inc.	Saint-Augustin, Quebec	Flat
Consumers Glass, a division of Consumers Packaging Inc.	Scoudouc, New Brunswick	Container
	Pointe-St-Charles, Quebec	Container
	Candiac, Quebec[1]	Container
	Etobicoke, Ontario	Container
	Milton, Ontario	Container
	Brampton, Ontario	Container
	Hamilton, Ontario	Container
	Lavington, British Columbia	Container

Source: Energy, Mines and Resources Canada.
[1] Closed March 1992.

TABLE 6. FIBREGLASS PLANTS IN CANADA

Company	Plant Location	Type of Fibre
Owens-Corning Canada	Candiac, Quebec	Insulating
	Markham, Ontario	Insulating
	Edmonton, Alberta	Insulating
Manson Insulation Inc.	Brossard, Quebec[1]	Insulating
Manville Canada Inc.	Innisfail, Alberta	Insulating
Graham Fiber Glass Limited	Erin, Ontario	Insulating
Ottawa Fiber Inc.	Ottawa, Ontario	Insulating
Owens-Corning Canada	Guelph, Ontario	Reinforcing

Source: Energy, Mines and Resources Canada.
[1] Uses glass marbles imported from the United States.

TABLE 7. TYPICAL BATCH FORMULATIONS FOR FLAT GLASS, GLASS CONTAINERS AND FIBREGLASS

Raw Materials	Percent by Weight	Source of
FLAT GLASS[1]		
Silica sand	60	SiO_2
High calcium limestone	4	CaO
Dolomitic limestone	15	MgO and CaO
Soda ash	20	Na_2O
Salt cake or gypsum	0.5	Na_2O,CaO and SO_3
Rouge	0.5	Fe Colorant
GLASS CONTAINERS[2]		
Silica sand	60	SiO_2
Limestone	14-18	CaO,MgO
Soda ash	19	Na_2O
Alumina source (feldspar, nepheline syenite or aplite)	4-5	Al_2O_3,Na_2O,SiO_2
Others		
Gypsum and/or barite	1	SO_3,BaO
FIBREGLASS		
Insulating fibre[3]		
Silica	40	SiO_2
Soda ash	10	Na_2O
Feldspar or nepheline syenite	20	Al_2O_3,Na_2O,SiO_2
Borax or ulexite	15	B_2O_3
Dolomite or limestone	15	MgO,CaO
Reinforcing fibre[4]		
Silica	28-30	SiO_2
Boric acid	8-11	B_2O_3
Colemanite	11-17	$CaO.B_2O_3$
Kaolin	26-28	Al_2O_3,SiO_2
Limestone or dolomite	28-31	CaO,MgO
Soda ash	0-1	Na_2O

Source: Energy, Mines and Resources Canada compiled data obtained from:
[1] LOF Glass Company, Toledo, Ohio; [2] Brockway Inc., Brockway, Pennsylvania;
[3] Fiberglas Canada Inc.; [4] PPG Canada Inc.

TABLE 8. SILICON CARBIDE PLANTS IN CANADA

Company	Plant Location
Norton Céramiques Avancées du Canada Inc.	Shawinigan, Quebec
General Abrasives (Canada) Ltd.	Niagara Falls, Ontario

Note: The production of one tonne of SiC requires the following raw materials, and the approximate tonnages:

Raw Materials	Tonnes
Silica sand (99.5% SiO_2)	1.5-1.6
Ground petroleum coke	1.2
Recycled SiC	2.5
Recycled graphite	0.06
Electrical energy	8000-10 000 kWh

Source: Energy, Mines and Resources Canada.

TABLE 9. SILICON AND FERROSILICON PLANTS IN CANADA

Company	Plant Location	Product
Elkem Metal Canada Inc.	Chicoutimi, Quebec	Fe-Si
SKW Canada Inc.	Bécancour, Quebec	Si; Fe-Si

Note: The production of one tonne of Si requires the following raw materials, and the approximate tonnages:

Raw Materials	Tonnes
Silica (lump quartz, +98% SiO_2)	2.60
Wood chips	1.5-2.0
Petroleum coke	0.50
Low ash coal	0.37
Charcoal	0.25
Pre-baked electrodes	0.10
Electrical energy	13 000 kWh

Source: Energy, Mines and Resources Canada.

TABLE 10. SODIUM SILICATE PLANTS IN CANADA

Company	Plant Location
National Silicates Limited	Toronto, Ontario Valleyfield, Quebec

Silver

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According to preliminary figures from The Silver Institute, Western World supply of silver from mines and secondary sources is estmated at 15 400 t, essentially unchanged from 1991. Industrial demand, including coinage, is expected to have increased to about 17 000 t in 1992, compared with 16 837 t a year earlier. The resulting supply deficit is believed to have been offset by a draw-down of government stocks. New York metal exchange inventories increased by 342 t during 1992, and this continued to place downward pressure on prices. The silver price declined during 1992 from a high of US$4.32/troy oz in mid-January to a low of $3.63/oz on December 29. The average price for 1992 was $3.94/oz.

CANADIAN DEVELOPMENTS

Silver production declined for the fourth year in a row to 1147 t in 1992, down from 1261 t in 1991. The drop was due to mine closures and reduced output in response to weak metal prices or the depletion of ore reserves.

In British Columbia, open-pit reserves and low-grade stockpile material were depleted during the fourth quarter of 1992 at the Equity Silver mine. However, drilling during the first half of 1992 delineated underground reserves of approximately 480 000 t averaging 190 g/t silver, 4.5 g/t gold, and 0.7% copper. Underground development of the new zone began during the second half of 1992. It was reported that the new zone will extend the mine's life to mid-1994, based on a mining rate of 1000 t/d. In preparation for closure, Equity Silver Mines Limited issued a C$37.5 million letter of credit to the Province of British Columbia. The funding is to cover post-closure effluent treatment costs as well as the restoration of the waste dump and plant site. The mine opened in 1980 and produced about 2 158 200 kg of silver, 15 500 kg of gold, and 81 650 t of copper to the end of 1992.

The polymetallic Samatosum mine, owned by Minnova Inc. (70%) and Rea Gold (30%), closed in September due to the depletion of ore reserves. The mine, located north of Kamloops, opened in 1989 and produced about 361 000 kg of silver, 636 kg of gold, 4300 t of copper, 4850 t of lead and 2500 t of zinc during its life. Waste rock was continually interlayered with carbonate-rich mafic rocks to reduce acid generation in order to minimize negative environmental effects. Reclamation activities completed in 1992 included recontouring, revegetation and fertilization of the waste dumps. The establishment of tree corridors is scheduled for 1993. The effluent treatment plant will also operate during peak run-off periods to process additional surface drainage.

Preliminary feasibility studies for the Eskay Creek property indicate that a 400-t/d operation would produce 7775 kg of gold and 311 000 kg of silver per year over an eight-year mine life. Property access and the complex metallurgy of the ore are two concerns that need to be resolved. The Government of British Columbia agreed to participate in the construction of a 60-km road into the Eskay Creek area. The metallurgical problems are more complex. Research indicates that 15%-25% of the gold can be extracted by gravity separation. It was also reported that a considerable portion of the deposit consists of refractory ore and contains a number of impurities (e.g., mercury and antimony) that must be converted into a saleable product or be rendered environmentally inert. The ore also contains active carbonaceous material that could absorb the gold and silver, interfering with their extraction by cyanidation. A complex process involving a variety of technologies for recovering the gold and silver is under consideration. These technologies include: hydrometallurgical processing (pressure oxidation), cyanidation, and a new process comparable to carbon-in-leach technology. More testing is planned to increase recoveries of gold and silver.

Redfern Resources Limited became the sole owner of the Tulsequah Chief property in northern

British Columbia after acquiring Cominco's 60% interest in the property. The property hosts drill-indicated reserves of 7.8 Mt grading 110 g/t silver, 2.7 g/t gold, 1.6% copper, 1.2% lead and 6.5% zinc.

In the Northwest Territories, Minnova Inc. and Metall Mining Corp. completed over 18 000 m of drilling on the Izok Lake base-metal property, located 360 km north of Yellowknife. The property hosts two shallow massive sulphide lenses that could be mined by open pit. The new drilling has increased reserves to 13.6 Mt averaging 77.7 g/t silver, 1.6% lead, 14.6% zinc, and 2.5% copper. A new lens, called Inukshuk, was also identified with reserves estimated at 2 Mt averaging 8% zinc and 2% copper. Further drilling is planned for 1993, along with metallurgical, transportation and environmental studies.

San Andreas Resources Corp. began drilling on its Prairie Creek massive sulphide property to expand and upgrade reserves and to test other known zones. The property is located over 300 km west of Yellowknife. Previous work by the Hunt brothers in the early 1980s focused on vein-type mineralization. Reserves were estimated at 2 Mt averaging 182 g/t silver, 11.75% zinc, 10.8% lead and 0.42% copper. Recent drilling to test the vein structures at depth intersected significant widths of Pine Point-style lead-zinc-silver mineralization that also contained copper and cadmium.

In Quebec, a labour contract at Noranda Minerals Inc.'s CCR copper-precious metal refinery in Montréal expired on May 30, 1992. Production remained unchanged and a new contract was signed in mid-June. The refinery produces about 715 400 kg/y of silver, 31 100 kg/y of gold, and 327 000 t/y of copper.

Aur Resources Inc. (55%) and La Société Minière Louvem Inc. (45%) announced plans to develop the Louvicourt deposit located near Val-d'Or, Quebec. The 5000-t/d mine is expected to come on stream in late 1994 at a cost of C$326.4 million. It is expected to produce about 432 300 kg of silver, 15 940 kg of gold, 816 700 t of copper and 304 400 t of zinc over its 14 years of production.

Cambior inc. purchased Placer Dome Inc.'s 43.6% controlling interest in VSM Exploration Inc. VSM has a 50% interest in the Grevet zinc deposit near Quévillon, Quebec. A feasibility study of the deposit's massive sulphide lenses (III, IV and 97) is planned for completion by the end of 1995. Possible and probable reserves for the property are reported at 12.7 Mt averaging 8.95% zinc, 0.5% copper and 36.2 g/t silver.

Agnico-Eagle Mines Limited discovered a new mineralized zone at its La Ronde mine in Quebec. Preliminary surface drilling outlined 545 000 t of probable ore averaging 40 g/t silver, 12 g/t gold, 4% zinc and 1.14% copper.

In New Brunswick, NovaGold Resources Inc. announced plans to process open-pit reserves of copper-silver ore at its Murray Brook mine. The copper-silver ore is capped by a gold-silver-rich gossan that has been mined for the last three years. It was also reported that monthly production from the gossan zone is approximately 250 kg of silver and 56 kg of gold.

WORLD DEVELOPMENTS

According to preliminary estimates from The Silver Institute, world silver mine production increased to about 13 800 t in 1992 from 13 435 t in 1991. The largest producing nations in descending order of output were: Mexico, the United States, Peru, the Commonwealth of Independent States (C.I.S.), Australia, Canada, Poland, and Chile.

Mexico's silver industry has been stricken by falling metal prices and high operating costs. New mining legislation is expected to stimulate growth in the mining sector by improving the investment climate. Foreign mining companies will be allowed to own 100% interest in exploration properties and retain 100% ownership of a mine for 12 years after it goes into production. After 12 years of operation, foreign companies will be restricted to owning a 49% direct interest in a mine and up to 49% of the majority Mexican partner. The government has also eliminated a 7% production royalty and reduced the maximum corporate tax rate from 50% to 35%.

The Peruvian government continued privatizing state-owned mining interests in an effort to rehabilitate the nation's mining sector. State-owned Empresa Minera del Centro del Perú S.A. (Centromin Perú S.A.) was reported to be high on the government's list for privatization. Centromin is Peru's largest lead and silver producer with an estimated total worth reported at US$600 million. The company dominates the silver sector, controlling more than 20% of the country's output. The government also announced the privatization of the state-owned Anatamina deposit in central Peru. Probable reserves were reported at 166 Mt averaging 17 g/t silver, 1.3% copper, and 1.1% zinc.

In Chile, silver production is estimated to have increased to 1010 t in 1992, up 50% from 674 t in

1991. The significant rise in production is largely due to increased production capacity at the La Coipa mine. The mine produced about 450 t of silver during 1992. In June 1991, Compania Minera Mantos de Oro, equally owned by Placer Dome Inc. and Consolidated TVX Mining Corporation of Toronto, commissioned a new 15 000-t/d crusher and cyanide leach plant at the La Coipa mine. Silver recoveries are expected to average about 76% for ore from the operation's three orebodies (Farellon, Ladera, and La Coipa Norte). It was also reported that production is expected to fall to about 310 t in 1993 due to a drop in ore grade. The operation is expected to produce over 68 t of gold and 4416 t of silver over its projected mine life of 14 years.

Bolivia was one of the first Latin American countries to reform its mining code. State-owned Corporacíon Minera de Bolivia (Comibol) placed the Bolivar silver-zinc-tin-lead mine up for sale during 1991. Bids received from domestic and foreign interests, such as Cia. Minera del Sur S.A. (Comsur) (one third owned by RTZ), Carnon Holdings, Tiwanacu S.A., and Consolidated Gold Fields PLC, were rejected by Comibol as they failed to meet the prequalifying requirements outlined in the tender documents. Estimated reserves at Bolivar are quoted to be 2 Mt averaging 350 g/t silver, 16.16% zinc, 1.64% lead and some tin.

Also in Bolivia, Arimetco International acquired a 52% interest in the Andacaba mine near Potisi. Mine production is expected to increase from 45 t/d to about 360 t/d over the next few years. The property is reported to host proven and probable reserves of 360 000 t averaging 343 g/t silver, 10% zinc and 4% lead. Approximately 1.8 Mt of probable reserves have also been identified.

In the United States, BMR Gold Corporation opened the Comstock mine in Nevada during 1992. The heap leach operation is expected to produce about 9330 kg of silver and 1550 kg of gold per year. In Arizona, Pima Mining NL constructed a 600 000-t/y carbon-in-leach plant at its Newsboy property. The open-pit operation is expected to produce 4665 kg of silver and 840 kg of gold per year.

In July, Asarco Inc. announced that it would temporarily close the Galena mine in Idaho due to depressed silver prices. Asarco leases the property from Coeur d'Alene Mines Corp., which retains a 62.5% participating interest. It was reported that the mine produced about 102 640 kg of silver in 1991.

Hecla Mining Company's Grouse Creek property in Idaho is expected to come on stream in 1993 at a capital cost of US$57 million. Proven and probable reserves are estimated at 13.6 Mt containing 528 000 kg of silver and 22 390 kg of gold.

Lac Minerals Ltd. (51%) and Equinox Resources Ltd. (49%) completed a drilling program to prove up reserves on their Rosebud property in Nevada. In 1991, the companies identified a probable mineral resource of 0.58 Mt averaging 11.2 g/t gold and 99.4 g/t silver.

With regard to the environment, two precious metal-processing facilities were reported to have contaminated sites that require clean-up. In June, the U.S. Environmental Protection Agency (EPA) began site remediation at an old silver recycling facility near Coalfield, Tennessee. Spent sodium cyanide, used to precipitate silver from X-ray films, had been left in containers on the ground and subsequently seeped into the soil. The EPA will spend US$76 800 to clean up the site, including the removal of 90.7 m^3 (120 cubic yards) of contaminated soil. It was also reported that the EPA will attempt to recover the clean-up costs from the owner of the property at the time of contamination and from anyone who can be shown to have brought film to the site for processing.

In Massachusetts, Engelhard Corp. discovered that ground water was contaminated by heavy metals used to manufacture alloys at its Plainville gold and silver fabricating facility. It was reported that remediation would require a capital investment of US$1.5 million plus $100 000-$150 000 to be spent over several years.

The U.S. Department of Defense (DOD) continued to reduce its silver stockpile during 1992 through the U.S. Mint's coinage programs. According to The Silver Institute, 2021.7 t (65 million oz) of silver stocks have been used in coinage programs since 1981. In 1992, the U.S. Congress passed the Defense Department Authorization Bill. The bill restricts the sale of silver from the stockpile to coinage programs or for use in government projects in order to minimize the impact of sales on the silver market. The Silver Institute estimates that, based on an average annual consumption rate of 10 million oz, the stockpile will be depleted by 1999.

In Australia, silver production is expected to increase over the next few years as new base-metal mines come on stream. Denehurst Ltd. and Macqueries Resources brought the Wilga polymetallic deposit on stream in 1992. The underground mine, located 250 km northeast of Melbourne, is expected to reach full capacity in 1995 or 1996. Proven and probable reserves are reported at 3.9 Mt averaging 38 g/t silver, 0.81 g/t gold, 3.6% copper, and 5.4% zinc. An additional mineral resource of 8.8 Mt has been identified at the nearby Currawong polymetallic massive sulphide deposit.

Also in Australia, Mount Isa Mines Holdings Limited and ANT Minerals completed feasibility studies at the McArthur River lead-zinc-silver deposit in the Northern Territory. Construction of the underground mine is expected to commence in 1993. It was also reported that the 1.5-Mt/y operation will produce approximately 49 800 kg/y of silver. Reserves are estimated at 47.4 Mt averaging 66 g/t silver, 15.7% zinc, and 6.5% lead.

In Asia, the Metal Mining Agency of Japan announced it will carry out a three-year exploration program at a base-metal occurrence in northeast Mongolia. The property is reported to host reserves of 7 Mt averaging 200 g/t silver and 10% combined lead and zinc.

The China National Nonferrous Metal Industry Corp. announced it was seeking partners for the development of the Chengmenshan polymetallic deposit in Jiangxi Province in southern China. Reserves are estimated to contain 276 t of silver, 68 t of gold, and 1.65 Mt of copper.

The state-run Trading Corporation of Pakistan placed 15 t of silver for sale. The 99.61%-99.90%-pure silver had been seized from smugglers attempting to move the silver into India via Pakistan.

In Iran, a 40 000-t/y lead smelter at the Angouran mine near Zanqan was commissioned in 1992. The smelter is reported to have the capacity to produce 12 t/y of silver.

In Morocco, a six-month strike at Société Métallurgique d'Imiter's silver mine near Ouarzazate in southern Morocco ended in mid-June. Morocco produced approximately 357 700 kg of silver in 1991, ranking ninth in world production.

CONSUMPTION AND USES

Although 1992 figures are not yet available, The Silver Institute estimates that world silver demand increased by 1.3% from 16 837 t in 1991. The major industrial uses for silver are in photographic materials, silverware/jewellery, electrical and electronic products, and brazing alloys and solders.

Despite the fact that developments in photographic technology and an increase in recycling have drastically reduced silver requirements for this application, photography has continued to be the most important industrial market for the metal. Overall consumption in 1991 was reported at 5816 t, compared to 5785 t in 1990. One of the largest single photographic applications, accounting for about 30% of total consumption, is in the production of X-ray films. In view of the increasing worldwide concern for human health, the use of X-ray film is expected to grow at an average annual rate of about 3% during the early 1990s.

It has been estimated that silver consumption in the photographic industry will grow by about 14% between 1991 and 1996. New camera designs and greater access to film development are considered to be two aspects which will encourage growth in this sector. Automatic 35-mm cameras and single-use cameras are increasing in popularity. It was estimated that 15 million single-use cameras were sold in 1991 compared to 10 million a year earlier. The mini-lab also promotes the increased use of film. This very efficient automated unit can be established in areas with low demand for film development at a relatively small investment.

It is expected that video cameras will continue to increase in popularity and make inroads into traditional silver halide markets. In response to these and other new developments in imaging technology, Kodak is developing a photo compact disc (CD) system. The system will transfer 35-mm photo negatives or slides onto a CD for viewing on TV sets or for interacting with personal computers. This will provide an inexpensive "high-tech" access to high-quality colour photographic images.

Jewellery and silverware fabrication represent the second most important market for silver, with Europe accounting for the majority of demand. European consumption of silver for jewellery and silverware has grown steadily from a low of 743 t in 1984 to about 2270 t in 1991. The increase in silverware demand is believed to be, in part, due to lifestyle changes and a return to the more traditional purchasing of quality products with investment potential and longevity. The two forms of silverware are sterling silver and silver-plated. When "sterling" is displayed on flatware, it means the piece meets the U.S. standard for solid silver, being 925 parts silver and 75 parts alloy, such as copper (added for strength). Silver-plated flatware is made of an alloy of nickel, copper or brass that is coated with pure silver.

The third largest market for silver, representing about 25% of industrial consumption in the United States, is in contact and conductor products for the electrical and electronics industries. While these industries have grown in importance, silver consumption in this area has remained relatively constant due to improvements in utilization technologies and miniaturization.

It was reported that the amount of silver used by the Western World in batteries increased by 30% over a five-year period to 96 t in 1991. The growth was attributed to a greater demand for silver oxide batteries. These batteries provide high voltage and power levels over extended periods of time, and can operate under high-temperature (+195°C) conditions. They are often used in critical applications such as surgical equipment, television cameras and the space shuttle.

Silver-coated fabrics are being used to protect sensitive electronic devices from stray microwave and radar interference that could cause malfunctions. Silver-coated polyester fibres are woven into sleeves to cover cables, into gaskets to protect connections, into blankets to cover electronic processors, and into wall coverings to block electronic surveillance. Silver-coated kevlar fibres are used for high-temperature applications, such as to cover the microprocessors that control truck engines. Silver-coated thread is used in clothing to dissipate the static electricity that attracts dust, or in hospital operating room rugs to prevent static build-up that could spark a fire in the oxygen-rich environment. Other silver-coated fibres are finely chopped and added to plastics to cover military equipment. The silver reportedly blocks heat from the equipment, making it much less visible to heat-seeking missiles.

Other promising uses of silver are in culinary, casting, informatics and water purification applications. A silver alloy coating for the bottom of microwaveable cookware is used to allow better browning or crisping of food surfaces. A silver-aluminum casting alloy, which is the strongest aluminum casting alloy known, provides high strength-to-weight ratios for use in aircraft. A silver-coated laser card can contain a patient's medical records and health history; 20 000 of the credit-card-sized records are being used in a pilot program in Japan. Silver is also being used in water purification systems. The U.S. Environmental Protection Agency removed silver from the U.S. Primary Drinking Water Standard List of Contaminants in 1991. This decision could result in an increase in the use of silver-copper electrodes, silver-based additives, or silver coatings on water reservoirs as methods to purify water systems in the United States. Ionics Inc., the largest U.S. supplier of silver-impregnated activated carbon for water purification, uses over 52 t/y of silver in this application.

Another growing market for silver is its use in utility power generation. Luz International constructed a number of solar-electric power plants in Southern California that use banks of silver-coated mirrors to capture the sun's energy. The company expects to complete five more plants by 1994. The new plants will serve the residential electrical demands of 810 000 people and reduce oil imports by more than 3 million barrels annually. It is estimated that 2500 kg of silver will be used to coat the project's 650 000 mirrors. The company's newest plant is reported to generate power at a cost of US8¢/kW.

The use of silver in the production of coinage has been one of the fastest growing markets for the metal in recent years. However, according to The Silver Institute, silver coin consumption in 1991 fell by 11% from a 10-year high of 980 t in 1990. The decline was reported to be mainly due to the worldwide recession, a strike at the Royal Canadian Mint, and the absence of Japan as a coin producer.

Although figures are not yet available, it is expected that the demand for some silver bullion coins grew in 1992. However, silver used in the production of the Canadian Silver Maple Leaf fell to 10 670 kg in 1992 from 639 000 kg in 1991. As for commemorative coins, the Royal Canadian Mint introduced the silver coin aviation series called "Pioneers of Powered Flight in Canada/1900-1949," in 1991. The 31-g coins, containing 92.5% sterling silver and having a 24-karat gold-covered cameo, will commemorate the first 50 years of powered flight in Canada. The fifth and sixth coins of the 10-coin limited-edition series were introduced in 1992.

Also, in 1992, the Royal Canadian Mint increased the silver content in the annual commemorative silver dollar to 92.5% silver. The silver dollar contained 80% silver when it was first struck in 1935, but was changed to 50% silver (50% copper) in 1971. In March 1992, the Mint introduced the first coin set in the International Olympic Committee's (IOC) five-year 15-coin commemorative series. The one gold and two silver coins produced in the theme "The Olympic Vision" were the first official IOC coins ever to be produced. Canada, Australia, France, Austria and Greece will each produce three coins between 1992 and 1996.

In addition, the U.S. Mint began marketing 4 million silver dollar coins in honour of the XXV Olympiad. Profits from the coin sales are to go to the U.S. Olympic Committee. The United States also minted a commemorative silver coin in honour of the 500th anniversary of Columbus's voyage to the Americas.

Mexico announced it would issue a 10-peso silver coin in 1993. The bi-metallic coin, containing 5 g silver and an aluminum brass alloy outer ring, will be the first general circulation silver coin to be used by a country since the early 1970s. It was also reported that about 218 t of silver would be used to mint 40 million coins in the first year.

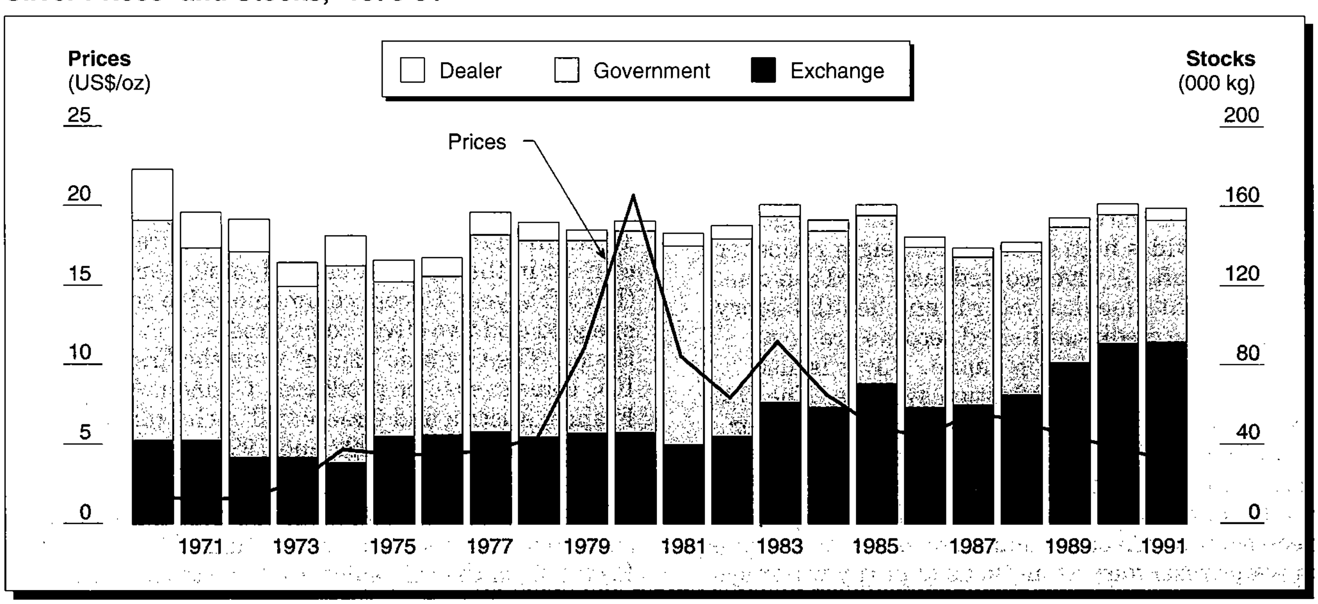
India, with a population of over 800 million, has been a major consumer of silver for centuries. Although imports of silver into India have been officially banned since 1948, trade has generally continued depending on the price in international markets and the level of domestic dishoarding. Between 1967 and 1985, India was a net exporter of silver as international prices rose. However, India has since become a net importer with more than 1300 t imported in 1991, down from a record level of 1865 t in 1990. The decrease in imports reflects a decline in demand. In 1991, the industrial use of silver grew by 12.5% from 600 t in 1990. However, the increase was not enough to offset a 24% decline in demand for silver in ornamental gifts from the 1990 level of 1100 t. The silver plating of articles, such as watches, ornaments or picture frames, acounted for most of the increase in industrial demand, but a significant increase in other uses was also reported. It was also reported that about 5 t/y of minute pieces of silver foil are added to cigarettes by the tobacco industry.

MARKETS, PRICES AND STOCKS

While silver is traded in the major financial centres around the world, the London Silver Market, part of the London Bullion Market Association, is the most important physical market. In June 1989, the London Metal Exchange discontinued its silver contract due to low trading volumes. The most important futures market is the Commodities Exchange, Inc. (COMEX) in New York.

According to The Silver Institute, year-end commodity exchange stocks of silver increased from 9079 t in 1990 to 9154 t in 1991. However, total stocks (i.e., government, exchange and dealer stocks) fell by 1.4% in 1991 from a 20-year high of 16 130 t in 1990, due to a draw-down in government stocks. In 1992, COMEX stocks grew from 8420 t at the beginning of the year to 8762 t by year-end, and subsequently continued to place downward pressure on prices. The silver price declined during 1992 from a high of US$4.32/oz in mid-January to

Figure 1
Silver Prices[1] and Stocks,[2] 1970-91



1 Average annual price (Handy & Harman).
2 Includes U.S. dealer inventories and exchange registered stocks.
SOURCES: Energy, Mines and Resources Canada; The Silver Institute; Handy & Harman.

a low of \$3.63/oz on December 29. The average price for 1992 was \$3.94/oz.

OUTLOOK

Mine production of silver may fall in 1993 as base-metal or gold producers cut back production or close in response to weak metal prices. Secondary supply is expected to continue its five-year slide and fall further due to weak metal prices. Fabrication demand is expected to remain stagnant or to possibly increase marginally if the U.S. economy picks up and industrial demand increases during the latter half of 1993. It is forecast that demand will outstrip supply, possibly for the fourth year in a row. However, the large overhang of world stocks, combined with a stagnant world recession, will continue to place downward pressure on silver prices. Silver prices in 1993 are forecast to range between \$3.50 and \$4.10/oz.

In the medium term, it is expected that mine production will grow at a slower rate than demand and that secondary output will remain relatively constant until prices recover significantly. It is also forecast that, by 1999, the U.S. Mint will have depleted Department of Defense stocks of silver and be purchasing material from the market. It is predicted that a supply deficit may persist throughout most of the decade and that a resulting draw-down on stocks will boost silver prices. By the end of the decade, silver prices could range between US\$5 and \$10/oz.

It should also be noted that silver consumption may increase dramatically toward the latter half of the decade if China and Eastern European and C.I.S. countries are successful in reforming their economies. It is believed that an increase in per capita income could result in a greater demand for silver in jewellery and silverware or in photographic and electronic equipment. However, economic growth in these countries could also result in additional silver supply from secondary production and greater by-product output if base-metal production capacity increases.

In Canada, annual silver production is expected to decline over the next few years as ore reserves are depleted at silver mines. It is expected that the decline in annual production capacity will be more than offset once new mines, such as the Louvicourt base-metal deposit in Quebec and the precious-metal Eskay Creek property in British Columbia, open.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
2616.10	Silver ores and concentrates	Free	Free	Free	Free	Free	Free
71.06	Silver (including silver plated with gold or platinum), unwrought or in semi-manufactured forms, or in powder form						
7106.10	Powder						
7106.10.10	Containing by weight 92.5% or more of silver	4%	Free	Free	Free	3.8%	2%
7106.10.20	Containing by weight less than 92.5% of silver	10.2%	6.5%	Free	Free	3.8%	2%
7106.91	Unwrought						
7106.91.10	Containing by weight 92.5% or more of silver	Free	Free	Free	1.2%	Free	2.5%
7106.91.20	Containing by weight less than 92.5% of silver	10.2%	6.5%	Free	1.2%	Free	2.5%
7106.92	Semi-manufactured						
	Containing by weight 92.5% or more of silver						
7106.92.11	In bars, sheets or plates	Free	Free	Free	1.2%	3.8%	2.5%-5.8%
7106.92.19	Other	11%	7%	Free	1.2%	3.8%	2.5%-5.8%
	Containing by weight less than 92.5% of silver						
7106.92.21	Containing by weight 50% or more of copper	4%	2.5%	Free	1.2%	1.8%	2.5%-5.8%
7106.92.22	Containing by weight less than 50% of copper	10.2%	6.5%	Free	1.2%	1.8%	2.5%-5.8%
7107.00	Base metals clad with silver, not further worked than semi-manufactured	10.2%	6.5%	Free	1.3%	4.6%	5.8%

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992; Official Journal of the European Communities, Vol. 35, No. L268, 1992, "Conventional" column; Customs Tariff Schedules of Japan, 1992.
[1] GATT rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. CANADA, SILVER PRODUCTION AND TRADE, 1991 AND 1992

Item No.		1991		1992p	
		(kilograms)		(kilograms)	
PRODUCTION	(SHIPMENTS)[1]				
	Newfoundland	x		x	
	Prince Edward Island	–		–	
	Nova Scotia	x		x	
	New Brunswick	158 366		238 823	
	Quebec	164 032		137 574	
	Ontario	293 861		212 681	
	Manitoba	42 956		43 682	
	Saskatchewan	x		x	
	Alberta	–		–	
	British Columbia	497 417		373 006	
	Yukon	86 631		117 904	
	Northwest Territories	16 966		23 357	
	Total	1 261 359		1 147 383	
	Total value ($000)	187 676		173 219	
				(Jan.-Sept.)	
		(kilograms)	($000)	(kilograms)	($000)
EXPORTS					
2600.00	Silver contained in ores and concentrates				
	Japan	358 822	39 646	201 309	25 216
	Italy	36 929	5 838	26 825	4 526
	South Korea	8 459	1 444	13 443	3 014
	United States	6 054	3 176	12 981	2 407
	India	–	–	9 338	2 231
	Germany	12 116	1 390	11 366	1 321
	United Kingdom	11 120	1 673	8 408	1 301
	Australia	5 211	1 197	4 856	1 160
	Belgium	59 324	6 658	2 903	219
	Other countries	25 823	2 707	16 476	1 804
	Total	523 858	63 729	307 905	43 199
2603.00	Copper ores and concentrates				
2603.00.81	Silver content	393 765	42 185	201 543	22 969
2607.00	Lead ores and concentrates				
2607.00.81	Silver content	68 741	15 102	79 255	16 968
2608.00	Zinc ores and concentrates				
2608.00.81	Silver content	34 505	2 374	12 231	967
2616.10	Silver ores and concentrates				
2616.10.81	Silver content	–	–	16	1
2616.90	Precious metal ores and concentrates				
2616.90.81	Silver content	26 847	4 068	14 860	2 294
71.06	Silver (including silver plated with gold or platinum), unwrought or in semi-manufactured forms, or in powder form				
7106.10	Powder	1 507	249	243	61
	Other				
7106.91	Unwrought	973 021	146 969	787 825	121 624
7106.92	Semi-manufactured	16 669	2 688	16 486	3 033
IMPORTS					
2600.00	Silver contained in ores and concentrates				
	Peru	94 641	10 167	63 210	6 938
	United States	62 417	9 345	30 945	5 065
	Australia	–	–	18 756	2 157
	Honduras	–	–	9 758	1 512
	Other countries	6 581	764	16 191	1 679
	Total	163 639	20 276	138 860	17 351

TABLE 1 (cont'd)

Item No.		1991		Jan.-Sept. 1992p	
		(kilograms)	($000)	(kilograms)	($000)
IMPORTS (cont'd)					
2603.00	Copper ores and concentrates				
2603.00.00.81	Silver content	15 133	2 348	33 623	4 469
2607.00	Lead ores and concentrates				
2607.00.00.81	Silver content	30 948	3 493	8 048	839
2608.00	Zinc ores and concentrates				
2608.00.00.81	Silver content	54 157	8 193	34 216	5 135
2616.10	Silver ores and concentrates				
2616.10.00.81	Silver content	63 382	6 240	62 930	6 902
2616.90	Precious metal ores and concentrates				
2616.90.00.10	Silver content	19	2	43	6
71.06	Silver (including silver plated with gold or platinum), unwrought or in semi-manufactured forms, or in powder form				
71.06.10	Powder	3 611	815	2 707	495
	Other				
7106.91	Unwrought	139 213	14 387	120 380	11 138
7106.92	Semi-manufactured	9 809	2 223	7 306	1 710
7107.00	Base metals clad with silver, not further worked than semi-manufactured	3 460	171	1 425	250

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; p Preliminary; x Confidential.
[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.

TABLE 2. CANADA, SILVER PRODUCTION, TRADE[1] AND CONSUMPTION, 1975, 1980, AND 1985-92

		Exports			Imports	Consumption[3]
	Production[2]	In Ores and Concentrates	Refined Silver	Total	Refined Silver	Refined Silver
	(kilograms)					
1975	1 234 642	471 410	713 566	1 184 976	420 078	642 089
1980	1 070 000	396 690	881 761	1 278 451	339 180	265 938
1985	1 197 072	338 834	1 325 694	1 664 528	575 815	217 613
1986	1 087 989	373 232	1 292 552	1 665 784	169 074	312 905
1987	1 374 946	488 235	555 665	1 043 900	140 960	331 245
1988	1 443 166	448 069	1 144 121	1 592 190	119 606	457 698
1989	1 312 433	527 205	1 023 561	1 550 766	251 330	531 046
1990	1 381 257	624 755	1 269 760	1 894 515	132 630r	579 407
1991	1 261 359	523 858	991 197	1 515 055	156 093	399 295
1992p	1 147 383	307 905a	804 554a	1 112 459a	131 818a	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
. . Not available; p Preliminary; r Revised.
a Exports and imports are January-September figures.
[1] Beginning 1988, Exports and Imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Ores and concentrates include HS classes 2603.00.81, 2607.00.81, 2608.00.81, 2616.10.81 and 2616.90.81. Refined silver includes HS classes 7106.10, 7106.91, 7106.92 and 7107.00. [2] Includes recoverable silver in: ores and concentrates for export; crude gold bullion produced; blister and anode copper produced at Canadian smelters; and base and other bullion produced from domestic ores. [3] Some years include only partial consumption for coinage.

TABLE 3. WORLD SILVER MINE PRODUCTION, 1989-91

	1989	1990	1991
		(tonnes)	
AMERICAS			
Mexico	2 306.1	2 170.0	2 206.9
United States	2 007.0	2 125.0	1 848.0
Peru	1 839.9	1 761.6	1 769.7
Canada	1 312.4	1 381.3	1 261.4
Chile	490.5	654.1	673.6
Bolivia	294.9	311.0	337.0
Other	214.5	193.7	194.1
Total Americas	8 465.3	8 596.7	8 290.7
EUROPE			
Spain	249.7	270.0	208.0
Sweden	200.0	225.0	253.0
Italy	97.0	103.4	178.4
Yugoslavia	133.0	105.3	92.2
Other	163.1	184.7	184.8
Total Europe	842.8	888.4	916.4
AFRICA			
South Africa	177.9	160.7	170.2
Morocco	194.8	240.5	233.9
Namibia	110.0	93.0	91.9
Other	117.4	129.0	89.8
Total Africa	600.1	623.2	585.8
ASIA			
Japan	155.8	149.9	170.7
Other	331.0	314.9	315.9
Total Asia	486.8	464.8	486.6
OCEANIA			
Australia	1 075.0	1 173.0	1 180.0
Other	92.8	111.2	135.9
Total Oceania	1 167.8	1 284.2	1 315.9
EASTERN COUNTRIES			
U.S.S.R.	1 500.0	1 380.0	1 270.0
Poland	1 003.0	833.0	867.3
North Korea	300.0	280.0	300.0
People's Republic of China	165.0	150.0	180.0
Other	162.7	124.0	82.3
Total eastern countries	3 130.7	2 767.0	2 699.6
Total world	14 693.5	14 624.3	14 295.0

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

TABLE 4. AVERAGE ANNUAL SILVER PRICES, 1970-92

Year	United States	United Kingdom
	(US$/oz)	(pence/oz)
1970	1.771	73.778
1971	1.546	63.086
1972	1.685	67.403
1973	2.558	103.783
1974	4.708	199.819
1975	4.419	200.118
1976	4.353	242.423
1977	4.623	265.512
1978	5.401	282.203
1979	11.094	519.607
1980	20.632	900.778
1981	10.518	515.303
1982	7.947	455.331
1983	11.441	753.644
1984	8.141	607.056
1985	6.142	477.560
1986	5.470	373.030
1987	7.001	428.243
1988	6.535	367.295
1989	5.500	335.538
1990	4.820	270.703
1991	4.039	230.198
1992	3.936	224.607

Sources: Handy & Harman; London Silver Market; Metals Week.

TABLE 5. CANADIAN CONSUMPTION[1] OF UNMANUFACTURED SILVER, 1990 AND 1991

	1990[2]	1991[2]
	(kilograms)	
Chemicals–silver salts and others	102 832	105 260
Coinage	115 417	64 175
Silver alloys	16 734	13 357
Wire, rod and sheet	13 782	7 604
Sterling and electroplating	8 290	12 913
Other uses	322 352	195 987
Total	579 407	399 295

Source: Energy, Mines and Resources Canada.
[1] Available data as reported by consumers. [2] Increase in number of companies being surveyed.
Note: Numbers may not add to totals due to rounding.

TABLE 6. MONTHLY AVERAGE SILVER PRICES, 1991 AND 1992

	London Silver Market		Handy & Harman	
	(C$/oz)	(US$/oz)	(C$/oz)	(US$/oz)
1991				
January	4.68	4.05	4.66	4.03
February	4.32	3.74	4.30	3.72
March	4.57	3.95	4.59	3.97
April	4.59	3.98	4.58	3.97
May	4.65	4.05	4.64	4.04
June	5.03	4.40	5.02	4.39
July	4.99	4.34	4.95	4.30
August	4.53	3.95	4.51	3.94
September	4.60	4.05	4.59	4.04
October	4.64	4.12	4.63	4.10
November	4.60	4.07	4.59	4.06
December	4.52	3.95	4.48	3.91
1992				
January	4.76	4.12	4.12	4.77
February	4.91	4.15	4.14	4.89
March	4.90	4.11	4.10	4.89
April	4.81	4.05	4.03	4.79
May	4.88	4.07	4.07	4.88
June	4.86	4.06	4.06	4.85
July	4.73	3.97	3.95	4.71
August	4.55	3.82	3.78	4.50
September	4.60	3.77	3.75	4.58
October	4.67	3.75	3.74	4.65
November	4.78	3.77	3.75	4.76
December	4.75	3.73	3.71	4.72

Sources: Energy, Mines and Resources Canada; London Silver Market; Handy & Harman.

TABLE 7. WORLD SILVER CONSUMPTION, 1989-91

	1989	1990	1991
		(tonnes)	
INDUSTRIAL USES			
United States	3 695.1	3 583.1	3 673.3
Canada	341.5	464.0	335.1
Mexico	466.5	329.7	289.3
United Kingdom	699.8	690.5	696.7
France	870.9	889.6	861.6
West Germany	1 424.5	1 586.3	1 657.8
Italy	500.8	510.1	510.1
Japan	3 185.0	3 321.9	3 377.8
India	799.4	1 200.6	1 284.6
C.I.S.[1] and Eastern Europe	2 951.7	2 864.6	2 575.3
Others	1 965.7	1 950.2	2 009.3
Subtotal	16 900.9	17 390.6	17 270.9
COINAGE			
United States	292.4	236.4	279.9
Canada	189.5	115.4	64.2
West Germany	295.5	59.1	174.2
France	124.4	59.1	49.8
Mexico	62.2	46.6	49.8
Others	192.8	298.2	239.4
Subtotal	1 156.8	815.2	857.3
Total	18 057.7	18 205.8	18 128.2

Sources: Energy, Mines and Resources Canada; Handy & Harman, "The Silver Market 1991."
[1] C.I.S. Commonwealth of Independent States.

Sodium Sulphate

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Sodium sulphate is produced mainly from natural brines and deposits found in alkaline lakes in areas with dry climates and restricted drainage, from sub-surface deposits and brines, or as a by-product of chemical processes. In Canada, sodium sulphate deposits are found in shallow lakes where hot summer temperatures concentrate salts in solutions to near saturation and cooler fall temperatures cause precipitation of sodium sulphate, which is harvested during the winter. Canada's sodium sulphate industry is based on extraction from natural brines and deposits in several alkaline lakes in Saskatchewan. Alberta's only operation closed down in 1991. In Canada, four plants producing natural sodium sulphate were in operation at the beginning of 1992 and, by year-end, there were five with the re-opening of the Cabri operation under Sotec Products Ltd. By-product sodium sulphate was recovered at one rayon plant in Cornwall, Ontario; however, the plant closed in 1992. On a positive note, Big Quill Resources Inc. started production of potassium sulphate from sodium sulphate brines at Big Quill Lake, Saskatchewan.

World production was estimated by the U.S. Bureau of Mines at approximately 4.8 Mt in both 1991 and 1992, with a split of about 51% from natural sources and 49% from various manufacturing processes, mainly as a by-product of the production of viscose rayon, hydrochloric acid, sodium dichromate, and about six other chemical processes.

In Canada, production capacity in 1992 totalled 524 700 t; the average production rate for each operation was below 60%. Canadian shipments for 1992 were 279 924 t valued at about $21 million. Exports in 1991 were mostly to the United States (98.6%), and amounted to 155 161 t, or 46.3% of Canadian shipments.

In the United States, natural and by-product sodium sulphate production is virtually evenly split, with three natural producers having a total capacity of 400 000 t/y and synthetic producers having a total capacity of about 400 000 t/y. In Europe, sodium sulphate is produced almost entirely as a by-product of chemical processes, with a total capacity of 1.4 Mt/y. In addition, the Netherlands has 29 000 t/y and Spain has 0.5 Mt/y of natural sodium sulphate capacity.

CANADIAN PRODUCTION AND DEVELOPMENTS

Deposits

The sodium sulphate deposits in Saskatchewan and Alberta have formed in shallow undrained lakes and ponds where inflow is greater than outflow. 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 repeated year after year and thick deposits of hydrous sodium sulphate, accompanied by other salts and mud, have accumulated. Deposits in Saskatchewan are considered to contain close to 100 Mt of anhydrous sodium sulphate.

Recovery and Processing

Because most of the sodium sulphate is recovered by the evaporation of concentrated brines or by dredging the permanent beds of crystals, weather is as important for the 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 constituents 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 earth-moving equipment. The harvested crystal is stockpiled adjacent to the plant.

Some operators use floating dredges to mine the permanent crystal bed. The slurry of crystal and brine is transported by pipeline to a screening house at the plant. If sufficiently concentrated, the brine from the screens is collected in an evaporation pond.

Since 1984, one company has used solution mining in lake beds that are 3-11 m thick. It pumps a concentrated brine to an air-cooled crystallizer at the plant where sodium sulphate is separated from other more soluble salts.

Processing of the natural salt consists of dehydration (Glauber's salt contains 55.9% water of crystallization) and drying. Commercial processes used in Saskatchewan include Holland evaporators, gas-fired rotary kilns, and submerged combustion and multiple-effect evaporators. Subsequent crushing and screening results in a product with uniform grain size and good flow characteristics. Salt cake, the product used principally in the pulp and paper industry, contains a minimum of 97% Na_2SO_4. Detergent-grade material analyzes up to 99.7% Na_2SO_4. Uniform grain size and free-flow characteristics are important in material handling and use.

Developments

In 1992, demand for Canadian natural sodium sulphate continued to decrease as a result of major changes in two of its major end uses: the pulp and paper industry and the detergent industry. However, 1992 was a far better year for detergent-grade than for kraft-grade as the pulp and paper industry continued to change its technology.

Compared to 1991, which saw the bankruptcy of Agassiz Resources Ltd., 1992 was a better year in many respect. The bright spot of the year was the re-opening at the end of the year of the Cabri operations (formerly owned by Agassiz Resources Ltd.) under the name Sotec Products Ltd., a company formed by former employees of Agassiz Resources Ltd. With this re-opening, Canada's annual production capacity rose by 12.8% from 469 000 t to 524 700 t. Canadian operations are now concentrated in Saskatchewan. Production at these operations has been well below capacity, generally below 60% of capacity, due to continued poor market conditions.

Mine production in 1992 was estimated at 279 800 t compared to 331 532 t in 1991. Mine shipments were 334 959 t in 1991 and 279 924 t in 1992. The average unit value of shipments declined from \$76.00/t in 1991 to \$75.16/t in 1992. These major drops in production and shipments between 1991 and 1992 are largely due to the closure of Agassiz Resources Ltd. in 1991.

Ormiston Mining and Smelting Co. Ltd. produced salt cake from brines of Horseshoe Lake. Millar Western Industries Ltd. produced salt cake from Whiteshore Lake. Saskatchewan Minerals, a wholly owned division of Dickenson Mines Limited, produced detergent- and kraft-grade material from the Ingebrit Lake and Chaplin Lake (kraft grade). Sotec Products Ltd. produced detergent-grade out of the Cabri plant using feedstock from Snakehole and Verlo lakes.

All Canadian producers of natural sodium sulphate are looking at diversification of their product lines in order to compensate for the sharp decline in usage by the pulp and paper industry. This is necessary for the sodium sulphate industry if it wishes to survive.

In light of the vanishing markets for sodium sulphate, Ormiston Mining and Smelting Co. Ltd. has developed and licenced a new process to produce sodium carbonate (soda ash) from sodium sulphate. Some small amounts are being produced and the company is now looking to develop markets before commencing industrial production. Ammonium sulphate is also produced as a by-product. Ormiston is considering the production of caustic soda (sodium hydroxide). In that respect, Ormiston has developed and patented a new electrolytic membrane process that is more effective than the conventional Solvay process. The co-product sulphuric acid can then be combined with ammonia to produce ammonium sulphate, which has a market of its own as fertilizer.

Millar Western Industries Ltd., which is now producing some detergent-grade in addition to its kraft-grade, has been considering the feasibility of producing potassium sulphate. However, at the end of 1992, the company announced that it was shelving the project based on company priorities. It is now considering the production of sodium hydroxide (caustic soda).

Big Quill Resources Inc., which operated throughout 1992, uses sodium sulphate brines from the south shore of Big Quill Lake to produce potassium sulphate using an ion exchange system. It has a capacity of 7000 t/y of potassium sulphate (about

8500 t/y of sodium sulphate) and plans to increase it in the near future. The main usage is as fertilizer for specialty crops, but it is also used in gypsum wallboard, cement and plaster as a set accelerator. Some of the products of Big Quill Resources Inc. are sold in the United States.

The sole producer of synthetic sodium sulphate in Canada, which was located in Cornwall, Ontario, closed in 1992. Courtaulds (Canada) Inc. was producing a detergent-grade as a by-product of viscose rayon production at a rate slightly in excess of 20 000 t/y. Production in 1992 is reported at being close to 16 000 t. Sodium sulphate produced by the Cornwall operation was distributed by Stanchem.

CONSUMPTION

In 1991, reported Canadian consumption of sodium sulphate continued its downward spiral with 144 287 t consumed compared to 184 045 t in 1990. About 80% was consumed by the pulp and paper industry, 16% by the detergent industry, 3% by the glass industry, and the remaining 1% by other industries. While consumption by the three main users continued to decrease, consumption by other industries displayed a growth of 15.6%. By way of comparison, in the United States, 44% is consumed by the detergent industry, 24% by the pulp and paper industry, 16% by the textile industry, 5% by the glass industry and 11% by other industries.

TRADE

In 1991, Canada exported 155 161 t compared to 166 174 t in 1990, a 6.6% drop. During the first nine months of 1992, Canada exported 116 712 t, a very small decrease when compared with the same period in 1991. The main destination of Canadian sodium sulphate remains the United States with more than 98% of Canadian exports. In 1991, Canada imported 963 t of sodium sulphate compared to 405 t in 1990. About 91% of Canadian imports originate from the United States.

USES

The main end uses for sodium sulphate are in the pulp and paper, detergent, glass, and dyeing industries.

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 make-up. About one third of sulphur input is retained in the organic chemicals recycled in the process. Lately, technical improvements in the process have significantly reduced the consumption of sodium sulphate per tonne of pulp produced to slightly less than 20 kg/t. The reduction is also due to the increasing use of chlorine dioxide as a bleaching agent. This bleaching chemical is manufactured internally and a sodium sulphate slurry is its by-product in many mills. Caustic soda and emulsified sulphur can be substituted for salt cake. Partial substitution reduces sulphur emissions, thereby facilitating compliance with stricter environmental controls.

Sodium sulphate is used as a builder, or more correctly as a diluent, in detergents (supplying the "bulk"). It is claimed to improve detergency through its effect on the colloidal properties of the cleaning system, but it is essentially inert. The curtailment in the usage of sodium tripolyphosphate (STPP), on the grounds of pollution control, also contributed to a decline in sodium sulphate production. The average sodium sulphate content of powder detergents is now between 20% and 25% in North America and Japan, about 25% in Western Europe, and above 50% in Eastern Europe. Liquid detergents now represent 35%-40% of the market but appear to have reached a plateau as substitutes.

Some sodium sulphate is used by the glass industry as a source of Na_2O to speed up melting and to prevent scum from forming on the surface of the melt. For typical container glass, the sodium sulphate used is 0.36% of the weight of the glass produced, while flat glass requires 5-10 parts of sodium sulphate per 1000 parts of silica sand. However, calcium sulphate and soda ash can partially replace sodium sulphate, particularly in the manufacture of flat glass and specialty glasses. Both natural and synthetic salt cake can be used providing the Fe_2O_3 content is less than 0.15%.

Sodium sulphate is also used in the textile industry in the dyeing process, particularly in the dyeing of wool. In addition, sodium sulphate is used in the manufacture of a number of chemicals such as potassium sulphate, sodium sulphide, sodium silicate, sodium hyposulphite, and sodium aluminum sulphate. Sodium sulphide is quantitatively the most important, and is used for de-hairing hides in the tanning process.

Other end uses include the manufacture of viscose sponges, feed supplements, boiler feed water treatments, veterinary medicines, sulphonated oils and printing inks, and in applications in the ceramics and photographic industries.

PRICES

Canadian list prices for natural sodium sulphate, f.o.b. western plants, were approximately $65-$75/t and $85-$91/t respectively for salt cake and detergent-grade in 1991. Small quantities were sold near the list price while large lots were sold at substantial discounts. One-year contracts at firm prices are common. In 1993, prices are expected to remain stable for salt cake and to improve slightly for detergent-grade. Prices for detergent-grade by-product sodium sulphate were in the order of $175-$180/t delivered in Ontario in bulk shipment.

OUTLOOK

Although 1992 overall was a better year than 1991, the North American natural sodium sulphate industry can expect a very limited growth in consumption over the next few years. Detergent-grade should remain stable and perhaps experience a slight increase of 1% or less while kraft-grade should continue to experience further reductions. If diversification by the various Canadian producers is successful, an increase in the production of natural sodium sulphate may be seen, but probably not until next year at best to allow for the purchase and installation of the necessary equipment.

Canadian shipments in 1992 were sharply below those of 1991, mainly due to the closure of the three Agassiz Resources Ltd. plants. In the North American pulp and paper industry, consumption of sodium sulphate continued at steady levels as substitution by caustic soda and emulsified sulphur ran its course. However, conditions in Canada were less positive than in the United States, mainly because of the impact of the recession on the pulp and paper sector and a faster move away from sodium sulphate. In the future, new processes using much less sodium sulphate will be introduced in this sector; therefore, the average consumption per tonne is likely to continue its decline and will only be partially offset by a higher output of pulp and paper. It is expected that the market for sodium sulphate in the Canadian pulp and paper industry will drop to around 70 000 t by 1995, which will represent a 40% drop over the 1991 reported consumption.

In the detergent industry, the situation seems to have stabilized. In Japan where superconcentrates were first introduced in 1987, users, after having tried the new products, are returning, to a certain degree, to the more conventional powders with Japanese consumption of sodium sulphate raising from 44 000 t in 1989 to 90 000 t in 1991. Such a trend also exists in Canada and in Europe. Liquid detergents, which were seen as a threat to powder detergents, also seem to have reached a peak of acceptance and, in some instances, are showing signs of receding. In the United States, the use of compact detergents and liquid detergents has also reached a peak and demand for sodium sulphate seems to have bottomed out.

The consumption of sodium sulphate in the United States in 1992 is estimated to have decreased by about 5.8% over 1991. U.S. exports rose by about 36% to 140 000 t due to exports to South Korea by a Korean partner in a California-based facility. The United States, which accounts for about 14% of the world consumption of sodium sulphate, reduced its import reliance factor from 8% in 1991 to 1% in 1992. Canadian exports to the United States are expected to stabilize at current levels or to even decline slightly as U.S. production of by-product sodium sulphate increases with the economic recovery. In fact, there are signs that they will try to access the Canadian market.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2833.11.00	Disodium sulphate	9.2%	Free	Free	Free-6.5¢/tonne

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992.

TABLE 1. CANADA, NATURAL SODIUM SULPHATE PRODUCTION AND TRADE, 1990-92

Item No.		1990		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
PRODUCTION (Shipments)							
	Saskatchewan	x	23 904	x	23 152	279 924	21 038
	Alberta	x	3 184	x	2 305	–	–
	Total	346 607	27 089	334 959	25 457	279 924	21 038
IMPORTS						(Jan.-Sept.)	
2833.11	Disodium sulphate						
	United States	350	52	876	104	347	52
	United Kingdom	26	3	63	9	18	2
	Germany	26	3	24	3	–	–
	Total	405	60	963	117	365	54
EXPORTS							
2833.11	Disodium sulphate						
	United States	159 279	15 480	152 981	15 402	116 712	11 657
	New Zealand	–	–	1 918	192	–	–
	United Kingdom	–	–	21	29	–	–
	Other countries	6 895	576	242	680	–	–
	Total	166 174	16 056	155 161	16 303	116 712	11 657

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; p Preliminary; x Confidential.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, NATURAL SODIUM SULPHATE PLANTS, 1992

	Plant Location	Source Lake	Annual Capacity
			(tonnes)
SASKATCHEWAN			
Sotec Products Ltd.[1]	Cabri	Snakehole and Verlo	55 000
Millar Western Industries Ltd.	Palo	Whiteshore	109 000
Ormiston Mining and Smelting Co. Ltd.	Ormiston	Horseshoe	90 700
Saskatchewan Minerals[2]	Chaplin	Chaplin	90 000
Saskatchewan Minerals[2]	Fox Valley	Ingebrigt	180 000
Total			524 700

Source: Company reports.
[1] Sotec Products Ltd. started operations in December 1992. [2] A division of Dickenson Mines Limited.

TABLE 3. CANADA, SODIUM SULPHATE PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975, AND 1980-92

Year	Production[1]	Imports[2]	Exports	Consumption[3]
		(tonnes)		
1970	445 017	26 449	108 761	291 439
1975	472 196	22 638	178 182	256 385
1980	496 000	20 211	245 831	232 045
1981	535 000	12 481	284 284	216 298
1982	547 000	17 293	367 931	191 988
1983	453 939	22 479	265 753	190 625
1984	389 086	20 562	233 776	235 504
1985	366 217	33 409	210 851	241 143
1986	370 726	17 551	233 397	228 360
1987	342 076	17 194	168 097	188 626
1988[b]	330 971	6 567	150 569	187 846
1989	327 444	5 152	171 358	223 135
1990	346 607	405	166 174	184 045
1991	334 959	963	155 161	144 287
1992[p]	279 924	365[a]	116 712[a]	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
. . Not available; [p] Preliminary.
[a] Imports and Exports are January-September figures. [b] As of 1988, trade figures represent disodium sulphate only.
[1] Producers' shipments of crude sodium sulphate. [2] Includes Glauber's salt and crude salt cake. [3] Available data as reported by consumers.

TABLE 4. CANADA, AVAILABLE DATA ON SODIUM SULPHATE CONSUMPTION,[1] 1989-91

	1989	1990	1991[p]
		(tonnes)	
Paper pulp, paper and paper products	180 044	143 040	115 871
Cleansers	36 200	35 904	23 472
Primary glass and glass containers	6 242	4 321	4 042
Other products[2]	649	780	902
Total	223 135	184 045	144 287

Source: Energy, Mines and Resources Canada.
[p] Preliminary.
[1] Available data as reported by consumers. [2] Chemicals, feed industry and other minor uses.

Stone

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The volume of all types of stone produced in Canada in 1992 was about 7% lower than the previous year, according to preliminary figures. Characterized by end use, production included dimensional stone, chemical and metallurgical grades of stone, and pulverized and crushed stone. Similarly, the total value of production decreased about 6% to $508 million.

Additional detailed information, particularly on regular aggregates, including crushed stone and sand and gravel, as well as on numerous lightweight aggregates, is included in a separate chapter entitled *Mineral Aggregates*.

Dimension stone relates to a variety of rock types that may be cut, shaped or simply selected for a broad range of construction/engineering, architectural or monumental requirements. The types of stone available are dependent on local geology, but mainly include granite, limestone, marble, sandstone and slate, as summarized in Tables 3 to 8 inclusive. The term "granite," as commercially applied, includes true granite, granodiorite, gneiss, and other medium- to coarse-grained igneous rocks. However, "black granite" includes anorthosite and other dark-coloured igneous rocks. Limestone and marble are often confused, marble being the metamorphosed equivalent of the former and usually including both dolomitic and calcitic varieties. As an industrial term, marble is used for recrystallized calcareous rock capable of taking a polish.

Canadian Developments

Shipments of dimension stone (mainly granite and limestone) were estimated to be 15%-20% lower in 1992, reflecting the downturn in commercial building and exports. Canadian companies, however, with up-to-date technology and aggressive marketing, have become an important part of the international stone industry. A wide variety of granite, particularly for construction uses, has become important, with most of the output centred in Quebec (80%-90%). Limestone/marble, sandstone and slate are also important in several parts of Canada.

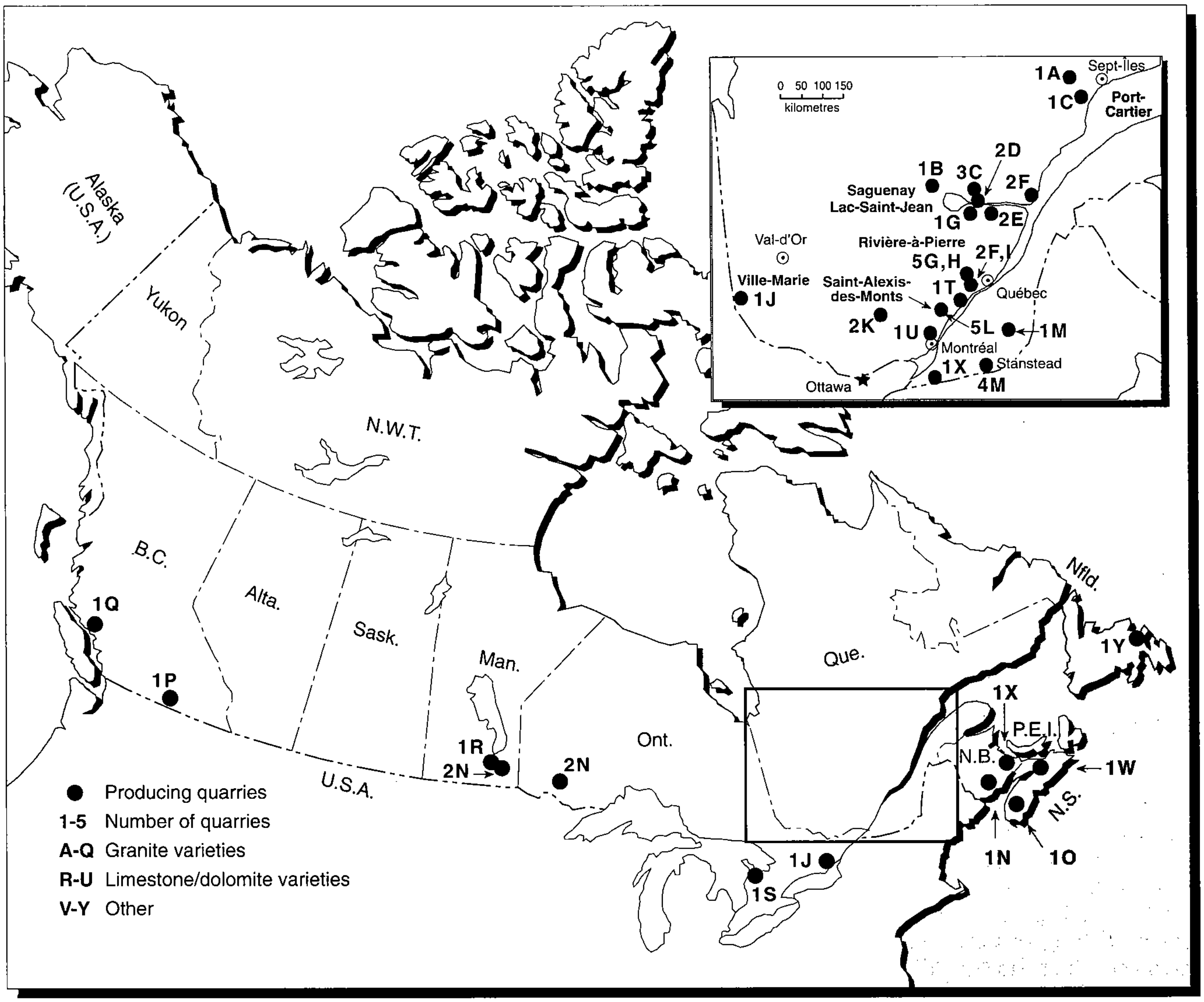
The 1980s saw considerable growth in the volume and value of rough granite produced in Canada for use in the construction sector, rising from 27 000 t valued at less than $1.2 million in 1978 to 108 000 t valued at $19.5 million in 1990 (Table 5).

Value added by further processing in the Canadian granite industry is substantial; for example, the total value of thin-cut tiles (1.3 cm and 1.0 cm), custom-cut panels, slabs, monuments and furniture is estimated to be about $110 million in 1990.[1] More than 90% of this output was from Quebec, with panels and thin tiles in 1990 accounting for approximately 70% ($50 million and $25 million, respectively) and monuments accounting for the remainder. This further processing is based on both domestic and imported block, demonstrating the importance of international trade in this sector. To encourage more trade, industry-government exchange visits were made between Japan and Canada in mid-year and late 1992. First, a Japanese granite mission visited numerous quarries and fabricating plants in Canada; later, Energy Mines and Resources Canada and two other departments, on behalf of numerous Canadian stone producers, helped organize product exhibits in both Tokyo and Nagoya.

During the past few years, the amount of granite used for monumental and ornamental purposes has declined in importance relative to construction uses; however, output has tended to remain stable.

Many provincial authorities continued assessments of their stone resources and, with the rejuvenated interest in much of the historical record, early works such as those by W.A. Parks[2] and M.F. Goudge[3] have proven to be classics on the subject. Promotional literature and display samples have been part of this work, often within the context of federal/provincial Mineral Development Agreements.

Figure 1
Canada, Architectural and Monumental/Ornamental Stone-Producing Centres, 1991

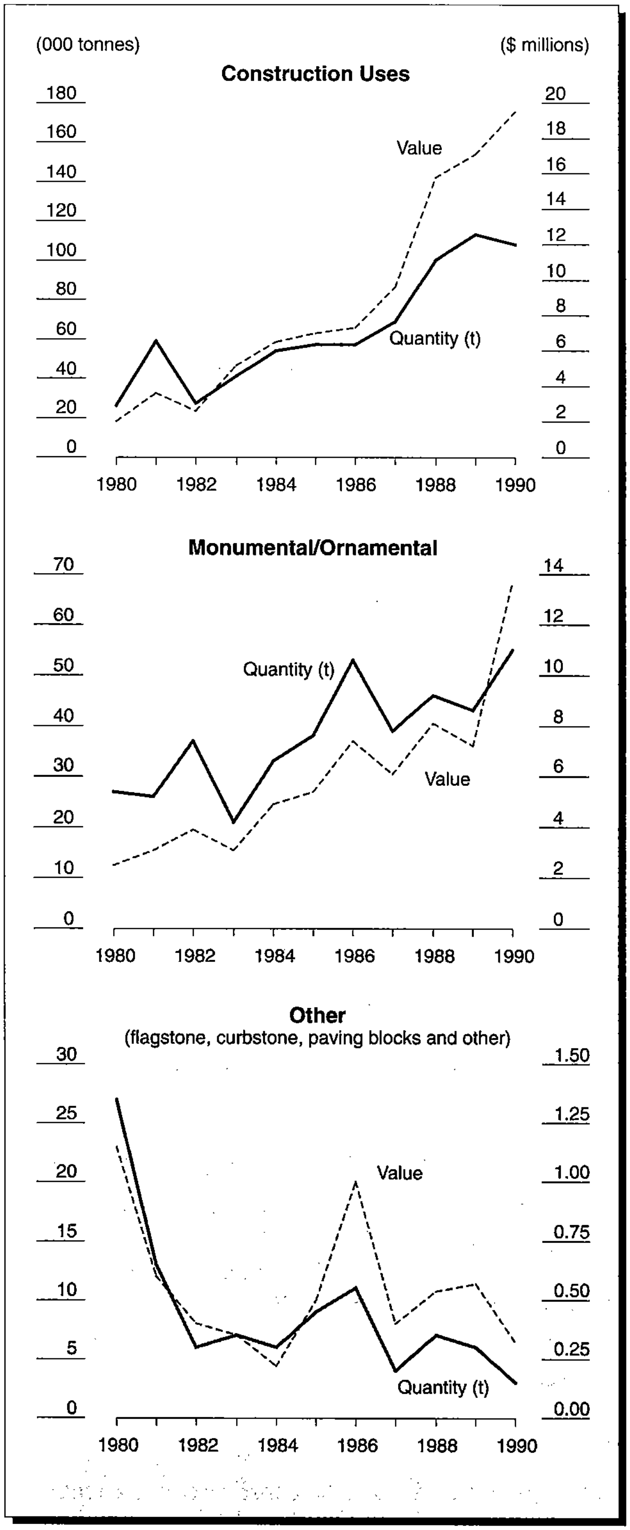


A Fine-grained pinkish-grey banded gneiss
B Medium-grained mahogany granite
C Coarse-grained black anorthosite
D Medium-grained black gabbroic anorthosite
E Medium-grained pinkish-grey quartz monzonite
F Fine-grained pink granitic gneiss
G Coarse-grained green charnockite
H Coarse-grained pink-grey or brown-grey granite
I Medium-grained grey dioritic gneiss
J Medium-grained red granite
K Fine-grained pink aplite
L Coarse-grained brown or red quartz monzonite
M Medium-grained grey granite
N Medium-grained pink granite
O Fine-grained blue-grey granite
P Coarse coral pink granite
Q Medium-grained blue-grey granite
R Light-coloured mottled dolomitic limestone (Tyndall)
S Fine-medium crystalline blue-grey to buff marble/dolostone (Arriscraft)
T Medium-grained light brownish-grey limestone (Deschambault)
U Medium-grained blue-grey limestone (Chazy)
V Medium-grained olive sandstone
W Fine-medium-grained olive-brown and blue-grey sandstone
X Fine-medium-grained white to buff sandstone (Potsdam)
Y Very fine-grained varicoloured slate

SOURCE: Mainly provincial departments of Mines and Energy.

Figure 2

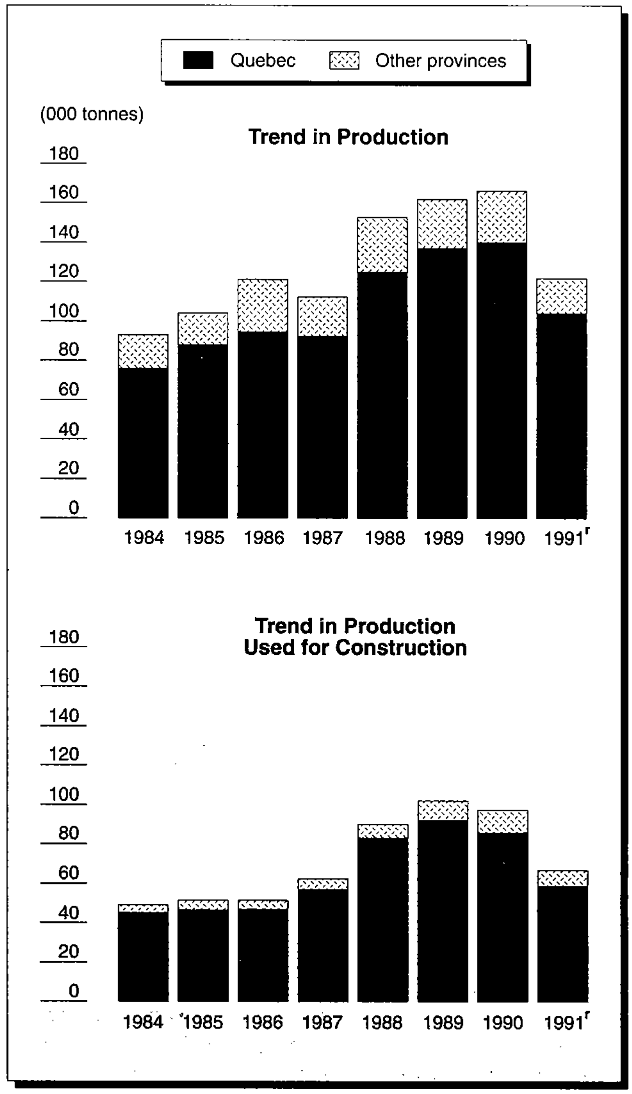
Canada, Production of Rough Granite (Sold and Used by Producers), 1980-90



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

Figure 3

Canada, Trends in Production of Rough Granite, 1984-91



r Revised.
SOURCES: Energy, Mines and Resources Canada; Quebec Ministry of Energy and Resources.

Atlantic Provinces

Limestone

Occurrences of limestone in the Atlantic provinces are common and have been systematically catalogued in the past.[4,5,6] Deposits of commercial importance are being worked in three of the four provinces.

In Newfoundland, outside of requirements for aggregate for highways, the most important operation is the manufacture of cement by North Star Cement Limited at Corner Brook.[7] Recently, the

Iron Ore Company of Canada (IOC) in western Labrador brought into production a dolomitic marble for use in self-fluxing "dolomitic-type" iron ore pellets.[8] Newfoundland Resources & Mining Company Limited, as mentioned in the *Mineral Aggregates* chapter, made several shipments of crushed limestone from its tidewater property on the Port-au-Port Peninsula.

In Nova Scotia, limestone for numerous uses is quarried in the central and eastern parts of the province. In New Brunswick, quarries operate at three locations: Brookville, Elm Tree, and Havelock.

Granite and Marble

Occurrences of granite in the Atlantic region have been described by Carr.[9] In Nova Scotia, a blue-grey granite produced near Nictaux is used mainly in the monument industry. Activity relating to granite, as well as to other types of stone, has been summarized in two publications.[10,11] Construction Aggregates Ltd., owned by Lone Star Industries, Inc. of Greenwich, Connecticut, continued shipping high-quality granite aggregate from the company's Porcupine Mountain quarry on the Strait of Canso. Plans to develop a granite aggregates quarry at Kelly's Mountain on Cape Breton Island remained on hold pending an environmental review.

Granite is quarried intermittently for uses that include building stone and monumental stone at a number of sites in New Brunswick.[12] A red, fine-to-medium-grained granite is available near St. Stephen, and fine-grained pink, grey and blue-grey granites are available in the Hampstead (Spoon Island) district. Other stone available on demand includes: a brown-to-grey, coarse-grained granite in the Bathurst area; a salmon-coloured, medium-grained granite near Antinouri Lake; and a black ferro-magnesian rock in the Bocabec River area. Finally, quarries in the St. George district, characterized by a red granite, are potential candidates for reactivation.

The exploration and assessment of a wide variety of granite and marble continued in Newfoundland and Labrador. On the northern Labrador coast, work concentrated on a large complex that hosts a uniform medium-grained, light-grey anorthosite containing up to 20% labradorite crystals exhibiting flashes of blue chatoyance on cut surfaces.[8] The deposit is being developed by the Labrador Inuit Development Corporation and an Italian company that intends to cut and market the stone under the name "Reflect Blue."

In Newfoundland, work concentrated mainly on several types of granite. These include: Borney Lake granite, a fine-to-medium-grained, black-to-grey gabbroic rock described as being similar to some South African "black granites"; Lumsden, a coarse-grained, megacrystic granite that has been used in a university building in St. John's; Dunamagon, an orange-pink granite characterized by a weak biotite-quartz foliation pattern; Petites, a medium-grained pink granite that has been used in the past in buildings in St. John's; and Seal Cove, a medium-grained rose granite that has a related red phase described as being comparable to Indian red granites. In western Newfoundland, blocks were extracted from the Goose Arm Road marble deposit following drilling at three sites. There are plans to evaluate the marble's processing characteristics and market acceptance in the United States.

Sandstone and Slate

In 1992, Newfoundland Slate Inc. opened a new slate production plant at Nut Cove, Trinity Bay, Newfoundland. More than $9 million was invested to bring the former Newfoundland Slate Quarries site into production. Ardoisières d'Angers, a major French company and a leading European marketer of roofing slates, provided up-to-date technology and will be the primary distributor. Distribution networks are also being established in Canada and the United States. At Bonavista Bay, Power Slate Inc. continued its efforts to bring the Keels slate deposit into production.

In Nova Scotia, a medium-grained buff sandstone known as "Wallace sandstone" is quarried for use as heavy riprap and for dimension stone. This stone enjoyed widespread architectural use in the past in central and Atlantic Canada and, as a result, is seeing growing use for renovation and restoration work.

In New Brunswick, a red fine-to-medium-grained sandstone has been quarried in Sackville for use in construction. Deposits are exploited on demand throughout Kent and Westmorland counties. Sandstone has been quarried in the past in Prince Edward Island and used locally.

Quebec

Limestone

Limestone occurs in the St. Lawrence and Ottawa River valleys and in the Eastern Townships. The century-old Deschambault quarry at St. Marc-des-Carrières is one of the few locations where blocks and other shapes are produced from time to time. Marble has been produced in the Eastern Townships and the Lac St-Jean areas.

Granite and Marble

Development mainly associated with granite has increased substantially since earlier reports became available.[13,14] Quarries have been opened from near Rouyn-Noranda in the west to Magpie, about 100 km east of Sept-Îles. About 20 companies quarry granite mainly in the Rivière-à-Pierre, Lac St-Jean, St. Lawrence North Shore, the Eastern Townships, and Appalachian regions. These companies now account for about 55 quarries classified as producers of granite for construction, monuments and/or furniture. Also in the province, there are 46 fabricating plants involved in processing granite for monumental and construction uses, according to a recent poster map and listing by the Quebec Ministry of Energy and Resources.[15]

Granicor Inc./Columbia Granite Inc. quarries numerous types of rough granite for its fabricating plants as well as for export markets. In addition, member companies of the Quebec Granite Producers Association, including Groupe Polycor Inc., A. Lacroix Ltée, and Granilac Inc., as well as others, continue regular operations and new site development where demand warrants it.

In 1992, Groupe Polycor purchased Dumas & Voyer, a quarrier of Caledonia granite since 1885 and a major fabricator of curbstones. Groupe Polycor's other quarrying divisions include Société Minière Polycorp Inc. and also Carrières Norgranit Inc., which is owned jointly with Rock of Ages. In addition to Dumas & Voyer Ltée, the Groupe's manufacturing division includes Granite Bussière Inc. and Tuiles Grani-Décor Tiles Inc.

Ancor Granite Tile Inc. operates a modern fabricating plant in Lachine. A wide range of thin-cut granite tiles serve the domestic and international markets.

Sandstone

Les Carrières Ducharme Inc., in Hemmingford, Huntingdon County, produces flagstone and construction blocks. This operation is the only company in Quebec producing this type of dimensional stone.

Ontario

Limestone

Major production is from Ordovician, Silurian and Devonian deposits; however, limestones in Ontario range in age from Precambrian through Devonian. A provincially funded three-volume study entitled *Limestone Industries of Ontario*, was completed in 1989. This work thoroughly assesses the geological resources, economic factors, and related industries associated with limestone, dolostone, and marble.[16]

Arriscraft Corporation quarries a blue-grey to buff-coloured dolostone from the Wiarton/Colpoy Bay Member of the middle Silurian Amabel formation near Wiarton. Sold under the name of Adair marble, this attractive stone has increasingly been used for up-scale construction projects, including the Canadian Chancery in Washington, D.C. Also in Washington, Adair marble was chosen as one of the types of stone used for the National Law Enforcement Officers Memorial built in 1991.

Marble

In the past, only a few uses for local construction-quality marble have been reported.[17]

Jarvis Resources Ltd. continued development at its marble property approximately 35 km north of Sudbury. Extensive exploration has delineated proven and probable reserves of approximately 5.5 Mt, according to the company. Installation of a slab and tile manufacturing plant for processing the multi-coloured marble began in 1992.

In the Bruce Peninsula region, Owen Sound Ledgerock Limited, as well as Ebel Quarries Limited, produces polished marble products on demand from rough stone as part of their quarrying and cutting operations. Other products produced by these and other companies in the region mainly relate to flagstone, landscaping stone and masonry stone using light-to-dark-brown-coloured dolostone from the Eramosa Member of the Amabel formation, locally referred to as Wiarton Dolostone.

Two Island Marble Corporation operated intermittently during the past two years. The company started its small-scale quarrying and cutting operation in 1990 in the Renfrew area of eastern Ontario.

Granite

Granites occur in northern, northwestern and southeastern Ontario.[18,19,20,21,22,23,24] In northwestern Ontario, Nelson Granite Limited continued to expand access to granite to complement its needs, mainly for the manufacture of monuments by affiliates in Ontario and New Brunswick. The company operates near Vermilion Bay, where there are exceptionally large reserves of pink granite. Canital Granite Ltd. of Winnipeg has quarried granite north of Kenora in northwestern Ontario. Current exploration and development work, carried out by an associated group, Manex Granit Inc. of Winnipeg, extends into adjacent regions of Manitoba and also throughout the Sudbury area. Palin Granite (Canada) Inc., owned by the largest private stone producer in Finland, opened a new quarry in the Sudbury area. Plans are to produce rough block for both the domestic and export markets. Several other companies are active in Ontario and quarry mainly on demand. These include Vior Inc.; Positano Granite, a division of Poscan Ltd.; Granite Quarriers (G.Q.I.) Inc.; and Granimar Quarries Ltd. Detailed activity throughout the province has been highlighted in a directory published by the Ontario Ministry of Northern Development and Mines.[25] A program by the same Ministry to assess the economic potential of building stone and industrial minerals continued in the districts of Nipissing and Parry Sound.

Sandstone

Sandstone quarried near Toronto, Ottawa and Kingston has been widely used in Ontario as building stone.[26] Medina sandstone is fine-to-medium-grained and varies from grey, through buff and brown to red, with some mottled units. Potsdam stone is medium-grained and varies from grey-white through salmon-red to purple, and is 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 Precambrian, Ordovician, Silurian, Devonian and Cretaceous ages occur. Limestones of commercial importance occur in the three middle periods and range from magnesian limestone through dolomite to high-calcium limestones.[3,27] A provincial publication reports on limestone as well as on other types of stone.[28]

Tyndall Stone, a mottled dolomitic limestone often referred to as "tapestry" stone, is the best known Manitoba limestone. It is quarried by Gillis Quarries, Limited at Garson, about 50 km northeast of Winnipeg. More than 25 000 m^2 were used on the Canadian Museum of Civilization very attractively situated on the Ottawa River in Hull, Quebec. 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 Cambrian to Triassic limestones. Major deposits characterized by a wide variety of types occur in Devonian and Carboniferous rocks.[28] 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 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] 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. Other operations at Terrace, Clinton, Westwold, Popkum, Dahl Lake, Doeye River and Cobble Hill have produced stone for construction and for filler use.[30]

Granite

In Manitoba, several companies quarry pink-to-reddish granite. Canital Granite Ltd., along with associate Manex Granit Inc., obtains granite from several sites to serve Canital's large tile manufacturing plant in Winnipeg. Exports of manufactured products vary considerably depending on construction activity, with the United States accounting for most of the demand. Cold Spring Granite (Canada) Limited, situated 14 km south of Lac du Bonnet, continues to produce about five "colours" of granite, mainly as large blocks for cutting and polishing in the United States. Some local block is quarried in the Medika, Manitoba area, as documented in a provincial report published in 1990.[31] The most recent investigations in the province, mainly related to granite, are included in the reports of activities for 1991 and 1992 by the Geological Services Branch of the Manitoba Department of Energy and Mines.

In Saskatchewan and Alberta, granite is not quarried on a regular basis. Some detailed work to evaluate potential reserves in Saskatchewan has been undertaken by the Saskatchewan Geological Survey.[32,33,34]

In British Columbia, the dimension stone industry has not flourished since the 1930s, although small quantities have been supplied from local sources. Margranite Industries Ltd., along with its marketing arm, C&S Ceramic Tile Distributors, completed a granite tile manufacturing plant in Surrey in 1992. Production started with a variety of British Columbia granites; output will mainly include a range of tile sizes depending upon demand. A detailed publication by the British Columbia Ministry of Energy, Mines and Petroleum Resources highlights past quarrying activity, along with uses relating to granite, marble, flagstone, jade and rhodonite.[35]

Sandstone

Sandstone for building and ornamental uses quarried near Banff, Alberta, is hard, fine-grained, medium-grey, and is referred to as "Rundle Stone." This stone is very popular locally and is best known for its use in the Banff Springs Hotel. Two companies are active: Thunderstone Quarries Ltd. and Rundle Rock Building Stone (1980) Ltd., both situated outside of the park near Canmore.

SPECIFICATIONS

Several test methods apply to dimension stone, but generally begin with compressive strength (ASTM C170) and absorption (ASTM C97). The compressive strength is defined as the maximum load per unit area that can be applied before the rock fails, reported in pounds per square inch (psi) and in megapascals (MPa). Absorption is defined as the percentage of water by weight that is absorbed over a 48-hour period.

CONSUMPTION AND MARKETS

Most dimension stone, including granite, limestone, marble, sandstone and slate, is used in construction-oriented projects. Limestone also has chemical-related uses, along with its large-scale use in the cement, lime, glass, and metal-smelting industries.

Granite, as a dimension stone, is processed mainly for interior and exterior floor- and wall-cladding, modular block panelling, and monuments. Increasingly, a broader range of colour and texture is being sought by developers and architects. Detailed consumption data for rough and finished granite, as well as for other types of stone, are not available. However, trends can be established based on production, imports, and less well-defined export data. During the 1980-90 period, Canada's production of rough granite approximately doubled and imports of roughly trimmed and cut granite block (codes 2516.11 and 2516.12) more than doubled (Table 9). Exports of rough granite have increased about eightfold in terms of volume since 1985 in response to demand in Japan, the United States and Italy. Exports of granite monumental or building stone – as represented by codes 6802.23, 6802.93, and 6802.99, mainly relating to a range of cut, sawn or worked products – were valued at $28.7 million in 1991 (Table 1). The United States accounted for about 95% of this market. In 1992, total exports of the equivalent products declined slightly to $28.1 million; however, detailed trade statistics indicate that exports to Japan increased substantially to $3.5 million, representing about 13% of the total.

Some specific uses for stone in the chemical field are: the neutralization of acid waste liquors; the extraction of aluminum oxide from bauxite; the 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. 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 in highway construction projects.

Dolomite is the source of magnesium metal produced by Haley Industries Limited at Haley, Ontario; the company also uses a high-calcium lime from south-eastern Ontario in the production of calcium metal. Dead-burned dolomitic limestone for use as a refractory is produced at Dundas, Ontario, by Steetley Quarry Products Inc. A magnesite deposit at Eon Mountain in British Columbia has been quarried by Baymag Mines Co. Limited since 1982. A range of final products is produced, including fused magnesia.

WORLD TRENDS, TRADE AND TARIFFS

World annual production of raw dimension stone is estimated to be about 30.5 Mt (about 11 million m^3), with Europe accounting for about two thirds of total output. About 50% is produced by six leading countries: Italy, Spain, Greece, the United States, France, and China. Italy has traditionally been the world's leading producer, accounting for about 7 Mt in 1990. Italy's dominance in production (accounting for about 50% of European output) also extends by the same proportion to exports, imports, and re-exports. There is a trend toward larger companies as bigger firms buy smaller companies and smaller companies amalgamate. In addition to lateral integration, there is more and more vertical integration where quarries are being bought by manufacturing companies and dealers.

Brazil, India and China have quite recently become important and are expanding production rapidly. In the former Soviet Union, some Western companies have investigated the possibility of joint ventures. However, political uncertainties, a lack of equipment, difficulties in obtaining representative samples, and transportation problems have discouraged progress.

Japan continued to be Canada's major customer for rough granite in 1992, accounting for about 75% of total exports. In the case of processed products (represented as granite monumental or building stone, as described), the United States is by far the leading customer; however, Japan is becoming more important and accounted for about 13% of the market in 1992. In 1991, Japan accounted for less than 5% of the market. Tariffs between Canada and the United States on all square or rectangular block or slab, along with tariffs relating to articles of granite, simply cut or sawn, were phased out in 1989. Tariffs relating to other types of worked stone, simply cut or sawn, as well as to tiles and similar articles, will be phased out in 1993. Some natural stone products classified as millstones or grindstones are subject to a later phase-out in 1998.

OUTLOOK

North American demand for structural stone products in the near term is expected to remain relatively weak because of the high vacancy rates in commercial buildings. However, it is predicted that demand for natural stone materials for aesthetic reasons will expand as new markets are developed. The Canadian dimension stone industry will remain highly competitive because of its advanced quarrying, processing and installation technology. Although the most rapid expansion has been associated with new quarries and fabricating plants in Quebec, modernization by several producers across Canada has increased the availability of high-quality finished products at competitive prices. Producers of high-quality rough blocks plan to continue to serve the large Japanese market in particular. In the case of producers active in both quarrying and processing, this strategy allows their new products to become better known. The use of improved European technology should continue to improve cost-effectiveness vis-à-vis substitutes, including aluminum, concrete, glass, and ceramics.

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Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2514.00	Slate, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape				
2514.00.10	Crude or roughly trimmed	Free	Free	Free	Free
2514.00.20	Merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape	5.5%	3.5%	Free	Free
2514.00.90	Other, including powder and waste	10.2%	6.5%	Free	Free
25.15	Marble, travertine, ecaussine and other calcareous monumental or building stone of an apparent specific gravity of 2.5 or more, and alabaster, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape				
	Marble and travertine:				
2515.11.00	Crude or roughly trimmed	Free	Free	Free	Free
2515.12.00	Merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape	Free	Free	Free	Free
2515.20	Ecaussine and other calcareous monumental or building stone; alabaster				
2515.20.10	Crude or roughly trimmed	Free	Free	Free	Free
2515.20.20	Merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape	5.5%	3.5%	Free	Free
25.16	Granite, porphyry, basalt, sandstone and other monumental or building stone, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape				
	Granite:				
2516.11.00	Crude or roughly trimmed	Free	Free	Free	Free
2516.12	Merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape	Free-5.5%	Free	Free	Free
	Sandstone:				
2516.21.00	Crude or roughly trimmed	Free	Free	Free	Free
2516.22.00	Merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape	5.5%	3.5%	Free	Free
2516.90	Other monumental or building stone				
2516.90.10	Crude or roughly trimmed	Free	Free	Free	Free
2516.90.20	Merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape	5.5%	3.5%	Free	Free
25.17	Pebbles, gravel, broken or crushed stone, of a kind commonly used for concrete aggregates, for road metalling or for railway or other ballast, shingle and flint, whether or not heat-treated; macadam of slag, dross or similar industrial waste, whether or not incorporating the materials cited in the first part of the heading; tarred macadam, granules, chippings and powder, of stones of heading Nos. 25.15 or 25.16, whether or not heat-treated				
2517.10.00	Pebbles, gravel, broken or crushed stone, of a kind commonly used for concrete aggregates for road metalling or for railway or other ballast, shingle and flint, whether or not heat-treated	Free	Free	Free	Free
2517.20.00	Macadam of slag, dross or similar industrial waste, whether or not incorporating the materials cited in subheading No. 2517.10	Free	Free	Free	Free

TARIFFS (cont'd)

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2517.30.00	Tarred macadam	10.2%	6.5%	Free	Free
	Granules, chippings and powder, of stones of heading Nos. 25.15 or 25.16, whether or not heat-treated:				
2517.41.00	Of marble	Free	Free	Free	Free
2517.49	Other				
2517.49.10	Limestone roofing granules	Free	Free	Free	Free
2517.49.90	Other	10.2%	6.5%	Free	Free
6801.00.00	Setts, curbstones and flagstones of natural stone (except slate)	5.5%	Free	Free	0.8%
68.02	Worked monumental or building stone (except slate) and articles thereof, other than goods of heading No. 68.01; mosaic cubes and the like, of natural stone (including slate), whether or not on a backing; artificially coloured granules, chippings and powder, of natural stone (including slate)				
6802.10	Tiles, cubes and similar articles, whether or not rectangular (including square), the largest surface area of which is capable of being enclosed in a square which is less than 7 cm; artificially coloured granules, chippings and powder				
6802.10.10	Roofing granules, artificially coloured	Free	Free	Free	1.3%
6802.10.90	Other	12.5%	8%	Free	1.3%
	Other monumental or building stone and articles thereof, simply cut or sawn, with a flat or even surface:				
6802.21.00	Marble, travertine and alabaster	5.7%	3.5%	Free	0.4%-1.2%
6802.22.00	Other calcareous stone	8%	5%	Free	1.2%
6802.23.00	Granite	5.5%	Free	Free	Free
6802.29.00	Other stone	8%	5%	Free	1.5%
	Other:				
6802.91.00	Marble, travertine and alabaster	9%	Free	Free	0.5%-1.2%
6802.92.00	Other calcareous stone	9.9%	6.5%	Free	1.2%
6802.93.00	Granite	10.2%	6.5%	Free	Free
6802.99.00	Other stone	10.2%	6.5%	Free	1.3%[a]
6803.00	Worked slate and articles of slate or of agglomerated slate				
6803.00.10	Roofing slate	Free	Free	Free	1.3%
6803.00.90	Other	10.2%	6.5%	Free	0.7%
68.04	Millstones, grindstones, grinding wheels and the like, without frameworks, for grinding, sharpening, polishing, trueing or cutting, hand sharpening or polishing stones, and parts thereof, of natural stone, of agglomerated natural or artificial abrasives, or of ceramics, with or without parts of other materials				
6804.10.00	Millstones and grindstones for milling, grinding or pulping	10.2%	Free	5.1%	Free
6804.23.00	Of natural stone	10.2%	Free	5.1%	Free

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992.
[a] Certain stone tiles originating in Canada are free of duty.

TABLE 1. CANADA, STONE EXPORTS AND IMPORTS, 1990-92

Item No.		1990		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
EXPORTS							
2514.00	Slate, whether or not roughly trimmed or merely cut, etc.	4	. . .	6	2	–	–
2515.11	Marble and travertine, crude or roughly trimmed	34	33	26	8	32	4
2515.12	Marble and travertine, merely cut, by sawing or otherwise into blocks, etc.	44	39	166	44	44	14
		(cubic metres)		**(cubic metres)**		**(cubic metres)**	
2516.11	Granite, crude or roughly trimmed	27 929	16 914	32 194	21 317	21 461	11 852
2516.12	Granite, merely cut, by sawing or otherwise, into blocks, etc.	4 236	2 456	4 703	1 304	516	898
2516.21	Sandstone, crude or roughly trimmed	50	2	–	–	–	–
		(tonnes)		**(tonnes)**		**(tonnes)**	
2516.22	Sandstone, merely cut, by sawing or otherwise, into blocks, etc.	51	48	55	60	3	23
2516.90	Monumental or building stone, n.e.s.	1 149	148	1 582	502	1 081	235
2517.10	Pebbles, gravel broken or crushed stone used for aggregates, etc.	1 356 158r	9 225r	1 442 984	9 749	1 530 560	9 592
2517.41	Marble granules, chipping and powder of 25.15 or 25.16 heat-treated or not	220	36	325	61	4 590	575
2517.49	Granules, chippings and powder n.e.s. of 25.15 or 25.16 heat-treated or not	20 197	388	9 749	195	51	8
6801.00	Setts, curbstones and flagstones of natural stone (except slate)	. .	6	. .	368	. .	21
6802.10	Tiles, etc., rectangular or square not more than 7 cm, etc., artificially coloured granules, chippings and powder	. .	152	. .	48	. .	267
6802.21	Monumental or building stone, cut or even, marble, travertine and alabaster	. .	98	. .	69	. .	636
6802.22	Monumental or building stone, cut or sawn, flat or even, other calcareous stone	–	–	. .	11	. .	132
6802.23	Monumental or building stone, cut or sawn, flat or even, granite	. .	3 186	. .	3 070	. .	2 677
6802.29	Monumental or building stone, cut or sawn, flat or even, n.e.s.	. .	44	. .	185	. .	182
6802.91	Worked monumental or building stone, n.e.s., marble, travertine or alabaster	. .	908	. .	1 243	. .	270
6802.92	Worked monumental or building stone, n.e.s., calcareous stone, n.e.s.	. .	13	. .	797	. .	6
6802.93	Worked monumental or building stone, n.e.s., granite	. .	25 965	. .	20 710	. .	13 437
6802.99	Worked monumental or building stone, n.e.s.	. .	1 357	. .	4 901	. .	4 899
6803.00	Worked slate and articles of slate or agglomerated slate	. .	3	. .	23	. .	44
6804.10	Millstones and grindstones for milling, grinding or pulping	. .	8 882	. .	6 851	. .	3 161
6804.23	Millstones, grindstones, etc., of natural stone	. .	1 030	. .	475	. .	926
IMPORTS							
2514.00	Slate, whether or not roughly trimmed or merely cut, etc.	1 876	644	2 269	600	859	392
2515.11	Marble and travertine, crude or roughly trimmed	1 971	433	864	261	664	215
2515.12	Marble and travertine, merely cut, by sawing or otherwise, into blocks, etc.	2 061r	1 185	2 593	2 082	2 128	1 661

TABLE 1 (cont'd)

Item No.		1990		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)							
2516.11	Granite, crude or roughly trimmed	45 112r	10 466	32 670	7 127	31 409	6 871
2516.12	Granite, merely cut, by sawing or otherwise, into blocks, etc.	1 034	778	2 365	1 351	2 252	1 178
2516.21	Sandstone, crude or roughly trimmed	2 613r	362	1 501	188	1 129	127
2516.22	Sandstone, merely cut, by sawing or otherwise, into blocks, etc.	9 396	1 914	7 060	1 440	4 870	1 036
2516.90	Monumental or building stone, n.e.s.	9 401	1 607	7 438	1 329	6 621	965
2517.10	Pebbles, gravel broken or crushed stone used for aggregates, etc.	996 051	5 509	1 021 411	6 144	721 117	5 087
2517.41	Marble granules, chipping and powder of 25.15 or 25.16 heat-treated or not	45 870r	5 604r	52 863	6 464	51 371	6 282
2517.49	Granules, chippings and powder n.e.s. of 25.15 or 25.16 heat-treated or not	132 516r	1 452r	108 863	1 237	84 501	1 275
6801.00	Setts, curbstones and flagstones of natural stone (except slate)	. .	739	. .	664	. .	484
6802.10	Tiles, etc., rectangular or square not more than 7 cm, etc., artificially coloured granules, chippings and powder	32 895	4 453r	34 577	4 203	38 509	4 451
6802.21	Monumental or building stone, cut or sawn, flat or even, marble, travertine and alabaster	. .	3 421r	. .	4 102	. .	4 597
6802.22	Monumental or building stone, cut or sawn, flat or even, other calcareous stone	. .	471	. .	204	. .	219
6802.23	Monumental or building stone, cut or sawn, flat or even, granite	. .	2 374r	. .	2 282	. .	4 248
6802.29	Monumental or building stone, cut or sawn, flat or even, n.e.s.	. .	427	. .	342	. .	525
6802.91	Worked monumental or building stone, n.e.s., marble, travertine or alabaster	. .	46 526r	. .	25 560	. .	11 806
6802.92	Worked monumental or building stone, n.e.s., calcareous stone, n.e.s.	. .	1 135	. .	1 469	. .	977
6802.93	Worked monumental or building stone, n.e.s., granite	. .	32 154r	. .	28 201	. .	11 029
6802.99	Worked monumental or building stone, n.e.s.	. .	1 291	. .	1 182	. .	671
6803.00	Worked slate and articles of slate or agglomerated slate	. .r	3 891	. .	3 200	. .	3 706
6804.10	Millstones and grindstones for milling, grinding or pulping	. .	1 604r	. .	1 291	. .	953
6804.23	Millstones, grindstones, etc., of natural stone	. .	1 935r	. .	1 570	. .	4 605

Source: Statistics Canada.
– Nil; . . Not available; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified; p Preliminary; r Revised.

TABLE 2. CANADA, TOTAL PRODUCTION OF STONE, 1990-92

	1990		1991		1992p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
BY PROVINCE[1]						
Newfoundland	1 501	9 952	1 270	7 691	930	4 947
Nova Scotia	7 271	39 459	4 632	24 810	4 210	19 799
New Brunswick	2 711	18 098	2 591	15 851	2 234	13 404
Quebec	40 634	243 573	34 801	208 805	31 634	205 775
Ontario	50 418	300 561	38 704	238 446	36 075	218 572
Manitoba	3 737	15 193	1 725	11 023	1 728	8 705
Alberta	317r	3 111r	321	3 556	347	4 309
British Columbia	3 271	24 327	2 779	24 685	3 724	28 766
Northwest Territories and Yukon	1 495	9 079	1 003	4 788	757	3 368
Total	111 355r	663 354r	87 826	539 654	81 639	507 645
BY USE[2]						
Dimensional stone			..	..	..	..
Rough	274	27 508	..	..	..	..
Monumental and ornamental stone (n.f.)	60	14 007	..	..	..	..
Other (flagstone, curbstone, paving blocks, etc.)	56	3 093	..	..	..	..
Chemical and metallurgical						
Cement plants, Canada	12 991	28 646	..	..	..	..
Cement plants, foreign	1 126	4 332	..	..	..	..
Lining, open-hearth furnaces	...	2	..	..	..	..
Flux in iron and steel furnaces	656	3 673	..	..	..	..
Flux in nonferrous smelters	16	390	..	..	..	..
Glass factories	171	2 975	..	..	..	..
Lime plants, Canada	2 367	18 602	..	..	..	..
Lime plants, foreign	236	1 532	..	..	..	..
Pulp and paper mills	214	1 850	..	..	..	..
Sugar refineries	37	274	..	..	..	..
Other chemical uses	846	5 332	..	..	..	..
Pulverized stone						
Whiting (substitute)	54	3 593	..	..	..	..
Asphalt filler	139	715	..	..	..	..
Dusting, coal mines	8	549	..	..	..	..
Agricultural purposes and fertilizer plants	914	13 195	..	..	..	..
Other uses	420	14 094	..	..	..	..
Crushed stone for						
Manufacture of artificial stone	37	718	..	..	..	..
Roofing granules	310	6 480	..	..	..	..
Poultry grit	56	1 201	..	..	..	..
Stucco dash	15	1 979	..	..	..	..
Terrazzo chips	4	514	..	..	..	..
Rock wool	...	34	..	..	..	..
Rubble and riprap	1 301	9 041	..	..	..	..
Concrete aggregate	11 363	66 615	..	..	..	..
Asphalt aggregate	9 151	55 031	..	..	..	..
Road metal	47 596	230 030	..	..	..	..
Railroad ballast	2 842	19 272	..	..	..	..
Other uses	33 452	175 325	..	..	..	..
Total	126 713	710 602	..	..	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
.. Not available; ... Amount too small to be expressed; n.f. Not finished or dressed; p Preliminary; r Revised.
[1] Data exclude stone used in the Canadian cement and lime industries. [2] Data include stone used in the Canadian cement and lime industries.
Note: Numbers may not add to totals due to rounding.

TABLE 3. CANADA, PRODUCTION OF LIMESTONE, 1989-91

	1989		1990		1991	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
BY PROVINCE[1]						
Newfoundland	413	2 713	800	4 595	987	5 329
Nova Scotia	177	1 934	185	2 044	122	1 975
New Brunswick	525	6 030	509	6 229	469	5 658
Quebec	32 752	152 910	30 801	154 493	24 821	126 419
Ontario	56 136	306 278	48 252	266 557	36 528	206 615
Manitoba	2 396	10 138	2 951	12 208	1 347	5 922
Alberta	328	3 365	243	2 527	263	3 020
British Columbia	1 823	12 855	1 810	14 573	1 735	14 470
Northwest Territories and Yukon	309	1 918	967	7 424	200	998
Total	94 859	498 141	86 519	470 649	66 471	370 406
BY USE[2]						
Dimensional stone						
Rough	57	2 563	98	3 683	. .	. .
Monumental and ornamental stone (n.f.)	. . .	52	4	233	. .	. .
Other (flagstone, curbstone, paving blocks, etc.)	30	2 405	34	1 888	. .	. .
Chemical and metallurgical					. .	. .
Cement plants, Canada	13 671	31 211	11 846	25 414	. .	. .
Cement plants, foreign	805	2 407	1 126	4 332	. .	. .
Lining, open-hearth furnaces	–	–	. . .	2	. .	. .
Flux in iron and steel furnaces	1 270	6 203	656	3 673	. .	. .
Flux in nonferrous smelters	52	1 258	16	391	. .	. .
Glass factories	258	4 930	171	2 975	. .	. .
Lime plants, Canada	2 162	13 386	2 367	18 602	. .	. .
Lime plants, foreign	237	1 397	236	1 532	. .	. .
Pulp and paper mills	216	1 928	214	1 850	. .	. .
Sugar refineries	40	318	37	274	. .	. .
Other chemical uses	1 316	7 780	846	5 332	. .	. .
Pulverized stone						
Whiting (substitute)	54	3 929	53	3 593	. .	. .
Asphalt filler	75	706	82	542	. .	. .
Dusting, coal mines	2	75	8	549	. .	. .
Agricultural purposes and fertilizer plants	980	13 409	858	12 394	. .	. .
Other uses	104	1 818	175	2 242	. .	. .
Crushed stone for						
Manufacture of artificial stone	1	5	1	10	. .	. .
Roofing granules	59	504	32	384	. .	. .
Poultry grit	57	1 208	53	1 035	. .	. .
Stucco dash	10	1 120	11	1 709	. .	. .
Rubble and riprap	858	4 293	547	4 546	. .	. .
Concrete aggregate	9 510	55 817	8 583	50 118	. .	. .
Asphalt aggregate	6 720	39 854	6 105	35 624	. .	. .
Road metal	48 515	230 269	40 853	195 657	. .	. .
Railroad ballast	560	2 820	985	4 698	. .	. .
Other uses	23 072	111 074	24 733	131 383	. .	. .
Total	110 692	542 738	100 732	514 665	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available; . . . Amount too small to be expressed; n.f. Not finished or dressed.
[1] Data exclude stone used in Canadian cement and lime industries. [2] Data include stone used in the Canadian cement and lime industries.
Note: Numbers may not add to totals due to rounding.

TABLE 4. CANADA, PRODUCTION OF MARBLE, 1989-91

	1989		1990		1991	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
BY PROVINCE						
Nova Scotia	. . .	21	3	253	3	175
Quebec	484	7 791	537	8 154	417	7 515
Ontario	254	11 162	231	11 547	222	11 202
Total	739	18 974	771	19 955	641	18 892
BY USE						
Dimensional stone						
Rough	22	999	19	850	. .	. .
Pulverized stone						
Agricultural purposes and fertilizer plants	51	829	56	801	. .	. .
Other uses	293	12 473	245	11 852	. .	. .
Miscellaneous stone						
Artificial stone	–	–	36	709	. .	. .
Roofing granules	2	37	1	14	. .	. .
Poultry grit	. . .	17	. . .	11	. .	. .
Stucco dash	–	–	5	270	. .	. .
Terrazzo chips	3	161	4	514	. .	. .
Crushed stone for						
Concrete aggregate	145	1 488	131	1 283	. .	. .
Road metal	139	645	183	869	. .	. .
Other uses	84	2 325	92	2 782	. .	. .
Total	739	18 974	771	19 955	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available; . . . Amount too small to be expressed.
Note: Numbers may not add to totals due to rounding.

TABLE 5. CANADA, PRODUCTION OF GRANITE, 1989-91

	1989		1990r		1991	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
BY PROVINCE						
Newfoundland	217	1 398	176	1 803	125	1 491
Nova Scotia	5 570	27 122	5 945	32 090	3 450	17 694
New Brunswick	1 658	7 820	2 039	11 364	1 956	9 523
Quebec	6 570	53 179	7 007	66 406	7 027	58 193
Ontario	1 731	18 410	1 927	21 097	1 946	19 354
Manitoba	353	2 938	659	2 959	378	5 101
Alberta	5	158	4r	409r	4	412
British Columbia	1 593	9 902	1 451	9 654	1 034	10 029
Northwest Territories and Yukon	307	2 252	317	1 267	378	3 075
Total	18 004	123 178	19 524r	147 048r	16 297	124 872
BY USE						
Dimensional stone						
Rough	113	17 055	108	19 505	. .	. .
Monumental and ornamental stone (n.f.)	43	7 156	55	13 729	. .	. .
Other (flagstone, curbstone, paving blocks, etc.)	6	572	3	320	. .	. .
Pulverized stone						
Asphalt filler	67	196	57	174	. .	. .
Crushed stone for						
Artificial stone	5	53	–	–	. .	. .
Roofing granules	267	5 839	278	6 083	. .	. .
Poultry grit	1	119	1	90	. .	. .
Rubble and riprap	724	4 809	588	3 882	. .	. .
Concrete aggregate	1 527	9 526	2 489	13 979	. .	. .
Asphalt aggregate	2 445	13 771	2 698	17 288	. .	. .
Road metal	5 445	24 995	5 817	30 584	. .	. .
Railroad ballast	2 183	15 018	1 630	13 333	. .	. .
Other uses	5 176	24 071	5 800	28 081	. .	. .
Total	18 004	123 178	19 524	147 048	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available; n.f. Not finished or dressed; r Revised.
Note: Numbers may not add to totals due to rounding.

TABLE 6. CANADA, PRODUCTION OF SANDSTONE, 1989-91

	1989		1990		1991	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
BY PROVINCE[1]						
Newfoundland	228	1 238	518	3 528	134	765
Nova Scotia	973	4 611	1 101	4 972	1 029	4 841
New Brunswick	90	52	69	38	45	62
Quebec	1 501	12 067	1 269	10 481	1 660	12 695
Ontario	118	1 086	7	1 355	9	1 275
Alberta	. . .	28	1	60	. . .	24
British Columbia	6	165	10	100	11	185
Total	2 917	19 247	2 975	20 534	2 888	19 849
BY USE[2]						
Dimensional stone						
Rough	62	2 805	46	3 451	. .	. .
Monumental and ornamental stone (n.f.)	24	1 005	1	45	. .	. .
Other (flagstone, curbstone, paving blocks, etc.)	2	234	19	886	. .	. .
Chemical process stone						. .
Cement plants, foreign	2	38	–	–	. .	. .
Cement plants, Canadian	–	–	11	54	. .	. .
Crushed stone for						
Poultry grit	1	109	1	66	. .	. .
Rubble and riprap	23	65	155	584	. .	. .
Concrete aggregate	330	2 138	160	1 235	. .	. .
Asphalt aggregate	231	1 438	268	1 646	. .	. .
Road metal	449	2 420	363	1 875	. .	. .
Railroad ballast	–	–	227	1 240	. .	. .
Other uses	1 792	8 995	1 734	9 505	. .	. .
Total	2 917	19 247	2 986	20 587	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available; . . . Amount too small to be expressed; n.f. Not finished or dressed.
[1] Data exclude stone used in Canadian cement and lime industries. [2] Data include stone used in Canadian cement and lime industries.
Note: Numbers may not add to totals due to rounding.

TABLE 7. CANADA, PRODUCTION OF SHALE,[1] 1989-91

	1989[a]		1990[a]		1991	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
BY PROVINCE[2]						
Newfoundland	4	15	7	26	25	106
Nova Scotia	11	29	37	101	29	124
New Brunswick	62	375	93	468	121	607
Quebec	1 297	4 508	1 020	4 039	875	3 983
Ontario	1 178	2 444	1	5	–	–
Manitoba	113	23	127	26	–	–
Alberta	41	69	68	116	54	101
Northwest Territories and Yukon	110	175	211	389	425	715
Total	2 817	7 637	1 566	5 169	1 529	5 635
BY USE[3]						
Dimensional stone	–	–	4	19	. .	. .
Chemical and metallurgical						
Cement plants, Canadian	227	594	263	919	. .	. .
Crushed stone for						
Rubble and riprap	–	–	10	29	. .	. .
Asphalt aggregate	91	536	80	473	. .	. .
Road metal	949	2 451	379	1 045	. .	. .
Other uses	1 777	4 650	1 965	5 862	. .	. .
Total	3 045	8 232	2 701	8 347	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available.
[1] May include slate. [2] Data exclude stone used in the Canadian cement and lime industries. [3] Data include stone used in the Canadian cement and lime industries.
Note: Numbers may not add to totals due to rounding.

TABLE 8. CANADA, PRODUCTION OF STONE BY TYPES,[1] 1980, 1985, 1990 AND 1991

	1980		1985		1990[r]		1991	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
Granite	39 983	140 914	17 219	95 424	19 524[r]	147 048[r]	16 297	124 872
Limestone	58 191	185 085	77 874	317 862	86 519	470 649	66 471	370 406
Marble	316	1 807	571	13 966	771	19 955	641	18 892
Sandstone	3 064	11 540	3 011	15 310	2 975	20 534	2 888	19 849
Shale[2]	1 812	1 810	1 561	3 059	1 566	5 169	1 529	5 635
Total	103 366	341 156	100 236	445 622	111 355[r]	663 354[r]	87 826	539 654

Sources: Energy, Mines and Resources Canada; Statistics Canada
[r] Revised.
[1] Data exclude stone used in the Canadian cement and lime industries. [2] May include slate.
Note: Numbers may not add to totals due to rounding.

TABLE 9. CANADA, ROUGH GRANITE, SUMMARY OF PRODUCTION AND TRADE, 1980, AND 1985-92

	Quantity / Value	Production[1]	Imports[2]	Exports[2]
1980	t	81 000	24 130	5 019[a]
	$ millions	5.6	1.9	0.7
1985	t	104 000	34 468	12 511[a]
	$ millions	12.8	6.2	1.7
1986	t	121 000	33 994	18 450[a]
	$ millions	15.7	6.6	2.7
1987	t	112 000	46 370	37 450[a]
	$ millions	16.1	7.9	6.0
1988	t	153 000	46 282	86 940[r]
	$ millions	24.4	11.2	16.2[r]
1989	t	162 000	52 337	107 105
	$ millions	24.8	11.7	17.3
1990	t	166 000	46 163	88 775
	$ millions	33.6	11.2	19.4
1991	t	122 000[e]	35 035	101 836
	$ millions	25.0[e]	8.5	22.6
1992	t	101 000[e]	44 949	98 000
	$ millions	21.0[e]	10.5	21.4

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[e] Estimated; [r] Revised.
[a] Coded as building stone, rough (90% is considered to be granite).
[1] Includes rough stone for construction, monumental/ornamental and other uses. [2] Includes codes 2516.11 (roughly trimmed block) and 2516.12 (cut block by sawing or otherwise). Some re-exports to the United States may also be involved.

TABLE 10. CANADA, VALUE OF CONSTRUCTION BY PROVINCE,[1] 1990-92

	1990			1991			1992		
	Building Construction[2]	Engineering Construction[2]	Total	Building Construction[2]	Engineering Construction[2]	Total	Building Construction[2]	Engineering Construction[2]	Total
					($ millions)				
Newfoundland	1 040	679	1 718	1 011	898	1 909	1 060	1 168	2 228
Nova Scotia	1 816	846	2 662	1 541	1 033	2 574	1 560	850	2 409
New Brunswick	1 314	719	2 033	1 147	1 061	2 208	1 166	1 039	2 205
Prince Edward Island	242	89	332	246	104	350	251	122	373
Quebec	16 394	6 552	22 946	14 996	6 592	21 588	14 077	7 027	21 104
Ontario	29 526	8 404	37 930	25 443	8 800	34 244	27 493	9 546	37 039
Manitoba	1 811	1 348	3 159	1 580	1 367	2 947	1 662	1 381	3 044
Saskatchewan	1 737	1 932	3 670	1 534	2 043	3 577	1 531	1 861	3 392
Alberta	6 283	7 494	13 777	5 391	7 191	12 582	5 689	6 754	12 443
British Columbia, Yukon and Northwest Territories	9 884	4 258	14 142	9 493	4 654	14 147	10 816	4 204	15 021
Total Canada	70 047	32 320	102 367	62 382	33 743	96 125	65 307	33 952	99 259

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Actual expenditures 1990, preliminary 1991, intentions 1992. [2] Includes total value of new and repair work purchased.
Note: Numbers may not add to totals due to rounding.

Sulphur

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World Overview

Transition was a key feature of 1992. For the previous 12 years, world markets had been kept in balance with regular stock withdrawals; in 1992, production of sulphur exceeded demand to a level where world stocks rose for the first time since 1979. A new era of increasing oversupply began. World production of elemental sulphur in 1992 was estimated at 35.6 Mt, a 2% decline over the previous year. A decrease in Frasch sulphur production (–17%) was not offset by a 4% increase in output from recovered sulphur. Major declines in Frasch sulphur occurred in Mexico, Poland, the former Soviet Union (FSU), and the United States, while an increase was reported in Iraq. Increases in production of recovered sulphur were registered in the United States, Canada, Western Europe, and Japan. In 1992, Frasch sulphur production accounted for 24% of total world sulphur output, a significant decline from the 28% level in 1991. Production of recovered sulphur accounted for 76%, of which gas processing contributed 44% and oil processing 29%, with the remaining 3% deriving from heavy oil and tar sands.

In 1992, world demand for sulphur in fertilizers decreased by 2.0%-2.5%. Consumption of sulphur for the production of phosphate fertilizers dropped in Western Europe, Eastern Europe, Latin America and the FSU; sales remained relatively stable in Oceania. Growth in consumption was reported in Asia, Africa (notably in Morocco), and the United States. In Asia, sulphur consumption rose in China and Taiwan while it remained stable in Japan. On the demand side, the most important event that affected the marketplace in 1992 was the introduction in India of a series of government policies affecting consumption and sourcing of sulphur for fertilizers. In early 1992, the Indian government decided to lower its level of subsidies on single superphosphate fertilizers (SSP) resulting in a drop in domestic SSP production and a subsequent reduction in sulphur consumption. In late March, India announced the "decanalization" of sulphur imports which broadened purchasing authority for sulphur from a state monopoly to an array of traders and individual consumers. In September, India deregulated domestic prices for phosphate fertilizers; however, to prevent a drastic rise in prices, the government introduced a short-term subsidy program for some fertilizers. The impacts of these measures were not fully realized in 1992, except for some changes by Indian consumers in their marketing practices and supply sourcing. Pressures were exerted on prices for imported sulphur and shifts amongst suppliers largely favoured exporters from the Middle East.

Canadian Developments

Elemental Sulphur

In 1992, Canada ranked as the world's second largest producer of elemental sulphur with an 18% share and remained the leading exporter with a 38% share of world trade.

Canadian production of elemental sulphur in 1992 was estimated at 6.5 Mt, an increase of 325 000 t (or 5.2%) over 1991. Production from natural gas processing accounted for 87.6% of total production, while the remainder was from oil sands plants (8.9%) and oil refineries (3.5%). Sulphur recovered from natural gas rose by 4.5% to 5.7 Mt; increases occurred both in Alberta, where sulphur production increased 4.4% from 4.95 Mt to around 5.17 Mt, and in British Columbia, where sulphur output grew 18% to 535 000 t.

The increase in sulphur production from natural gas was a result of improved recovery and higher operating rates at several gas processing plants. Processing plants at Pine River, Whitecourt, Hanlan Robb and Bigstone, amongst others, demonstrated a larger sulphur production compared to the previous year. Demand for western Canadian natural gas was firmer in 1992, with total demand growing 22%, mostly due to strong sales to the United States.

The production of sulphur from tar sands reached a record level of 575 000 t, a 5% increase over the previous year. Both Syncrude and Suncor registered an increase in their respective outputs. Recovery of sulphur from oil refining was estimated at 227 000 t, a similar level to that of last year; decreases in output in Ontario and New Brunswick were offset by increases in Saskatchewan and Quebec, combined with additional tonnage from the commissioning of the new heavy oil upgrader at Lloydminster, Saskatchewan.

Shipments of elemental sulphur dropped 10% to 6.2 Mt, mainly because of significantly weaker offshore sales, which decreased by 0.9 Mt to 3.7 Mt. Sales to the United States rose while domestic sales were reported stable. For the first time in 13 years, the combination of an increase in production and a reduction in sales led to a net addition to stocks. At the beginning of 1992, inventories were estimated at 2.8 Mt; during the year, close to 0.4 Mt were added, leaving stocks at 3.2 Mt by year-end.

Exports to the United States were estimated at 1.92 Mt in 1992, a 14% increase over the previous year. In 1992, the United States remained the dominant export destination for Canadian sulphur, accounting for 34% of Canada's total exports compared to 31% in 1991.

During the year, Canada's offshore exports of sulphur totalled 3.7 Mt, a 19% decrease compared to 1991. Canadian sulphur was exported to more than 30 countries. For the first nine months of 1992, Canada exported close to 2.8 Mt, compared to 3.47 Mt for the same period the previous year. Lower sales were reported to Latin America, Europe and Asia; shipments to Africa remained stable and exports to Oceania increased. Africa, and more specifically Morocco, was Canada's major destination with a total 53% share of Canada's 1992 offshore exports. Sales to Morocco reached 830 000 t by the end of the third quarter of 1992, representing a net 74 000-t increase over last year; Morocco was Canada's major destination and accounted for 30% of Canada's offshore sales in 1992 (compared to 22% in 1991). Gains registered in Morocco (+10%), Senegal (+33%), and Israel (+5%) were totally offset by a major decline in our shipments to South Africa (–37%) and Tunisia (–27%). Exports to Oceania rose 70%, with strong sales to New Zealand (+83%) and Australia (+43%); Oceania accounted for 7% of offshore sales. Shipments decreased by 22% in Latin America, with a much-reduced level of sales reported in Mexico (–44%) and Brazil (–20%). No sales were made to Cuba and Peru. Latin America accounted for 17% of total offshore sales, a share similar to the previous year. Sales to Europe, which accounted for 3% of total sales, dropped 68%; no sales were reported to Belgium, the former Soviet Union and Yugoslavia, resulting in a net 220 000-t loss over last year. Shipments to Asia decreased by 44% to 574 000 t, compared to about 1.0 Mt the previous year. Major declines were reported in India (–71%), Taiwan (–83%), and Indonesia (–13%). South Korea was the major destination in Asia, representing 7% of Canada's total offshore sales in 1992; shipments to this country rose 19% over the same period the previous year. Asia accounted for 21% of offshore exports in 1992, compared to 29% in 1991.

Canadian sulphur stocks in early January 1992 were estimated at around 2.8 Mt, distributed mostly amongst 18 sites in Alberta. Early in 1992, remelts were carried out at a 50 000-t/m rate to supplement production for meeting requirements in domestic and export markets; however, the net withdrawals from stocks ended in February. By March, stock movements generated net additions on a monthly basis at a rate varying between 30 000 t/m and 45 000 t/m; after July, this rate rose to 60 000-80 000 t/m, and culminated at close to 100 000 t/m by the end of the year. Despite some sporadic remelts during the year, net additions to stocks in 1992 totalled close to 0.4 Mt, leaving about 3.2 Mt by year-end. Major additions to stocks were reported at Ram River (with a 70% share of all additions), Kaybob III, and East Calgary. Net declines in stocks occurred at few locations, with Kaybob I/II, Waterton, and East Crossfield being the largest remelt sites for 1992. By the end of 1992, six sites in Alberta accounted for 78% of remaining stocks, with major volumes (above 350 000 t) held at East Crossfield, Rainbow Lake, Ram River, and Waterton.

Alberta

In Alberta, Shell Canada Limited's Caroline project was on schedule for initial start-up by early 1993 with a 1.4-Mt/y sulphur capacity; the first unit of the plant will be commissioned in March 1993 and the second unit one month later. The $540 million gas plant is designed to achieve 99.8% sulphur recovery. More than 15 deep wells will supply the plant with sour gas containing up to 35% H_2S through a network of pipelines totalling 200 km in length. Recovered sulphur in a liquid form is shipped by way of a 42-km underground pipeline to a forming facility at Schantz. The $76 million forming and handling facility, with a capacity to form 4500 t/d of sulphur pellets, was completed in mid-1992. Storage capacity on site for sulphur in blocks is estimated at close to 650 000 t, and formed sulphur storage is estimated at 30 000 t. Late in 1992, the forming facility was commissioned with sulphur hauled from the Burnt Timber sour gas processing plant.

During 1992, Shell terminated its 228-t/d sulphur demonstration project at the super sour gas pilot plant located near Bearberry; the experiment for recovering sulphur from gas with 90% H_2S was concluded satisfactorily.

The tie-in of Obed sour gas fields to the Kaybob III plant encountered technical problems late in 1991 and was shut down for the whole year in 1992; later during 1992, Chevron Canada Resources Limited acquired the fields from Imperial Oil Limited and planned to tie in the gas reserves in 1993.

In April, Suncor Inc.'s tar sands refining operation in northeastern Alberta was affected by a fire, which damaged one of its hydro-treaters at Fort McMurray; full operation resumed in August. In 1992, Suncor continued to evaluate options to extend the life of its operations beyond the 8- to 10-year current reserves; options being considered include a new mine, the development of new transportation technologies to access remote reserves, and the use of the current upgrader to process bitumen extracted from other producers. Late in 1992, Suncor negotiated new oil sands leases to exploit a new mine by 1996/97.

During 1992, Syncrude Canada Ltd. requested a five-year extension on its expiring 1987 expansion permit from Alberta's Energy Resources Conservation Board.

Several other activities were carried out in Alberta that were related to the sulphur industry: Imperial Oil Ltd. ceased to recover sulphur at its Joffre gas plant in mid-1992; BP Canada Inc. changed its name to Talisman Energy Inc.; Co-enerco Resources Ltd. completed the property purchase of the Zama gas plant from Amoco Canada Petroleum Company Ltd.; Suncor Inc. acquired the Simonette gas plant from Shell Canada Limited; Petro-Canada sold its 37% interest in Westcoast Energy Inc.; North Canadian Oils Limited became operator of the Progress gas plant instead of Shell Canada Limited; OMV (Canada) Ltd. took over as plant operator at Rainbow Lake instead of NW Resources Ltd.; Morrison Petroleum Ltd. and Canadian Gas Gathering Systems Inc. (CGGS) purchased the controlling interest of Gulf Canada Resources Limited in the Nevis gas plant (CGGS will be the new operator); and Poco Petroleums Ltd. acquired the Sturgeon Lake South gas plant from Shell Canada Limited. Late in 1992, Prism Sulphur Corporation signed two new members, Bow Valley Industries Ltd. and Enerplus Energy Services Ltd., increasing its number of shareholders to 29.

British Columbia

In 1992, gas exploration flourished during the year following extensive discoveries in northeastern British Columbia since 1990. In 1992, several new gas reserves were discovered in the Monkman Pass area, and at Burnt River, Klua, Brazion, and South Brazion. These occurrences are located close to Westcoast Energy Inc.'s gas processing plant at Pine River; the company has plans to expand its gas processing and sulphur recovery capacity by 1995.

Late in 1991, Westcoast Energy Inc. completed its $105 million expansion at the Taylor-McMahon gas plant; close to 100 000 t/y of sulphur recovery capacity was added. Compared to 1991, sulphur production at Taylor increased by 14% and reached 188 000 t in 1992.

Imperial Oil Limited announced that its oil refinery at Ioco, British Columbia, will shut down in 1993 and be converted into a product terminal in the near term.

Petro-Canada Products Inc. announced its intention to rationalize its oil refining operations; its Port Moody refinery in British Columbia is to be converted into a handling facility for refined products from Petro-Canada's Edmonton refinery by the third quarter of 1993.

Shell Canada Products Limited is to convert its Shellburn refinery at Burnaby, British Columbia, into a product-finishing plant and terminal facility in mid-1993.

Pacific Coast Terminals at Port Moody completed a major investment program in mid-year with the installation of a new conveyor system to by-pass the StakeRake reclaimer in the sulphur storage area; the by-pass system will allow direct delivery from railcars to vessels.

Saskatchewan

In 1992, a new heavy oil upgrader at Lloydminster was commissioned by Husky Oil Operations Ltd.; the sulphur recovery capacity of the Bi-Provincial Upgrader is estimated at 90 000 t/y.

Eastern Canada

In Newfoundland, Newfoundland Processing Limited is scheduled to begin recovering sulphur at the Come-by-Chance oil refinery during 1993. The refinery's sulphur recovery capacity is estimated at 200 t/d.

In Nova Scotia, Imperial Oil Limited announced that its oil refinery at Dartmouth, which was slated for possible closure at the end of 1992, will continue to operate due to substantial improvements in cost reductions and yield.

In Ontario, Imperial Oil Limited announced that its oil refineries at Sarnia and Nanticoke will be running at a reduced rate. Petro-Canada plans to reduce its activities at the Lake Ontario-Mississauga oil refinery, which will be reconfigured into an asphalt and lubricant plant in 1993/94.

Sulphuric Acid

In 1992, sales of sulphuric acid were lower than last year. Demand for sulphuric acid was reported steady in the pulp and paper sector, but it dropped in the industrial chemicals, uranium ore leaching, and titanium dioxide manufacturing sectors. Domestic prices in eastern Canada declined 5% on an f.o.b. plant basis.

The production of sulphur products from smelters in 1992 was estimated at 896 300 t, a 3% increase from 1991. Sulphuric acid production rose as significant increases were registered in New Brunswick and Quebec. Lower output occurred at Cominco and Horne (Noranda), and higher production was recorded at CE Zinc and Falconbridge Limited. Also in 1992, the production of liquid sulphur dioxide from smelters rose 3%, and shipments by 6%, mostly due to the higher recovery achieved at Inco Limited. Demand for liquid SO_2 was strong in the pulp and paper sector for its use in the making of bleaching agents and in the de-inking of recycled papers.

In 1991, the consumption of sulphuric acid in Canada was estimated at close to 2.35 Mt, a 7% decrease over 1990. The acid produced from smelters accounted for 51% of total acid consumed; the remaining 49% was supplied by sulphur-burning operations. Sulphuric acid consumption in eastern Canada amounted to 0.95 Mt, a 13% decline over 1991, and accounted for 41% of total Canadian consumption. Agricultural chemicals accounted for 48% of sulphuric acid consumption, followed mainly by inorganic chemicals (18%), pulp and paper (15%), and uranium mining (5%).

Brunswick Mining and Smelting Corporation Limited (BMS) ran its smelter plant at Belledune, New Brunswick, at high rates during 1992 following the resumption of its operations after a 10-week strike that ended in September 1991. During 1992, the company saw its production rise by 30% despite a 12% reduction in its workforce. In 1992, BMS purchased close to 50 000 t of sulphuric acid to supplement its feed for the Belledune phosphate fertilizer plant. Late in 1992, the fertilizer plant was temporarily shut down to increase its inventory of sulphuric acid.

Cominco Ltd. of Vancouver, British Columbia, continued to evaluate different technologies to solve technical problems at its QSL lead smelter in Trail. The new $110 million plant, which started in December 1989, was shut down in March 1990 due to inadequate performance and low recovery. One option being envisioned is to adopt the Kivcet smelting process developed in Russia.

Falconbridge Limited is currently conducting research on methods to reduce its sulphur dioxide emissions to 75 000 t/y at capacity production by 1996. Late in 1992, the company started the construction of a new liquid sulphur dioxide (SO_2) unit at the Kidd Creek operation in Ontario. The plant is to use a portion of the SO_2 stream from the existing smelter in Timmins. The 30 000-t/y SO_2 facility is slated for completion in the fall of 1993. Liquid sulphur dioxide will be sold mainly to the pulp and paper and mining industries in eastern Canada and the northeastern United States.

Hudson Bay Mining and Smelting Co., Limited continued its work on the construction of a new zinc pressure leach plant and copper smelter in Flin Flon, Manitoba. The $171 million zinc plant will allow the company to meet its sulphur dioxide emissions reduction target of 25% to 220 000 t/y by 1994. The plant is scheduled to be completed by mid-1993; close to 35 000 t/y of sulphur will be recovered and stacked.

Inco Limited is expected to complete the construction of its second of two oxygen flash furnaces in 1993 at its Copper Cliff smelter operations in Ontario. The first flash furnace and a new 2900-t/d acid plant were put on stream last year. The total capital cost of the modernization project rose to $600 million from the initial $500 million; the project is already 85% completed. The company's SO_2 emission targets for 1994 have been set at 265 000 t/y.

Late in 1992, both major nickel producers in Ontario, Inco Limited and Falconbridge Limited, announced a series of measures to face the current oversupply situation that affects international nickel markets. The companies announced plans to reduce costs including labour cuts and a series of shut-downs for early 1993 and during the summer of 1993.

WORLD DEVELOPMENTS

In 1992, world sulphur production declined 2% compared to 1991. Production decreased in Eastern Europe (including Poland and the FSU), Latin America, and North America. Increases in production were reported in the Middle East, Asia and Western Europe.

For the first nine months of 1992, world trade of elemental sulphur remained stable at 10.65 Mt. Canada accounted for 40% of world trade, compared to a 44% share in 1991. Other major exporters were Poland (18%) and Saudi Arabia (16%). In 1992, sulphur imports dropped in Latin America (–20%), Western Europe (-22%) and Eastern Europe (–32%), while increases were reported in Africa (+24%) and Oceania (+70%). North Africa was the leading importing region with volumes reaching 3.5 Mt for the first nine months of 1992; this region accounted for 33% of world sulphur trade, followed by the United States (20%), and Asia (18%). Canada registered lower sales in most of its markets, except in the United States and Oceania. In 1992, Canadian exporters maintained a strong position in Oceania (100%), the United States (67%), and Latin America (49%); however, market share was lost in Africa (to Poland and the United States), Asia (to Saudi Arabia, Iran and Japan), and the Middle East. Overall, Saudi Arabia registered major gains in exports (+6%), particularly in Asia; most of the other exporting countries lost market share during the first nine months of 1992.

United States

The United States was the world's largest sulphur producer as well as a major Frasch-producing country in 1992, accounting for 26% of world production. Production of elemental sulphur decreased by 4.5% to 9.1 Mt; sulphur recovered from oil and gas processing plants accounted for 75% and amounted to 7 Mt (a 6% increase compared to 1991 due to higher recovery of sulphur from both sour natural gas and crude oil). The decline in total sulphur production was due to much-reduced output from Frasch mines as a consequence of technical problems encountered in 1992 and the closure of two operations late in 1991. Frasch output was estimated at 2.1 Mt, down 27% from 2.9 Mt in 1991. Production of other forms of sulphur (e.g., sulphuric acid) remained unchanged at 1.3 Mt and accounted for approximately 12% of overall production of sulphur-in-all-forms. In 1992, sulphur was produced at 169 plants operating in 32 states. Apparent U.S. consumption was reported at 12.9 Mt for use mostly in fertilizers (62%), chemicals (11%), and petroleum refining (4%). Exports rose 320 000 t to 0.93 Mt. Imports declined by 8% to about 2.8 Mt, of which Canada supplied 68%, with the rest coming mostly from Mexico. Producers' stocks of elemental sulphur dropped by 0.5 Mt to 0.7 Mt at year-end.

Freeport-McMoran Inc. Resource Partners, Ltd. (FMRP) commissioned its new 2.5-Mt/y Frasch mine at the Main Pass Block 299 sulphur deposit, 30 km offshore the mouth of the Mississippi River in the Gulf of Mexico. The project is a joint venture between FMRP (which has a 58.3% interest in the operation), IMC Fertilizer Group Inc. (a 25% interest), and Homestake Mining (a 16.7% interest). In 1992, production at Main Pass was estimated at 100 000 t. Sulphur production from Main Pass is forecast to reach 2.0 Mt/y by 1994. During 1992, Freeport Sulphur Co. continued to run its other Frasch mine, Caminada, which produced 0.85 Mt in 1992. Pennzoil Sulphur Co. produced close to 1.0 Mt at the Culberson Frasch mine in West Texas, while Texasgulf Inc. produced about 0.15 Mt at its Boling Dome mine in New Gulf, Texas. During 1992, several oil and gas companies in the United States pursued expansion and development projects that will impact on future U.S. sulphur supply; more than 25 projects in 12 states are to increase U.S. sulphur recovery capacity by 2000 t/d between 1993 and 1994.

Late in 1992, Pennzoil Sulphur Co. initiated a request to the U.S. Department of Commerce (DOC) for an administrative review on anti-dumping of elemental sulphur from Canada. Fifteen Canadian companies, of which some are current exporters and others are defunct companies, were cited in the request. Early in 1993, the DOC announced its intention to proceed with its investigation on sulphur sales from these Canadian companies during the December 1, 1991 to November 30, 1992 period.

Former Soviet Union

In the Former Soviet Union, sulphur was produced in 1992 in the Ukraine (Frasch at Rozdol), in Turkmenistan (Frasch at Gaudark), in Russia (recovered from gas at Astrakhan and Orenburg), in Uzbekistan (recovered from gas at Mubarek), and in Kazakhstan (recovered from oil and gas at Tengiz). In 1992, the FSU was the world's third largest producer of sulphur with a 14% share of world production. Its elemental sulphur production declined 6.5% to 5 Mt. Gas-recovered sulphur was the major source of sulphur production accounting for 54%.

In 1992, three of the four lines at the Astrakhan I sour gas plant were operating satisfactorily during the year; sulphur output from this plant in 1992 was estimated at 1.2 Mt, a 20% increase over the previous year. The start-up of Astrakhan II is expected in 1995 and full utilization at both Astrakhan I and II is forecast after 1996. In 1991, the first oil-gas separation and processing plant at Tengiz I started up with a sulphur recovery capacity designed at 0.45 Mt/y; in 1992, this unit ran at 50% of capacity. The Tengiz II plant is 75% completed; the Tengiz III plant is 5% completed. Other Tengiz plants are expected to be built after 1997. These new units are planned with sulphur-forming facilities. Liquid sulphur recovered from Tengiz I and II will primarily serve domestic markets; future international sales will be marketed by a joint venture between Tengizneftegas and Metallgesellschaft of Germany. Frasch sulphur production in 1992 was projected to decline from 2.0 Mt to 1.6 Mt; most of the decline occurred in the Ukraine as Frasch sulphur operations continued to face environmental and economic pressures. In the near future, Frasch production is expected to decline gradually to 1.5 Mt/y by 1993.

In 1992, Chevron Corporation of the United States signed a joint-venture agreement with the Republic of Kazakhstan to develop the Tengiz and Korolev oil fields on the northeastern coast of the Caspian Sea. Proven reserves were estimated at between six and nine billion barrels of oil containing up to 16% H_2S. In addition to oil, the deposits comprise substantial reserves of gas, natural gas liquids, and sulphur.

Poland

Poland was the fourth largest world producer of elemental sulphur accounting for 7% of world production. Poland extracted Frasch sulphur at three mines and one industrial pilot project at Baznia (30 000 t/y). The major mines are located at Jeziorko, Machow, and Grzybow. In 1992, sulphur production in Poland dropped 24% to 2.9 Mt from 3.9 Mt in 1991. Severe economic, technical and environmental problems plagued the Polish sulphur industry during 1992. Cutbacks in production were reported at the Jeziorko Frasch mine and at the Machow open-pit operation. Reserves at Machow continued to decline while the Grzybow Frasch operation is gradually being phased out due to declining reserves that are expected to be depleted by 1994. The new Frasch replacement mine at Osiek is expected to be commissioned in 1993/94 with an initial design capacity of 450 000 t/y. During the year, a proposal to expand the Jeziorko operation was rejected by the Polish government; the reason cited was environmental concerns in the Tarnobrzeg area. Exports for 1992 were estimated at 2.5 Mt, an 8% decrease over 1991.

Saudi Arabia

Saudi Arabia was the fifth largest sulphur producer in the world with a 5% share. In 1992, Saudi sulphur production was reported unchanged at 2.0 Mt. Close to 75% came from natural gas processing at Ras Tanura, Shedgum, and Berri, while the remainder was recovered from oil refineries at Al Jubayl and Yanbu.

Mexico

Mexico was the world's sixth largest producer of sulphur, accounting for 4% of world production. Mexico produced 1.46 Mt of sulphur in 1992, 260 000 t less than last year. Frasch production declined 30% to 0.7 Mt and accounted for half of the total Mexican sulphur output. Sulphur production from oil refining and gas processing rose to 750 000 t from 715 000 t in 1991. Technical problems continued to be experienced at the Jaltipan and Coachapa-Otapan Frasch mines, which were owned by Azufrera Panamericana SA (APSA); by the end of 1992, both mines were reportedly shut. The only remaining operating Frasch mine, located at Texistepec, was owned by Compagnhia Exploracion del Istmo (CEDI) and produced 0.5-0.6 Mt/y. In 1992, the Mexican government initiated the privatization of APSA; however, late in 1992, the company declared a technical bankruptcy. Assets from APSA are to be liquidated in 1993. APSA was the marketing agent for both CEDI and Petroleos Mexicanos (Pemex). By 1993, it is expected that Pemex will directly market its own sulphur production recovered from five gas processing plants and two crude oil refineries across Mexico.

Other Middle East Countries

In Iraq, the gas plant at Kirkuk ran at a rate of 200 t/d during 1992 for an estimated output of 70 000 t. The Mishraq Frasch mine operated during the whole year and extracted close to 670 000 t of sulphur which were, for the major part, put into inventories. In Kuwait, the Shuaibai refinery, which suffered damages during the 1991 Persian Gulf War, is expected to resume operation in the second half of 1993; the plant has a sulphur recovery unit with a design capacity of 1200 t/d. In Abu Dabhi, new granulating equipment and forming facilities are being installed by National Oil Co., and expansion work was completed at Das Island with an incremental sulphur capacity of 300 000 t/y. In Iran, sulphur production in 1992 rose slightly to 760 000 t due to improved processing and sulphur recovery at the 150-t/d gas plant at Razi; a new 200-t/d oil refinery is expected to come on stream by 1996. In Qatar, a three-stage gas-related project is planned in North Field by Qatar General Petroleum Corp.; close to 240 000 t/y of sulphur recovered from gas is expected at Umm Said by 1994.

PRICES

Affected by a 40% drop in prices in 1991 and encouraged by the formation of a new sulphur export consortium in Canada, world sulphur suppliers sought stability in international prices for 1992. However, early spot indications in January 1992 signalled another tough year for sulphur producers. In January, sulphur prices, f.o.b. Vancouver, were quoted at US$67-72/metric tonne, with no gap between contract and spot prices. In the Middle East, the Government Established Price (GEP) was quoted at US$65/t, f.o.b. Persian Gulf.

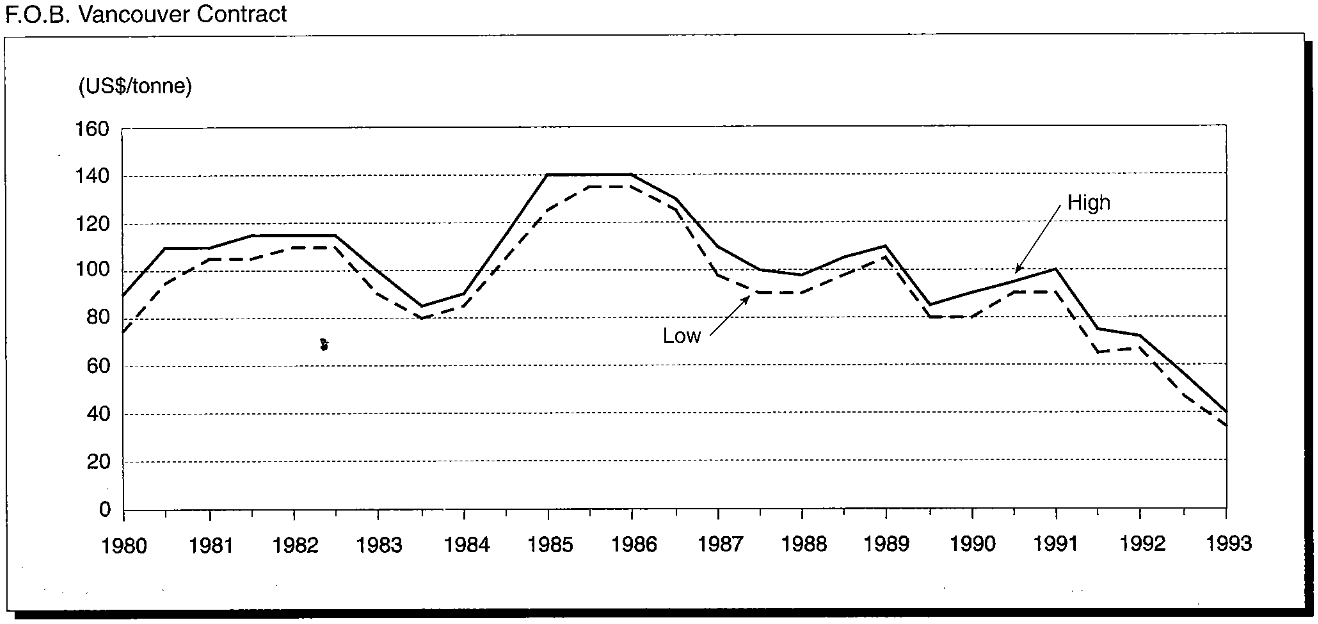
Vancouver prices started to slide in February to US$60-63/t and stabilized at US$58-63/t during the second quarter of 1992. With weak levels of sales realized by Canadian exporters during the first half of 1992, prices eroded further by July, and dropped to US$37-56/t at year-end. Overall, Vancouver sulphur prices decreased by 45% in 1992, compared to a 40% decline in 1991. In Saudi Arabia, GEP quotations were reported steady at $65/t between January and October; however, in November, the GEP decreased by US$7/t to US$58/t, f.o.b. Jubayl (Saudi Arabia).

Prices in North American markets also dropped. At the beginning of 1992, prices for liquid sulphur (f.o.r. Alberta) varied between US$20/t and $25/t. Quotations remained unchanged until October, when new quotations reflected the intensifying competition between U.S. and Canadian suppliers in the Florida market. In the last quarter of 1992, sulphur prices dropped to US$8-10/t, f.o.r. Alberta. In the United States, the Tampa liquid sulphur price was posted at US$98/long ton, ex-terminal, between January and October 1992. In September, U.S. sulphur suppliers reduced the Tampa sulphur quotations by US$10/long ton to US$88/long ton.

USES

About 60% of all sulphur consumed in the world is used in the production of fertilizers such as superphosphate, ammonium phosphate, and ammonium sulphate. The second largest consuming sector is the chemical industry, where sulphur is used in products ranging from pharmaceuticals to synthetic fibres in plastics

Figure 1
Sulphur Prices, 1980-93
F.O.B. Vancouver Contract



SOURCE: Energy, Mines and Resources Canada.

and petroleum catalysts. Other consumers of sulphur include the manufacturers of titanium dioxide in pulp and paper, iron and steel, and nonferrous metals. These consuming industries use sulphur in the form of sulphuric acid, which accounts for almost 90% of total sulphur consumption (60% of sulphuric acid consumption is in fertilizers). Products requiring sulphur in non-acid form include insecticides and fungicides, pulp and paper, photography, leather processing, rayon, and rubber.

OUTLOOK

In 1990 and 1991, international sulphur markets were affected by international events that were independent from its own dynamic: the phosphoric acid dispute between Morocco and India in 1990, and the Persian Gulf War in 1991. However, in 1992, sulphur markets were affected by events directly related to its market conditions: an increasing production of recovered sulphur, declining output in Frasch sulphur, weak sulphur demand, rising competition between sulphur exporters, and falling international prices. The conditions that prevailed in 1992 are not expected to change significantly in 1993.

In 1993, Canadian sulphur production is projected to reach 7.4 Mt, a 0.8-Mt increase that is mostly related to gas projects in Alberta; increases in sulphur recovery are also expected from oil refining and heavy oil processing. Sulphur production from smelters will likely remain stable as lower output, due to reduced operating rates at nickel producers in Ontario, will be offset by additional tonnage from the commissioning of the second flash furnace at Inco.

World sulphur production in 1993 is expected to increase significantly. In Canada, the commissioning of Shell's Caroline gas-liquids-sulphur project and the reactivation of the Obed sour gas field to Chevron's Kaybob III processing plant will add substantial tonnage to Canadian sulphur output. In the United States, Freeport's Main Pass Frasch mine will achieve a higher operating rate to reach a sustainable 2.0-Mt/y production level by 1994. In the Middle East, Iraq's Mishraq Frasch operation is set for a major increase in output for 1993 and new sources of sulphur are expected to come on stream in Abu Dhabi and Qatar. In the former Soviet Union, the commissioning of the second Tengiz complex is expected in 1993. New projects will bring close to 2.5 Mt/y of additional capacity, while improvements in operating rates at Main Pass (United States), Astrakhan (Russia), and Mishraq (Iraq) will likely add more than 1.8 Mt of sulphur in 1993. However, reductions in Frasch sulphur production are projected in Mexico (Jaltipan and Coachapa-Otapan mines), the United States (Caminada mine), Poland (Grzybow and Machow mines), and Turkmenistan (Gaudark mine). These forecast reductions could surpass 0.75 Mt in 1993.

Also in 1993, demand for sulphur in phosphate fertilizers will be facing uncertainties in both India and China; a significant reduction in fertilizer consumption will impact on the imports of finished and semi-finished phosphate products from the United States and North African countries.

In the medium term, The Sulphur Institute of Washington, D.C., forecasts that world sulphur demand will grow at an annual rate of 1% between 1991 and 1996, to reach 60.2 Mt/y in 1996. Sulphur consumption in non-fertilizer applications is projected at 24 Mt/y in 1996, a similar level to that of 1991. Sulphur consumption in fertilizers is forecast to grow at close to 1.5%/y between 1991 and 1996 to about 36 Mt/y by 1996. According to the International Fertilizer Industry Association, growth rates above 4.0%/y are predicted in Latin America and Southeast Asia; however, the high level of consumption predicted for India could be hindered by government policies regarding its level of subsidies on phosphate fertilizers. In Eastern Europe and the FSU, consumption of phosphate fertilizers is expected to improve from 1992 levels, which were estimated to be at the bottom of the decline that began in 1988; in the FSU, fertilizer consumption is projected to increase by 10% overall in the 1991-96 period and to reach, by 1996, a level that prevailed in 1991. Consumption of sulphur for fertilizers is projected to decrease in Western Europe and to remain stable in United States.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2503.00	Sulphur of all kinds, other than sublimed sulphur, precipitated sulphur and colloidal sulphur				
2503.10.00	Crude or unrefined sulphur	Free	Free	Free	Free
2503.90.00	Other	Free	Free	Free	Free
2802.00.00	Sulphur, sublimed or precipitated; colloidal sulphur	Free	Free	Free	Free
2807.00.00	Sulphuric acid; oleum	Free	Free	Free	Free
2811.23.00	Sulphur dioxide	Free	Free	Free	0.8%

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992.

TABLE 1. CANADA, SULPHUR SHIPMENTS AND TRADE, 1991 AND 1992

Item No.		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)
SHIPMENTS[1]					
	Sulphur in smelter gases[2]	748 965	89 187	773 647	79 155
	Elemental sulphur[3]	6 937 884	376 505	5 869 456	121 451
	Total sulphur content	7 686 849	465 692	6 643 103	200 606
IMPORTS				(Jan.-Sept.)	
2503.10	Sulphur, crude or refined				
	United States	1 369	202	232	45
	Other countries	60	16	53	15
	Total	1 429	218	285	60
2503.90	Sulphur, n.e.s.				
	United States	7 593	1 903	5 803	1 800
	Other countries	4	1	290	80
	Total	7 597	1 904	6 093	1 880
2802.00	Sulphur sublimed or precipitated; colloidal sulphur				
	United States	1 258	390	721	314
	Other countries	10	8	–	–
	Total	1 268	398	721	314
2807.00	Sulphuric acid; oleum				
	United States	79 092	6 672	67 725	5 680
	Other countries	114	15	64	8
	Total	79 206	6 687	67 789	5 688
2811.23	Sulphur dioxide				
	United States	130	66	119	63
	Total	130	66	119	63
EXPORTS					
2503.10	Sulphur, crude or unrefined[4]				
	United States	1 652 412	158 199	1 452 735	82 230
	Morocco	822 747	87 671	739 977	55 396
	Tunisia	351 544	39 945	247 991	19 159
	Indonesia	264 796	27 773	216 948	17 151
	Brazil	316 239	36 158	177 217	14 389
	Senegal	119 871	14 494	135 470	11 376
	South Africa	136 247	13 391	107 851	10 116
	New Zealand	47 203	5 147	126 989	9 678
	South Korea	144 768	14 059	124 196	9 452
	Israel	112 149	13 029	114 451	8 924
	India	355 223	41 946	119 853	8 400
	People's Republic of China	44 613	4 914	81 459	7 877
	Mexico	162 574	18 868	89 101	7 508
	France	112 218	11 986	79 680	6 544
	Australia	42 566	4 407	59 477	4 132
	Argentina	81 785	7 729	56 778	3 760
	Chile	44 773	5 160	29 377	2 224
	Thailand	46 300	4 762	28 965	2 188
	Taiwan	120 306	12 749	37 778	1 903
	Other countries[4]	306 054	34 880	58 128	2 944
	Total	5 284 388	557 267	4 084 421	285 351
2503.90	Sulphur, n.e.s.				
	United States	17 893	1 699	3 012	441
	New Zealand	–	–	5 317	238
	Total	17 893	1 699	8 329	679
2802.00	Sulphur, sublimed or precipitated; colloidal sulphur				
	United States	431	56	110	21
	Total	431	56	110	21
2807.00	Sulphuric acid; oleum				
	United States	1 265 687	48 980	1 007 653	41 554
	Other countries	53	14	79	30
	Total	1 265 740	48 994	1 007 732	41 584
2811.23	Sulphur dioxide				
	United States	73 039	11 060	55 571	9 025
	Total	73 039	11 060	55 571	9 025

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; n.e.s. Not elsewhere specified; p Preliminary.
[1] Data compiled regardless of origin (i.e., domestic and foreign source materials). [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, Italy, Cuba, Bangladesh, the U.S.S.R., Yugoslavia and Uruguay.

TABLE 2. CANADA, SOUR GAS AND OIL SANDS SULPHUR EXTRACTION PLANTS, 1989-92

Operating Company	Source Field or Plant Location	H_2S in Raw Gas	Daily Sulphur Capacity[1]			
			1989	1990	1991	1992
	(Alberta, except where noted)	(percent)	(tonnes)			
SOUR GAS, ALBERTA						
Alberta Energy Company Ltd.	Sinclair-Hythe	3	256	256	256	256
Amerada Hess Corporation	Olds-Garrington	15	389	389	389	389
Amoco Canada Petroleum Company Ltd.	Bigstone Creek	16	385	385	385	385
Amoco Canada Petroleum Company Ltd.	Brazeau-Peco	0.8	110	110	110	110
Amoco Canada Petroleum Company Ltd.	Caroline-Garrington	0.3	–	10.4	10.4	10.4
Amoco Canada Petroleum Company Ltd.	Caroline-Harmattan	0.8	8	8	8	8.3
Amoco Canada Petroleum Company Ltd.	East Crossfield-Elkton	34	1 797	1 797	1 797	1 797
Amoco Canada Petroleum Company Ltd.	Edson-Pine Creek	1.4	289	289	292	292
Amoco Canad Petroleum Company Ltd.	W. Pembina-Brazeau	11	340	340	520	520
Amoco Canada Petroleum Company Ltd.	Windfall-Whitecourt	21	1 330	1 330	1 333	1 333
Canadian Gas Gathering Systems Inc.	Nevis	4	197	197	197	196.6
Canadian Occidental Petroleum Ltd.	Mazeppa-Okotoks-Medallion	36	577	577	577	577
Canadian Occidental Petroleum Ltd.	Paddle River	0.1	19	19	19	19
Chevron Canada Resources Limited	Kaybob South III-Obed	16	3 557	3 557	3 557	3 557
Chevron Canada Resources Limited	Medicine Lodge	7.5	–	–	45	55.9
Co-enerco Resources Ltd.	Zama	8	74	74	74	74
Encor Energy Corp. Inc.	Teepee Creek	8	30	30	30	23
Gulf Canada Limited	Brazeau River-Nordegg	1.3	42	42	46.5	46.5
Gulf Canada Limited	Homeglen-Rimbey	1	128	128	128	127.5
Gulf Canada Limited	Strachan	9	953	953	953	953
Home Oil Company Limited	Carstairs	0.5	65	65	65	64.8
Husky Oil Ltd.	Rainbow Lake	2	139	139	142	142
Husky Oil Ltd.	Ram River (Ricinus)	19	4 572	4 572	4 572	4 572
Imperial Oil Resources Limited	Bonnie Glen	0.4	12.5	12.5	34.5	34.5
Imperial Oil Resources Limited	Joffre	3.4	17	23.5	23.5	23.5
Imperial Oil Resources Limited	Quirk Creek	9	299	299	301	301.2
Imperial Oil Resources Limited	Redwater	2.6	11	11	11	11
Mobil Oil Canada, Ltd.	Harmattan-Elkton-Leduc	46	490	490	66	66.2
Mobil Oil Canada, Ltd.	Lone Pine Creek	10	157	157	162	162
Mobil Oil Canada, Ltd.	Wimborne	13	182	182	182	182
Norcen Energy Resources Limited	Minnehik-Buck Lake	0.1	45	45	45	45
North Canadian Oils Limited	Progress	0.7	15	15	16	14.5
OMV (Canada) Ltd.	Rainbow-Fire	1.0	25	25	20	19.9
Pembina Corporation	Turner Valley	1.2	11	16	16	15.9
Petro-Canada Inc.	Brazeau-Peco	7	444	444	447.3	447.3
Petro-Canada Inc.	Gold Creek	3	43	43	43	43
Petro-Canada Inc.	Hanlan Robb	9	1 092	1 092	1 092	1 092
Petro-Canada Inc.	Wildcat Hills	4	177	280	280	280.3
Petrogas	East Calgary-Crossfield	17	1 696	1 696	1 696	1 696
Poco Petroleums Ltd.	Sturgeon Lake South	9.5	98	98	98	98
Saratoga Processing Company Limited	Savannah Creek (Coleman)	24	389	389	389	389
Shell Canada Limited	Caroline-Bearberry	90	–	–	228	228
Shell Canada Limited	Caroline	35	–	–	–	4 504
Shell Canada Limited	Burnt Timber Creek	13	489	489	489	489
Shell Canada Limited	Jumping Pound	6	597	597	597	597
Shell Canada Limited	Waterton	19	3 107	3 107	3 107	3 107
Suncor Inc.	Rosevear	8	110	110	111	111.3
Suncor Inc.	Rosevear South	8	171	171	171	171
Suncor Inc.	Simonette River	16	95	95	95	95
SOUR GAS, BRITISH COLUMBIA						
Amerada Hess Corporation	Boundary Lake	–	3.7	3.7	3.7	3.7
Amoco Canada Petroleum Company Ltd.	Cypress	–	14.1	14.1	14.1	14.1
Westcoast Energy Inc.	Fort Nelson	2	674	674	674	674
Westcoast Energy Inc.	Taylor Flats-McMahon	1.6	460	460	460	558
Westcoast Energy Inc.	Pine River	12	1 055	1 055	1 055	1 070
OIL SANDS, ALBERTA						
Suncor Inc.	Mildred Lake	n.a.	441	441	441	441
Syncrude Canada Ltd.	Fort McMurray	n.a.	1 255	1 255	1 255	1 255

Source: Energy Resources Conservation Board publication, October 1992.
– Nil; n.a. Not applicable.
[1] Maximum design capacity.

TABLE 3. CANADA, CRUDE OIL AND HEAVY OIL REFINERY SULPHUR CAPACITIES OPERATING IN 1990-92

Operating Company	Location	Daily Capacity 1990	1991	1992
			(tonnes)	
Canadian Ultramar Limited	St. Romuald, Quebec	50	50	50
Chevron Canada Limited	Burnaby, British Columbia	10	10	10
Consumers' Co-operative Refineries Limited	Regina, Saskatchewan	220	220	220
Imperial Oil Limited	Dartmouth, Nova Scotia	76	76	76
	Edmonton, Alberta	40	40	40
	Nanticoke, Ontario	35	35	35
	Port Moody, British Columbia[1]	20	20	20
	Sarnia, Ontario	140	140	140
Husky Oil Operations Ltd.[2]	Lloydminster, Saskatchewan	–	–	250
Irving Oil Limited	Saint John, New Brunswick	100	100	100
Petro-Canada Products Inc.	Edmonton, Alberta	56	56	56
	Lake Ontario-Mississauga, Ontario	44	44	44
	Lake Ontario-Oakville, Ontario	40	40	40
	Port Moody, British Columbia[1]	25	25	25
Shell Canada Limited	Burnaby, British Columbia[1]	15	15	15
	Sarnia, Ontario	35	35	35
	Scotford, Alberta	14	14	14
Sulconam Inc.	Montréal, Quebec	300	300	300
Suncor Inc.	Sarnia, Ontario	50	50	50
Total effective capacity[3]		1 270	1 270	1 520

Sources: Mineral Policy Sector, Energy, Mines and Resources Canada; Company interviews, 1992.
[1] Operations to shut down in 1993. [2] Came on stream in 1992. [3] Effective capacity comprises operating productive capacity.

TABLE 4. CANADA, PRINCIPAL SULPHUR DIOXIDE AND SULPHURIC ACID PRODUCTION CAPACITIES, 1992

Operating Company	Plant Location	Raw Material	Annual Capacity		
			Liquefied SO_2	Sulphuric Acid[1]	Sulphur Equivalent[2]
			(000 tonnes)		
EASTERN CANADA					
Brunswick Mining and Smelting Corporation Limited	Belledune, N.B.	SO_2 lead & zinc conc.		176	58
CE Zinc	Valleyfield, Que.	SO_2 zinc conc.		430	140
Falconbridge Limited	Kidd Creek, Ont.	SO_2 zinc conc.		220	72
	Kidd Creek, Ont.	SO_2 copper conc.		470	153
	Sudbury, Ont.	SO_2 nickel conc.		355	116
Gaspé Copper Mines, Limited	Murdochville, Que.	SO_2 copper conc.		165	54
Inco Limited	Copper Cliff, Ont.	SO_2 pyrrhotite and nickel conc.		950	310
	Copper Cliff, Ont.	SO_2 copper conc.	100	n.a.	50
Noranda Minerals Inc.	Rouyn-Noranda, Que.	SO_2 copper conc.		425	139
Sulco Chemicals Ltd.	Elmira, Ont.	Elem. sulphur		33	11
Subtotal			100	3 224	1 103
WESTERN CANADA					
Border Chemical Company Limited	Transcona, Man.	Elem. sulphur		150	49
Cameco Corporation-Rabbit Lake Operation	Rabbit Lake, Sask.	Elem. sulphur		72	23
Cameco Corporation-Key Lake Operation	Key Lake, Sask.	Elem. sulphur		72	23
Cominco Ltd.	Trail, B.C.[3]	SO_2 lead & zinc conc.	80	430	210
Esso Chemical Canada	Redwater, Alta.	Elem. sulphur		910	297
Marsulex Inc.	Fort Saskatchewan, Alta.	Elem. sulphur		160	52
Sherritt Gordon Limited	Fort Saskatchewan, Alta.	Elem. sulphur		233	75
Westcoast Energy Inc.	Prince George, B.C.	Elem. sulphur	30	75	40
Subtotal			110	2 102	769
Total Canada			210	5 326	1 872

Sources: Mineral Policy Sector, Energy, Mines and Resources Canada; Canadian company interviews 1992.
n.a. Not applicable.
[1] 100% H_2SO_4. [2] Elemental sulphur equivalent of sulphuric acid is 32.7% and sulphur equivalent of liquefied SO_2 is 50%. [3] Cominco operation at Trail also has a 30 000-t/y production capacity for elemental sulphur, which has been added to the total sulphur equivalent production capacity of Cominco.

TABLE 5. CANADA, SULPHUR SHIPMENTS AND TRADE, 1982-92

	Shipments[1]				Imports[2]	Exports[2]
	Pyrites	In Smelter Gases	Elemental Sulphur	Total	Elemental Sulphur	Elemental Sulphur
	(tonnes)					
1982	9 000	627 000	6 945 000	7 581 000	2 159	6 111 444
1983	–	678 286	6 631 123	7 309 409	2 365	5 670 275
1984	–	844 276	8 352 978	9 197 254	3 019	7 326 847
1985	–	822 359	8 102 163	8 924 522	3 167	7 848 380
1986	–	758 231	6 965 775	7 724 006	10 763	6 257 054
1987	–	783 115	7 322 791	8 105 906	24 711	6 571 800
1988	–	856 496	8 106 641	8 963 137	21 825	7 384 160
1989	–	808 789	6 868 930	7 677 719	18 311	5 514 059
1990	–	789 815	6 873 495	7 663 310	13 203r	6 057 523
1991	–	748 965	6 180 049	6 929 014	9 026	5 302 281
1992p	–	773 647	6 349 664	7 123 311	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available; p Preliminary; r Revised.
[1] Shipment data compiled regardless of origin (i.e., domestic and foreign source materials). [2] Includes only elemental sulphur in a crude or refined form.

TABLE 6. CANADA, SULPHURIC ACID PRODUCTION, TRADE AND APPARENT CONSUMPTION, 1981-91

	Production	Imports	Exports	Apparent Consumption
	(tonnes - 100% acid)			
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
1984	4 043 389	28 330	553 780	3 517 939
1985	3 890 092	17 306	744 732	3 162 666
1986	3 536 062	29 127	755 606	2 809 583
1987	3 436 977	44 623	803 178	2 673 422
1988	3 804 856	40 078	851 622	2 993 312
1989	3 718 578	28 433	978 190	2 768 821
1990	3 829 570	71 319	1 280 502	2 620 387
1991	3 613 708	79 206	1 265 740	2 427 174

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

TABLE 7. WORLD PRODUCTION OF SULPHUR, 1988-91

	1988		1989		1990		1991p	
	All-Forms[1]	Elemental	All-Forms	Elemental	All-Forms	Elemental	All-Forms	Elemental
	(000 tonnes)							
WESTERN EUROPE								
Finland	569	45	679	45	609	46	605	42
France	1 154	974	1 067	874	1 079	898	1 180	1.013
Germany	2 046	1 294	2 566	1 451	2 213	1 386	2 306	1 396
Italy	721	280	734	285	792	297	794	230
Norway	201	8	232	15	237	48	255	20
Spain	1 375	51	1 219	65	1 055	75	957	85
Others	1 787	809	1 695	860	1 617	794	1 619	893
Total, Western Europe	7 853	3 461	8 192	3 595	7 602	3 544	7 716	3 779
AFRICA								
South Africa	803	185	815	215	757	170	613	185
Others	224	10	233	10	265	10	255	10
Total, Africa	1 027	195	1 048	225	1 022	180	868	195
ASIA, MIDDLE EAST								
Japan	2 530	1 090	2 656	1 176	2 844	1 268	2 745	1 244
Saudi Arabia	1 450	1 400	1 500	1 500	1 850	1 850	2 045	2 045
Others	2 892	2 358	3 445	2 858	3 168	2 507	2 782	2 100
Total, Asia, Middle East	6 872	4 848	7 601	5 534	7 862	5 625	7 572	5 389
OCEANIA	280	60	285	65	304	70	325	70
NORTH AMERICA								
Canada	6 919	6 017	6 809	5 859	6 863	5 923	7 091	6 221
United States	10 746	9 618	11 591	10 397	12 315	10 192	11 653	9 503
Total, North America	17 665	15 635	18 400	16 256	19 178	16 115	18 744	15 724
LATIN AMERICA								
Mexico	2 244	2 144	2 192	2 012	2 447	2 142	1 762	1 762
Others	813	348	928	370	897	342	1 028	432
Total, Latin America	3 057	2 492	3 120	2 382	3 344	2 484	2 790	2 194
Total, Western World	36 755	26 691	38 646	28 057	39 312	28 018	38 015	27 351
EASTERN EUROPE								
Poland	5 169	5 004	5 030	4 865	4 616	4 456	4 087	3 917
Others	1 745	233	1 325	120	958	96	775	105
Total, Eastern Europe	6 914	5 239	6 355	4 985	5 574	4 552	4 862	4 022
U.S.S.R.	11 513	7 178	10 855	6 640	9 829	5 729	9 384	5 334
China	4 990	340	5 160	330	5 460	330	5 620	340
Other countries[2]	205	–	205	–	240	–	240	–
Total World	60 377	39 448	61 221	40 412	60 415	38 629	58 121	37 047

Source: The British Sulphur Corporation Limited, 1992.
– Nil; p Preliminary.
[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 North Korea, Vietnam and Cuba.

TABLE 8. CANADA, SULPHURIC ACID, REPORTED CONSUMPTION BY END USE, 1989-91

	1989	1990	1991p
		(tonnes)	
Agricultural chemicals and fertilizers	1 330 022	1 180 773	1 120 460
Industrial inorganic chemicals	520 108	496 600	424 615
Pulp and paper	286 085	279 873	359 031
Uranium mines	300 095	218 362	123 896
Nonferrous smelting and refining	122 648	100 654	84 049
Crude and refined petroleum products	50 100	37 293	41 971
Other mines, metal and nonmetal	32 784	19 355	30 154
Leather and textile	27 951	27 390	24 178
Soap and cleaning compounds	17 242	19 260	16 829
Metal rolling and extruding	8 960	7 315	11 613
Electrical products	9 748	6 830	5 722
Food, brewery and distillery	654	821	1 449
Plastics and synthetic resins	7 358	600	653
Other end uses	129 585	132 513	102 767
Total	2 843 340	2 527 639	2 347 387

Source: Reports from producing companies, compiled by Mineral Policy Sector, Energy, Mines and Resources Canada.
p Preliminary.

Talc, Steatite and Pyrophyllite

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SUMMARY

Talc, when isolated as a pure mineral, is composed of 63.4% SiO_2, 31.9% MgO, and 4.8% H_2O. However, as an industrial commodity, talc seldom approaches this chemical composition. Mineral impurities contributing to a divergence from the composition of pure talc and often appearing in talcose mixtures are tremolite, chlorite, dolomite, calcite, mica, and magnesite. Its combination of physical properties, such as extreme softness and whiteness, a high fusion point, a low thermal and electrical conductivity, its hydro-phobic and organophilic nature, and its chemical inertness, allows talc to be very versatile in its application. Talc products are found in the paint, pulp and paper, ceramic, cosmetic, plastic, chemical, rubber, and construction products industries.

Pyrophyllite is a hydrous aluminum silicate containing, in its pure form, 66.7% SiO_2, 28.3% Al_2O_3, and 5.0% H_2O. The mineral possesses physical properties characteristic of talc and, as a result, finds its way into similar applications. Major markets for pyrophyllite are associated with ceramics, refractories, and insecticides.

Reported Canadian consumption of ground talc was 63 529 t in 1991, representing a decrease of 9.2% from 70 004 t in 1990. Pulp and paper consumed 41% of the reported 1991 talc consumption, while asphalt roofing consumed 27.8%, and paint, 8%. Industries such as ceramics, rubber, cosmetics, chemicals, refractories, fertilizers and gypsum products, consumed the remaining 23.2%. The consumption pattern in 1991, by user, was not significantly different from 1990.

Preliminary 1992 figures for Canadian shipments of talc, steatite and pyrophyllite showed a 6.3% increase from those of 1991. Shipments in 1992 totalled 122 111 t compared to 114 898 t in 1991. The average unit value, however, for the three commodities (talc, steatite and pyrophyllite) decreased by 4.5% from C$116/t in 1991 to C$110/t in 1992.

Imports of crushed or powdered talc for the first nine months of 1992 increased by 8.6% to 33 749 t from the 1991 level of 31 071 t, while exports decreased slightly by 1.9% from 25 628 t in 1991 to 25 137 t in 1992.

Talc is produced in Canada by three companies: Bakertalc Inc. located in Quebec; Canada Talc Limited located in Ontario; and Luzenac Inc., with a Quebec-based operation originally known as B.S.Q. Talc Inc. and an Ontario-based operation known for years as Steetley Talc Inc. There were no significant changes to production capacity during 1992 with overall capacity estimated at 150 000 t/y; processes and product lines remained almost unchanged. Pyrophyllite is produced in Newfoundland by one company, Armstrong World Industries Canada Ltd.

In 1992, world production of talc, steatite and pyrophyllite was 8.96 Mt, about the same as the revised figure of 8.93 Mt for 1991. China was the major-producing country at 2.3 Mt (26%), followed by Japan at 1.3 Mt (15%), and the United States at 1.07 Mt (12%); South Korea, India, and Brazil accounted for 1.89 Mt (21%). Production from Japan and South Korea was mainly for pyrophyllite. In North America, the production of pyrophyllite amounted to approximately 120 000 t in 1992.

The demand for talc in plastics is estimated to be growing between 4% and 5%/y, representing the fastest growing application of talc in North America. A greater demand for talc in the pulp and paper industry may be seen as a result of environmental pressures to recycle waste paper; specifically, the installation of de-inking machines should increase the need for talc. A survey carried out by Energy, Mines and Resources Canada (EMR) in 1988 showed that the Canadian pulp and paper industry will use 42 000 t of talc in the year 2000; such a demand corresponds to a growth of about 4%/y.

In contrast to North America, talc is used extensively as a paper-making pigment in Europe to

enhance the quality of paper. Since the technology is already in place, this area may represent an opportunity for Canadian producers. Domestic producers currently supply the pulp and paper industry with a talc utilized mainly as a pitch-control agent.

MINERALOGY AND GEOLOGY

Talc is a hydrous magnesium phyllosilicate represented by the chemical formula $Mg_3Si_4O_{10}(OH)_2$. Theoretically, the mineral is composed of 63.4% SiO_2, 31.9% MgO, and 4.8% H_2O. In nature, talc is usually intimately associated with numerous other minerals such as dolomite, calcite, quartz, and those of the serpentine and amphibole mineral groups. Its colour is characteristically pale green, grey or creamy white. It exhibits a pearly and greasy lustre and presents a soapy feel.

Talc is derived from the alteration (hydration) of non-aluminous magnesium silicate rocks in an intensive metamorphic environment. The most common host rocks for the formation of talc are dolomite and ultramafic rocks. However, talc can also be found associated with mafic igneous rocks and sedimentary rocks. The mineral occurs as veinlets, tabular bodies, or irregular lenses.

Steatite, or soapstone (the name used in earlier EMR mineral yearbooks), is a massive variety of talc containing varying quantities of mineral impurities such as chlorite, dolomite, calcite, quartz, and minerals from the serpentine and amphibole groups. Due to its chemical inertness and hydrophobic properties, steatite is known for its durability.

Pyrophyllite is a hydrous aluminum silicate with the chemical formula $Al_2Si_4O_{10}(OH)_2$. Theoretically, it is made up of 28.3% Al_2O_3, 66.7% SiO_2, and 5% H_2O. The mineral is formed by the hydrothermal alteration of acid igneous rocks, predominantly those that are andesitic to rhyolitic in composition. It occurs in low- and medium-grade metamorphic rocks rich in aluminum. Pyrophyllite's physical properties are practically identical to those of talc and, for this reason, it finds industrial uses similar to talc.

CANADIAN PROFILE

Consumption

Reported Canadian consumption of ground talc was 63 529 t in 1991, representing a decrease of 9.2% from 70 004 t in 1990. EMR's 1991 nonmetallic mineral consumption survey indicated that pulp and paper accounted for 41% of reported talc consumption, asphalt roofing for 27.8%, and paint for 8%. The remaining 23.2% was used by the ceramics, rubber, cosmetics, chemicals, refractories, fertilizers and gypsum products industries. The consumption pattern in 1991, by user, was not significantly different from 1990. Although the reported consumption of talc for 1992 is 63 529 t, the true consumption is probably closer to 90 000 t. Previous years' experience has shown that consumption reported to EMR represents approximately 80% of the total consumption.

Shipments

In 1992, reported Canadian shipments of talc, steatite and pyrophyllite increased 6.3% from 114 898 t in 1991 to about 122 111 t in 1992. The average unit value, however, for the three commodities (talc, steatite and pyrophyllite) decreased by 4.5% from C$116/t in 1991 to C$110/t in 1992. Producers' confidentiality is protected when calculating the average unit value by aggregating the values of all three mineral products (talc, steatite and pyrophyllite). Since these values vary considerably from each other, the reader should consider that changes in the average unit value from year to year may sometimes reflect variations in shipments of individual products and are not always indicative of a change in the unit value of talc.

Talc is currently produced in the provinces of Ontario and Quebec, and pyrophyllite is produced in the province of Newfoundland. Preliminary figures for 1992 showed, as indicated above, a slight increase in total shipments of talc and pyrophyllite from 1991 levels. This small change can be accounted for mainly by higher shipments of pyrophyllite in 1992.

The U.S. Bureau of Mines, in its 1991 global production figures, ranks Canada as the fourteenth largest talc, steatite and pyrophyllite producer in the world. In 1990, Canada ranked thirteenth, after Austria, for these commodities.

Trade

Imports of crushed or powdered talc, steatite and pyrophyllite for the first nine months of 1992 were 33 749 t, 149 t and 425 t respectively; for the same period in 1991, these figures were 31 071 t, 165 t and 467 t. This represents an increase in crushed or powdered talc of 8.6%, a decrease in steatite of 10.7%, and a decrease in pyrophyllite of 9.9%. The unit value of each commodity decreased between 1992 and 1991. For crushed or powdered talc, the value decreased by 3.2% from C$192/t to C$186/t; for steatite, the value decreased by 10.5% from C$163/t to C$148/t; and for pyrophyllite, the value decreased 13.5% from C$101/t to C$89/t. Talc imports for the first nine months of 1992 represent little change over those of 1991; all of the pyrophyllite and almost all of the talc came from the United States. Steatite imports, however, are now mainly from Brazil with the United States supplying less than 10%.

Exports of crushed or powdered talc for the first nine months of 1992 were 25 137 t. This represents a decrease of 1.9% or 491 t. Talc, as well as steatite and pyrophyllite, is exported almost exclusively to the United States.

Deposits

In 1992, there were three Canadian talc producers: Luzenac Inc. in Ontario and Quebec, Bakertalc Inc. in Quebec, and Canada Talc Limited in Ontario.

Luzenac Inc., now part of Luzenac America Inc., which in turn is owned by RTZ Corp. Plc., operates two mines, one in Ontario and one in Quebec. The Ontario property is an open-pit operation located in Penhorwood Township, 70 km southwest of Timmins. At that locality, talc occurs in talc-magnesite deposits derived from the alteration of ultramafic volcanic rocks. Ore, containing 35% talc, is processed by flotation and is fine-ground at a plant in Timmins to high-purity platy products such as fillers for the paint, paper, plastic, and rubber industries. Grades for the cosmetic and pulp industries are also produced. Current capacity at Luzenac's Ontario operation is 55 000-65 000 t/y, depending on product mix.

The Quebec property, also an open-pit operation, is located near St-Pierre-de-Broughton, where two deposits are mined from the Pennington dike in the Leeds and Thetford townships. A ground calcitic talc product containing about 70% talc is produced, which is used as a filler in joint cement, auto-body compounds and plastics, and as a dusting agent in asphalt roofing shingles and rubber products. Luzenac Inc. has applied its expertise to expand the Quebec plant to produce talc-carbonate and talc-chlorite products suitable for paint, flooring and plastics end uses. The Quebec operation is also involved, on a small scale, in the production of steatite refractory slabs and sculpture blocks. Current plant capacity for talc is about 40 000 t/y, but it can easily be expanded to 60 000 t/y should market demand warrant it.

Bakertalc Inc. produces talc and steatite from an underground operation at South Bolton, Quebec, 95 km southeast of Montréal. The ore is trucked 16 km south to the company's processing plant at Highwater where a high-quality talc grade is produced for use in the pulp and paper industry as well as dry-milled talc grades for use as industrial fillers in paints and plastics. Bakertalc Inc. is also a supplier of steatite slabs and blocks. The company is currently developing a deposit in the same area and reserves are believed to be larger than the existing reserves at South Bolton. The introduction of a pelletizer has improved product handling for use in the paper industry, and overall production capacity is estimated at approximately 18 000 t/y depending on product mix. St-Lawrence Chemical Inc. is the sole distributor of Bakertalc's products, and the proposed merger with International Larder Minerals Ltd. is on hold until the profitability of Bakertalc improves.

Canada Talc Limited operates both underground and open-pit talc-dolomite orebodies at Madoc, Ontario. The orebodies occur in crystalline dolomite where talc is of exceptional whiteness; mineral impurities consist mainly of sulphides, mica, and prismatic tremolite. The company produces both talc and dolomite from its orebodies; its present production capacity for talc is between 30 000 and 40 000 t/y. Dry-ground and micronized products are produced for various filler applications with the finer grades for the plastics industry. The company is presently involved in extensive discussions with potential investors for a significant cash input to develop the East Zone, which would require flotation to process the talc. Sales are approximately 80% to the United States and other international markets.

Commercial Industrial Minerals Limited (CIML) holds mining leases on a large talc-tremolite deposit near Robertsville, Ontario. The company operated for about five months in 1992 producing about 400 t of tremolite, valued at C$65 000, for use as a reinforcing filler in brake linings. The addition of a cage mill has enabled the company to produce a finer product without destroying the acicular nature of the tremolite. Ore reserves have been estimated at 2 Mt of tremolite and 0.35 Mt of talc.

Carey Canada Inc. has discovered a large, high-grade talc deposit located on farmland between the towns of Leeds Station and East Broughton, Quebec. Preliminary diamond drilling results in 1987 indicated about 8 Mt of ore grading 78%-80% talc; about one half would require no stripping, while the remaining 4 Mt would require limited stripping. The results of further drilling in 1990 to determine more precisely the morphology of the deposit and to obtain better estimates of ore reserves are still being evaluated. Laboratory and pilot plant testing through flotation and micronizing to produce a minus-2-micron high-grade talc product indicated recoveries of 85%-90% and showed no associated asbestos or tremolite.

Pacific Talc Ltd. owns a talc-magnesite deposit located 17 km north of North Bend in southwestern British Columbia with proven reserves of 1 Mt grading 60% talc and 30% magnesite with minor quantities of chlorite, carbonaceous and iron oxide minerals. Laboratory and pilot plant studies have demonstrated that high-quality paper-grade talc can be produced by flotation, and the company is planning commercial trials at five paper mills (three in British Columbia and two in the U.S. Pacific Northwest). A 150-t sample is being processed to produce about 45-50 t of high-grade talc. The project plans for an open-pit operation with ore being trucked 70-100 km to a processing plant near Langley, British Columbia. Production for the first year is forecast at 56 000 t, rising to 200 000 t in year three.

Highland Talc Ltd., which owns a talc-magnesite deposit in the same general area as Pacific Talc Ltd., has outlined reserves of 43 Mt grading 60%-65% talc. Development work planned for 1993 involves obtaining a 2500-t sample for processing in Finland. The beneficiated product will be used for paper mill trials and other product development. Highland Talc considers it worthwhile to process the sample in Finland because the company will be buying into technical development information.

Trifco Minerals Ltd. holds an interest in a talc deposit located 35 km east of Quesnel, British Columbia. Drilling at the Do-Do Creek peridotite talc deposit and the trenching of exposed new talc mineralizations have indicated reserves of 1 Mt grading about 70% talc. Dolomitic talc was also exposed in the area and reserves are estimated at 250 000 t grading 40% talc. There was no reported development in 1992.

A talc deposit located at Devil's Cove, Newfoundland, is held jointly by Noranda Exploration and Corona Corporation. Drilling and trenching have indicated a significant deposit estimated to contain several million tonnes. Initial testwork trials, however, have indicated that recovery of high-grade talc will be low. A joint venture is being pursued with International Larder Minerals.

Armstrong World Industries Canada Ltd. (Newfoundland Minerals Division) mines pyrophyllite from an open-pit operation near Manuels, 19 km southwest of St. John's, Newfoundland. Reserves are believed to be sufficient for 40 years at current production levels; production capacity is estimated at about 65 000 t/y. The ore is crushed, sized and hand-cobbed at the mine site to produce a pyrophyllite-quartz product, which is shipped to the United States where it is finely ground for use in high-quality ceramic tiles. Shipments were down in 1991 but were expected to increase in 1992. A minor quantity of some lower-grade pyrophyllite is also used in the local manufacture of joint cement, paint, and other products.

World Overview and Developments

In 1991, world production of talc, steatite and pyrophyllite, at 8.93 Mt, was down slightly by 1.7% from the revised 1990 figure of 9.08 Mt. Talc accounted for approximately 36% of production and pyrophyllite for 25%, with 33% as unspecified. Asia is responsible for about 60% of the world's production of talc, steatite and pyrophyllite, which is up by 20% from 1990 levels. Asia also accounts for the majority of world pyrophyllite production with 2 Mt in 1991; Japan's production was 1.23 Mt. Western Europe and North America are the second most important producers with about 14% each of world production of talc and pyrophyllite, followed by South America (7%) and the former Soviet Union (5%). The four leading producer countries of talc in the Western World are the United States with 1.04 Mt, India with 400 000 t, Finland with 375 000 t, and Brazil with 330 000 t. Pyrophyllite production is dominated by Japan with 1.23 Mt, followed by South Korea with 660 000 t, Brazil with 120 000 t, India with about 80 000 t, and the United States with an undisclosed amount. Canada's pyrophyllite production is about 35 000-45 000 t/y.

United States

U.S. production of talc decreased slightly by 3.2% from 1991 to 1992. Talc and steatite were produced in 8 states by 12 companies operating 19 mines. Pyrophyllite was produced by 2 companies operating 3 mines in North Carolina. The major talc-producing states, which accounted for 96% of domestic production, were Montana, New York, Texas, and Vermont.

In 1991, Cyprus Minerals Co. signed a letter of intent to sell its talc operations to RTZ Corporation PLC, London. The sale includes talc operations in Alabama, California, Montana, and Vermont. Pfizer Inc. completed its flotation mill at the Barretts, Montana, operation. The US$8.6 million expansion will permit the company to produce a higher-value talc product and extend the life of recoverable reserves.

The U.S. Bureau of Mines estimates sales of crude and processed talc and pyrophyllite were US$35 million, which represents a 4% increase over 1991 figures. U.S. apparent consumption increased 2% in 1992, and exports rose 5% from 1991 levels. Major consumers of ground talc were the construction industry with applications in ceramic tiles, sanitary ware, joint compounds, paint, plastics, and roofing. End-use distribution consisted of ceramics (31%), paint (17%), paper (16%), roofing (11%), plastics (6%), cosmetics (5%), and insecticides, refractories, rubber, and other end uses (14%).

Pyrophyllite production figures have been withheld since 1991, but the U.S. Bureau of Mines reports that pyrophyllite production decreased by 8% from 1991 levels. Consumption of pyrophyllite was in ceramics, refractories, and insecticides. Minor amounts are used in paint, plastics, rubber, and other industries.

USES AND SPECIFICATIONS

Talc is an extremely versatile mineral which is used primarily in a fine-ground state. Steatite is essentially used in massive or block form. There are many industrial applications of ground talc, although fewer than a dozen countries use talc on a major scale.

In pulp and paper, the softness, chemical inertness, high reflectance, hydrophobic and organophilic properties, and the particle shape of talc are characteristics that permit its use as a pitch-control agent, as a paper filler, and as a coating pigment. For filler applications, maximum particle size should generally not exceed 20 microns, although 40-micron grades are also used for some applications. As a coater, talc particle size must not exceed 10 microns; as a pitch-control agent, it should be as close to 1 micron as possible.

In ceramics, finely ground talc is used 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. The average particle size for talc used in most ceramics must range between 6 and 14 microns, with 90%-98% of the material passing through a 325-mesh screen.

In plastics, talc improves dimensional stability, chemical and heat resistance, impact and tensile strength, and electrical and insulation properties. Talc is used in both thermoplastics and thermosets, primarily 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. The mineral must be free of iron impurities and grits, and the average particle size must be less than 8 microns.

In paints, high-quality talc is used as a pigment extender. A low carbonate content, a near-white colour, a fine particle size with controlled size distribution, and a specific oil absorption are required properties. However, due to the large variety of paints, precise specifications for talc pigments are often agreed upon between consumers and suppliers. Paint characteristics which influence the use of talc as a pigment extender are gloss, adhesion, flow, hardness, and hiding power.

In pharmaceuticals, high-purity talc is used in preparations and cosmetics, mainly because of its softness, its hydrophobic property, and its chemical inertness. When it is finely ground, high-purity talc can be used as a filler in tablets and as an additive in medical pastes, creams and soaps.

In construction, 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 and auto-body patching compounds, and as a carrier for insecticides. Other applications include cleaning compounds, polishes, electric cable coatings, foundry facings, adhesives, and linoleum backings.

Steatite, which can be cut, sawn and easily carved, is used mainly in sculpturing. However, the material can also be used as refractory bricks or blocks and, because of its softness and resistance to heat, as marking crayons for metal workers.

Pyrophyllite can be ground and used in much the same way as talc. In ceramics, it imparts a very low co-efficient of thermal expansion to tiles. For that application, the product must be ground to minus 45 microns and must contain minimal amounts of quartz and sericite impurities. Because of its much lower heating shrinkage than fire clays and its ability to maintain its strength after heating, pyrophyllite is also used by the refractory industry. Foliated or micaceous varieties are used as fillers.

PRICES

Canadian talc prices varied according to the degree of processing. In 1992, prices ranged from C$50 to

$300/t and, based on estimates, the 1992 unit value for domestic processed talc increased by 2.6% to C$138/t over 1991 levels. This increase can be accounted for by better prices for the pulp and paper-grade talc. The unit value of imported processed talc for the first nine months of 1992 decreased slightly by 3.1% from C$192/t in 1991 to C$186/t in 1992. The unit value of exported processed talc for the first nine months of 1992, however, increased slightly by 5.8% from C$196/t in 1991 to C$208/t in 1992.

Pyrophyllite experienced an 8% price decrease in 1992. Prices for that commodity are now in the C$35-45 range.

OUTLOOK

During 1992 there was a 6.3% increase in Canadian talc production, which is an indication that the talc industry is emerging from the recession. Shipments of talc to the manufacturing industries (e.g., automobile and construction) have stabilized and should improve with an improvement in the economy. In the long term, growth is expected to be highest in the plastics industry. The pulp and paper sector, where recycling is becoming increasingly important to protect the environment, will also use larger volumes of talc in the coming years. In that area, talc will be required in the de-inking process.

In 1988, EMR conducted a survey of the pulp and paper industry. Results showed that Canadian consumption of 42 000 t of talc is expected in the year 2000. This figure corresponds to an annual growth of around 4%.

Note: Information in this review was current as of February 1, 1993.

PRICES

Talc, f.o.b. mine, bagged, carload lots

	(US$/short ton)
New York	
Ground	90.00
99.5%, 325 mesh	100-110.00
99.5%, 400 mesh, micronized	165
Vermont	
Ground, off-colour	136.00
Talc	
Norwegian, ground (ex-store) United Kingdom	£140-150
Norwegian, micronized (ex-store) United Kingdom	£165-220
French, fine ground c.i.f.	£120-190
Finnish, micronized c.i.f.	£140-200
Italian, cosmetic, c.i.f.	£175
Chinese, normal, ex-store United Kingdom, 200 mesh	£144
Chinese, normal, ex-store United Kingdom, 325 mesh	£155
New York, U.S.A. ex-works	
Paint, 200 mesh	100
Paint, 400 mesh	180
Ceramics, 200 mesh	83
Ceramics, 325 mesh	92
Pyrophyllite	
Australian, bulk, ex-store	
Refractory grade	25-35
Ceramic and filler grades	35-45
United States, min. 20 ton lot, for export, f.o.b.	80-92

Sources: Chemical Marketing Reporter, December 24, 1990; Industrial Minerals, January 1993.
c.i.f. Cost, insurance and freight; f.o.b. Free on board.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
25.26	Natural steatite, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape; talc				
2526.10	Not crushed, not powdered	9.2%	6%	Free	Free
2626.10.00.10	Natural steatite				
2526.10.00.20	Talc				
2526.20	Crushed or powdered				
2526.20.10	Talc of particle size not exceeding 20 microns	4%	Free	Free	0.4%
2526.20.90	Other	9.2%	6%	Free	0.4%
2530.90.40	Pyrophyllite	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992.

TABLE 1. CANADA, TALC, STEATITE AND PYROPHYLLITE SHIPMENTS AND TRADE, 1991 AND 1992; AND CONSUMPTION, 1989-91

Item No.		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)
TOTAL SHIPMENTS (talc, steatite and pyrophyllite)		114 898	13 278	122 111	13 481
IMPORTS				**(Jan.-Sept.)**	
2526.10.00.10	Natural steatite, not crushed, not powdered				
	Brazil	28	2	136	14
	United States	22	13	13	7
	People's Republic of China	227	22	–	–
	Total	277	39	149	22
2526.10.00.20	Talc, not crushed, not powdered				
	United States	2 166	211	1 517	193
	France	10	7	2	1
	People's Republic of China	186	29	–	–
	Total	2 362	248	1 519	195
2526.20.10.00	Talc of a particle size not exceeding 20 microns, crushed or powdered				
	United States	26 168	5 022	20 209	3 955
	Japan	24	8	43	9
	People's Republic of China	–	–	6	4
	United Kingdom	6	. .	2	1
	Total	26 198	5 031	20 260	3 970
2526.20.90.00	Other natural talc, crushed or powdered				
	United States	14 938	2 569	13 428	2 297
	Japan	60	15	47	13
	People's Republic of China	21	16	8	6
	United Kingdom	511	339	6	4
	Other countries	5	3	–	–
	Total	15 535	2 944	13 489	2 321
2530.90.40.00	Pyrophyllite				
	United States	624	66	425	38
	Total	624	66	425	38
EXPORTS					
2526.10.00	Natural talc, not crushed, not powdered				
	United States	19	14	56	11
	Total	19	14	56	11
2526.20.00	Natural talc, crushed or powdered				
	United States	33 709	6 513	24 779	5 068
	France	19	11	292	128
	Germany	79	28	28	17
	United Kingdom	103	41	38	16
	Other countries	88	21	–	–
	Total	33 998	6 616	25 137	5 231

		1989	1990	1991p
			(tonnes)	
REPORTED CONSUMPTION[1] (ground talc, available data)				
	Pulp and paper and paper products	27 670	27 887	26 012
	Asphalt roofing products	24 167	20 171	17 637
	Paint and varnish	6 538	5 341	5 092
	Ceramic products	4 118	4 487	3 588
	Rubber products	2 318	2 676	2 452
	Toilet preparations	1 560	1 457	1 573
	Other products[2]	6 076	7 985	7 175
	Total	72 447	70 004	63 529

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available or not applicable; p Preliminary.
[1] Reported from EMR survey on the consumption of nonmetallic minerals by Canadian manufacturing plants. [2] Chemicals, gypsum products, refractory brick, rubber products and other miscellaneous uses.
Note: Figures may not add to totals due to rounding.

TABLE 2. CANADA, TALC STEATITE AND PYROPHYLLITE SHIPMENTS, 1970, 1975, 1980, 1985, AND 1990-92

	Tonnes
1970	65 367
1975	66 029
1980	91 848
1985	126 860
1990	130 861
1991	114 898
1992p	122 111

Source: Energy, Mines and Resources Canada.
p Preliminary.

TABLE 3. CANADA, TALC IMPORTS AND EXPORTS, 1982-91

	Imports	Exports to United States
	(tonnes)	
1982	33 895	9 550
1983	34 808	16 345
1984	38 117	22 512
1985	40 466	26 912
1986	38 745	33 997
1987	48 595	35 232
1988	37 027	~~42 472~~ 44501
1989	48 017	46 808
1990	43 739r	39 808r
1991	44 095	33 728

Sources: Statistics Canada; U.S. Bureau of Mines, Minerals Yearbook for Export data 1982 to 1989.
r Revised.

TABLE 4. WORLD PRODUCTION OF TALC, STEATITE AND PYROPHYLLITE, 1987-91

	1987[r]	1988[r]	1989[r]	1990[r]	1991[e]
			(000 t)		
Japan[1,2,3]	1 297	1 294	1 289	1 275	1 295
United States[1,3]	1 163	1 237	1 252	1 267	1 037[w]
People's Republic of China	1 700	1 900	2 100	2 200	2 300
Republic of Korea[1,3]	852	820	932	839	840
U.S.S.R.[e]	530	530	530	500	450
India[2,3]	410	482	512	470	480
Brazil[1,3,4]	581	561	715	570	570
Finland[1]	324	379	398	385	375
France[1]	330	320	330	284	300
Australia[1,3]	212	205	200	205	216
North Korea[e]	170	170	170	170	170
Italy[1,2]	151	159	146	159	159
Canada[1,2,3]	136	146	145	137	115
Norway[1]	100	100	100	100	100
Austria[2]	130	133	135	134	133
Other countries	403	417	405	389	308
Total	8 489	8 853	9 359	9 084	8 848

Sources: Energy, Mines and Resources Canada; U.S. Bureau of Mines, Talc and Pyrophyllite 1991.
[e] Estimated; [r] Revised; w Pyrophyllite withheld.
[1] Talc. [2] Steatite. [3] Pyrophyllite. [4] Algomatolite.

Tin

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World tin mine production was estimated to be about 177 000 t in 1992, a slight decrease from the 1991 total of 179 200 t. Tin metal production was expected to be about 180 000 t, down from 196 000 t in 1991. World consumption of refined tin was estimated to be slightly less than the 212 400 t of 1991. The decrease in tin metal production due to shortages of tin concentrates more than offset weaker demand and, as a consequence, tin stocks fell further during the year. The price of tin averaged US$2.55/lb on the London Metal Exchange (LME), compared to $2.54/lb in 1991.

The Association of Tin Producing Countries (ATPC) agreed to decrease its export quotas by member countries by over 8% from 1991 levels. Meanwhile, the U.S. Defense Logistics Agency (DLA) sold almost 8700 t of tin from its stockpile in fiscal year 1992. In September, the U.S. Senate authorized the DLA to increase sales to 12 000 t in fiscal year 1993, adding to the concerns of tin producers that increased sales would adversely affect tin markets.

Canadian Developments

Canada ceased being a producer of tin concentrates in 1992 with the closure of Rio Algom Ltd.'s East Kemptville mine in Nova Scotia on January 3, 1992. The mine produced 4400 t of tin in concentrate in 1991, which was shipped to smelters in Malaysia.

Reclamation at the site of the 9000-t/d open-pit mine was put on hold and the mine and concentrator were placed on care and maintenance pending the outcome of proposals by other parties to re-open the operation.

Canadian consumption is expected to have been similar in 1992 to the 3100 t consumed in 1991.

World Developments

Decreased production from Brazil's Bom Futuro tin mine, due to legal disputes and declining grades, has been responsible for that country falling from first place in world tin mine production in recent years. In 1991, Brazil was third behind China and Indonesia, although production in both these countries also declined from 1990 totals. These trends continued in 1992.

Malaysia remained the world's largest producer of tin metal in 1992. Although outputs have continually declined due to world shortages of tin concentrates, the same has occurred with other major producers.

Brazil

Brazilian tin production declined in 1992 for the third consecutive year. Decreasing production from the Bom Futuro mine in Rondonia State was the major cause. Production at Bom Futuro was estimated to be 8000 t of tin in concentrates in 1992, compared to 10 000 t in 1991 and 17 000 t in 1990.

Legal disputes between Eseba, a consortium of Brazilian tin mining companies led by state-owned Paranapenema SA, and Cogari, a cooperative of independent "garimpeiros" miners, took place throughout 1992 for control of Bom Futuro. Eseba obtained the right to mine at Bom Futuro in June. However, mining by the garimpeiros continued and, in September, Cogari obtained an injunction to temporarily suspend extraction of tin at the mine. Due to questions about the validity of the injunction and the lack of law enforcement at the site, both parties continued to extract tin at Bom Futuro.

Meanwhile, tin concentrates continued to be smuggled into neighbouring Bolivia despite the confiscation of some of the material by Brazilian police. Bolivian smelters have been under-utilized in recent years due to the closure of high-cost domestic underground mine capacity.

Brazil produced 29 500 t of refined tin in 1991, ranking third behind Malaysia and Indonesia.

China

China has become an increasingly important producer of tin in recent years. In 1991, China ranked first in the world in tin mine production with 33 700 t of tin in concentrate, and fourth in metal production with 26 600 t.

Tin deposits in the country are an extension of those in Southeast Asia and are concentrated in the provinces of Yunnan, Guangxi, Guangdong, Jiangxi and Hunan, and on the island of Hainan. According to the China National Nonferrous Metals Industry Corp., between 40% and 60% of China's tin reserves remain unexploited.

Indonesia

Indonesia produced 30 100 t of tin in concentrates in 1991. Production in 1992 is expected to be lower due to the restructuring of the Indonesian tin industry, which began in 1990 in response to low world tin prices.

PT Tambang Timah began producing low-lead tin after purchasing a crystallizer from China. The low-lead material contains less than 0.01% lead and is used primarily in the production of tinplate. The company operates Indonesia's only tin smelter, which has a capacity of 38 500 t/y of refined tin. In 1991, Indonesia produced 30 400 t of refined tin.

Malaysia

Malaysian mine production continued to decline in 1992. Production fell by 32% during the first 11 months of the year compared to the same period in 1991. This marks the third consecutive year of decline. In 1991, Malaysia produced 20 700 t of tin in concentrate. Some Malaysian tin mining companies indicated that, due to rising domestic mining costs, they would begin using their expertise to develop tin deposits abroad.

Faced with decreasing grades, high operating costs and low tin prices, the number of tin mining operations in Malaysia continued to diminish. An exception was the re-opening in May of the Sungei Lembing mine, which was brought back on stream by a Chinese-Malaysian partnership.

Imports of tin concentrates increased in 1992 as the country's two tin smelters relied to a greater degree on foreign feed sources. Malaysia remained the world's leading producer of refined tin in 1991, producing 42 700 t. The two tin smelters, operated by Datuk Keramat Holdings Bhd. and Malaysia Smelting Corp. Bhd., have a combined capacity of 120 000 t/y of refined tin.

Bolivia

The Bolivian state-owned mining company, Corporacion Minera de Bolivia (Comibol), continued a workforce reduction program in order to reduce costs. The Bolivian government has opened Comibol's mining enterprises to outside participation through joint ventures and leases. The firm signed a lease arrangement whereby Paranapanema of Brazil can reprocess tailings grading 0.3% tin at the Catavi mining complex in Bolivia beginning in September 1993. Paranapanema will contract with local smelters to treat the cassiterite concentrate. Bolivian mines produced 16 700 t of tin in concentrate in 1992, down from 16 800 t in 1991.

Bolivia's state-owned smelting company, Empresa Nacional de Fundiciones (ENAF), signed a toll smelting agreement with Peruvian company Minsur for the treatment of 3600 t of concentrate at ENAF smelters, which have excess capacity. Bolivia produced 14 700 t of refined tin in 1991.

Thailand

Billiton BV's Thaisarco subsidiary, Thailand's major tin smelting company, commenced a two-year US$1.7 million offshore tin exploration program. The program is an attempt to confirm tin reserves beneath the Andaman Sea off Thailand's west coast. The company's Phuket smelter, which has a capacity of 38 000 t/y of refined tin, has experienced shortages of concentrate feed in recent years. Thailand produced 10 900 t of tin in concentrates in 1991.

Meanwhile, Thai Pioneer Enterprises re-opened its Pathum Thani smelter which had been idle for 10 years. The plant, currently operating at 10% of its 5000-t/y capacity of refined tin, is producing tin of 99.9% purity. The plant will utilize higher grade concentrates, mostly of domestic origin. Thailand produced 11 300 t of refined tin in 1991.

Commonwealth of Independent States

Hyundai Resources Development Co. announced plans for a joint venture with a Russian firm to develop the Pravouny tin deposit near Khabarovsk in far-eastern Russia. The deposit, estimated to contain 50 Mt of ore, could support an annual production of 5000 t of tin in concentrate. A number of smelting sites in Southeast Asia and Russia are being considered. Estimated production of tin in concentrates by the C.I.S. in 1991 was 11 000 t.

Tin smelters in the C.I.S. have been operating at well below capacity in recent years due to shortages of concentrates. Although tin-smelting capacity is currently in excess of 35 000 t, the C.I.S. only produced 12 000 t of refined tin in 1991. Recently, Russian tin smelters, like the Novosibirsk Integrated Tin Works in south-central Russia, have been seeking contacts with Western World firms for sources of feed.

United States

The U.S. Senate passed the 1992 Defense Authorization Bill in September authorizing the U.S. DLA to sell 12 000 t of tin from its stockpile in fiscal year 1993, which began October 1, 1992. No timetable was set for the complete liquidation of the stockpile but the Defense Department recommended a five-year period. Several tin-producing countries have criticized the authorized sales as excessive considering current weak tin markets and prices. The DLA sold almost 8700 t of tin from its stockpile in fiscal year 1992.

MIDCO Inc. announced the start-up of its 3000-t/y secondary tin smelter in Missouri. Prior to 1992, MIDCO had been producing tin-lead solder at the facility.

Portugal

Despite lower-than-expected third-quarter output at the Neves-Corvo copper-tin mine of Sociedad Minera de Neves-Corvo (Somincor), production for 1992 was forecast to be 3200 t of tin in concentrate compared to 2000 t in 1991. Somincor has indicated that output in 1993 is expected to increase again to about 6500-7000 t of contained tin. Tin is a by-product of copper mining at Neves-Corvo and tin production is more sensitive to copper prices than to those of tin.

The company also continued its upgrading program aimed at improving the grade of concentrates from its flotation and gravity circuits. Neves-Corvo produces low-, medium- and high-grade tin concentrates.

Other Countries

Lucky Metals Corp. decided to close its 1500-t/y Changhang tin smelter in South Korea. The company indicated low tin prices and difficulty in obtaining concentrates as reasons for the closure. The smelter had been producing about 1000 t/y of refined tin from concentrates sourced mainly from China. The recent opening of Mainland Metals Co.'s tin smelter in Hong Kong, which also obtains source feed from China, had compounded Lucky Metals' source problem.

In Germany, Metallgesellschaft AG announced a planned reduction of 40% in output from its secondary lead-tin smelter due to high tin scrap prices. The smelter produces about 2000 t/y of tin metal.

Carnon Holdings Ltd. plans to develop two new levels at its South Crofty underground tin mine in Cornwall. The development plan also includes refurbishing the South Crofty mill. The program will be carried out over the next five years.

In South Africa, Rooiberg Tin Ltd. announced that it would close part of its tin mining operations and concentrate on higher-grade ore reserves. The decision was taken in light of continuing low tin prices.

RECYCLING

Before 1987, all beverage cans in Canada were made from tinplated steel. In that year, manufacturers began switching to aluminum due to lower material costs and more efficient recycling processes (according to the Steel Can Recycling Institute, the recycling rate in the United States for aluminum cans in 1991 was 62% compared to 46% for steel cans). Aluminum cans also have a higher recycle value than steel cans. However, the production costs for tin cans in recent years have been lower than for aluminum. Steel cans are physically easier to recycle, and the steel does not require detinning when reintroduced into the furnace. Also, the top and bottom sections of the can provide the aluminum that steelmakers use to remove oxygen. In Ontario, the use of tinplated steel in the soft-drink can market has risen from 35% in 1989 to about 90% in 1991.

Efforts have been made in several countries to increase the recyclability of steel cans. Recently, three large steelmakers announced a joint cooperative effort to make tinplate more competitive with aluminum for cans. Usinor Sacilor of France, Nippon Steel Corporation of Japan, and Weirton Steel Corp. of the United States hope to improve the recycling process for steel cans and develop a thinner gauge steel for tinplate. In South Africa, a consortium of companies, which includes Iscor Ltd.

and Crown Cork & Seal Corp., have organized a recycling program which has a five-year goal of reaching a 50% recycling rate for South Africa's 100 000-t/y production of tin cans.

International Organizations

The Association of Tin Producing Countries

The Association of Tin Producing Countries (ATPC) is an organization consisting of seven tin-producing states: Malaysia, Indonesia, Thailand, Bolivia, Australia, Zaire and Nigeria. In 1991, ATPC countries represented only 47% of total world tin mine production. China and Brazil are not members of the ATPC.

The ATPC began a supply rationalization scheme in March 1987. Its objective was to accelerate the absorption of the huge tin inventories caused by the cessation of the International Tin Council buffer stock operations and to prevent further price declines. The program involved the establishment of yearly export quotas among its members. Brazil, although not a member of the ATPC, has cooperated in recent years in limiting its exports of tin.

Since the formation of the supply rationalization scheme, stock levels have dropped from 73 000 t to an estimated 27 000 t at the end of 1992. The ATPC considers 20 000 t to be a normal stock level for tin. In September, the ATPC agreed to increase 1993 exports by member countries to 89 400 t from the 1992 total of 87 100 t. Brazil and China have agreed to limit exports to 24 000 t and 15 000 t, respectively. The ATPC has also indicated that export quotas will likely be lifted by 1994 as weak prices are forcing member nations to produce less tin.

Research Organizations

The International Tin Research Institute (ITRI) 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 five of the major tin-producing countries: Indonesia, Malaysia, Nigeria, Thailand and Zaire. Its headquarters and laboratories are in Uxbridge, England. In early January 1992, the ITRI closed five of its seven information centres to reduce costs. The centres in Belgium and the United States were retained. In October, the ITRI established the International Tin Research Association, a commercial arm that will allow tin consumers to have greater access to its research and technical resources.

The South-East Asian 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, 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 laboratory are located in Ipoh, Malaysia. In addition to the work being conducted in the laboratory, field projects are maintained in various member countries in Southeast Asia. The centre is financed by equal contributions from member countries.

Uses

Solder recently surpassed tinplate as the largest market for tin and currently represents approximately 31% of tin consumption. In Canada, it accounted for over 53% of tin consumption in 1990. Strong growth in the electronics industry, which accounts for over 50% of tin used in solders, has provided a new impetus for tin use. The amount of tin in solder depends on the application, with the average being 30%-70%. In tin-lead solders, tin is the active metal forming the bond with the metals being joined. The lead serves to lower the melting point of the solder. For higher temperature applications, alloys of high tin content (above 95% tin) are often used. The tin is alloyed with small amounts of antimony or silver.

Metals such as bismuth or indium may be added to tin-based solders to lower the melting point. Such solders are known as fusible alloys. A recently developed use for fusible alloys is in the manufacture of plastic components with complex internal structures for use in the automotive and aerospace industries. These components are made using a casting of tin-bismuth or tin-lead-antimony alloy which can then be melted away without damaging the delicate internal configuration of the plastic part.

Tinplate is the second most important use and accounts for about 30% of world tin metal consumption. Tinplate use in the canning industry has been under severe competitive pressures from aluminum, except for large containers where, due to rigidity problems with aluminum, tin-plated steel is still preferred. Also, thinner tin coatings on food and beverage cans have reduced the consumption of tin. Tinplate competition also comes from non-tin-coated steels, polymer-coated steel, and tin-free steel (TFS). TFS is steel plate which is electrolytically coated with a thin layer of metallic chrome and chrome oxide.

Tin consumption for tinplating is expected to change only marginally in the near future. Although the use of tin-plated steel in the canning market will increase with more efficient recycling programs, thinner tin coatings will be necessary in order to keep tinplated steel cost-competitive with aluminum.

The fastest growing new use for tin has been in chemical applications. Tin is used in an array of inorganic and organic chemicals, for application as plastic (polyvinyl chloride) stabilizers, agricultural pesticides, anti-fouling paints for ships, and biocidal compounds for the protection of materials such as paints, textiles and building materials. Recent research has shown the effectiveness of tin-based compounds as flame and smoke inhibitors. As fire retardants, these compounds are non-toxic, safe and easy to handle, and have a wide range of applications.

Tin is also used for tinning (which includes electronic uses, hot dipping and electroplating in the electronics industry), in the manufacture of pewterware, and in bronze, brass and other tin-containing alloys. Tin-containing alloys are used in construction, machinery and equipment, and consumer durables. Tin-zinc alloys are known for their corrosion resistance. A recently developed and commercialized tin-nickel alloy electroplating process has led to coatings that are characterized by their hardness, good lubricating qualities and attractive appearance.

The use of tin capsules for sealing wines represents a promising new market for tin. A recent ban on tin-lead capsules for wine in European Community countries has led to the successful introduction of tin capsules in wine bottling. Tin is ideal for this purpose because it is non-toxic, is easily adapted to existing capping technology, forms an attractive, high-quality product, and can be easily and safely opened. The International Tin Research Institute estimates that the potential market for this application could be 10 000 t/y of tin.

World tin consumption is estimated at 212 000 t in 1992 compared to 212 400 t in 1991.

PRICES AND STOCKS

Tin prices rose throughout the first half of 1992 from a 65-month low in January of US$2.49/lb. The price was buoyed by speculative buying and a slowdown in smelter deliveries due to the scarcity of high-grade tin concentrates. The price of tin reached its high for the year at $3.28/lb on July 1.

With poor physical demand persisting and the confirmation that the U.S. DLA would increase its stockpile disposal limit to 12 000 t in fiscal year 1993, prices fell throughout the autumn. Tin ended the year at $2.63/lb and averaged $2.55/lb.

Even with demand at a similar level to 1991, tin stocks continued to fall in 1992. Estimated tin stocks stood at 27 000 t at the end of 1992 compared to 39 000 t at the beginning of the year.

OUTLOOK

A further loss of mine capacity took place in 1992 due to rising costs and continuing low tin prices. As a result, several tin smelters are expected to continue experiencing shortages of tin concentrates in 1993 and to operate at well below capacity. As a result of reduced supply and an expected increase in demand from an improving world economy in late 1993, stock levels are forecast to fall further despite increased sales of stockpiled tin from the U.S. DLA.

Tin prices are forecast to increase in 1993 due to the improved supply/demand situation and to average US$2.75/lb for the year.

Chemical uses and the substitution of tin for lead in solders and packaging materials will continue to be the most promising areas for increased tin usage. However, the consumption of tinplate is likely to continue its decline of recent years. Efforts to increase the recyclability of tin-plated steel cans to capture a larger share of this market from aluminum are likely to be at least partially offset by the use of thinner tin coatings or alternate materials.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
2609.00	Tin ores and concentrates	Free	Free	Free	Free	Free	Free
7204.30	Waste and scrap of tinned iron or steel	Free	Free	Free	Free	Free	Free
8001.10	Tin, not alloyed	Free	Free	Free	Free	Free	Free
8001.20	Tin alloys						
8001.20.10	Tin-antimony alloys	Free	Free	Free	Free	Free	3.2%
8001.20.20	Tin-lead-antimony alloys	6.8%	Free	Free	Free	Free	3.2%
8001.20.90	Other	10.2%	6.5%	Free	Free	Free	3.2%
8002.00	Tin waste and scrap	Free	Free	Free	Free	Free	Free
8003.00	Tin bars, rods, profiles and wire						
8003.00.10	Bars and rods, not alloyed or of tin-antimony alloys	Free	Free	Free	0.8%	3.2%	3.7%
8003.00.10.10	Not alloyed	Free	Free	Free	0.8%	3.2%	3.7%
8003.00.30	Bars and rods, of phosphor-tin alloys	5.5%	3.5%	Free	0.8%	3.2%	3.7%
8003.00.50	Bars and rods, of other alloys; profiles; other wire	10.2%	6.5%	Free	0.8%	3.2%	3.7%
8004.00	Tin plates, sheets and strip, of a thickness exceeding 0.2 mm						
8004.00.10	Of tin-lead-antimony alloys	6.8%	Free	Free	0.4%	2.5%	3.7%
8004.00.20	Of phosphor-tin alloys	5.5%	3.5%	Free	0.4%	2.5%	3.7%
8004.00.90	Other	10.2%	6.5%	Free	0.4%	2.5%	3.7%
8004.00.90.10	Not alloyed	10.2%	6.5%	Free	0.4%	2.5%	3.7%
8004.00.90.20	Of tin-antimony alloys	10.2%	6.5%	Free	0.4%	2.5%	3.7%
8004.00.90.90	Other	10.2%	6.5%	Free	0.4%	2.5%	3.7%
8005.20	Powders and flakes						
8005.20.10	Powders, not alloyed	4%	Free	Free	0.8%	2.9%	4.9%
8005.20.20	Alloyed powders, flakes	10.2%	6.5%	Free	0.8%	2.9%	4.9%
8006.00	Tin tubes, pipes and tube or pipe fittings (i.e., couplings, elbows, sleeves)	10.2%	6.5%	Free	0.4%	4.5%	4.9%
8007.00	Other articles of tin	10.2%	6.5%	5.1%	1.8%-2.5%	5.3%	5.8%
8007.00.00.10	Anodes for electroplating	10.2%	6.5%	5.1%	1.8%-2.5%	5.3%	5.8%

Sources: Customs Tariffs, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992; Official Journal of the European Communities, Vol. 35, No. L268, 1992, "Conventional" column; Custom Tariff Schedules of Japan, 1992.

[1] GATT rate is shown; lower tariff rates may apply circumstantially.

Note: Where there is a tariff "range," a complete match of the HS code was not available; therefore, the high and low for the product in question is shown.

TABLE 1. CANADA, TIN PRODUCTION AND TRADE, 1991 AND 1992, AND CONSUMPTION, 1990 AND 1991

Item No.		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)
PRODUCTION					
	Tin content of tin concentrates and lead-tin alloys	4 392	25 241	–	–
EXPORTS				**(Jan.-Sept)**	
2609.00	Tin ores and concentrates				
	Malaysia	3 508	21 734	401	2 654
	Mexico	199	1 155	–	–
	United Kingdom	9	57	–	–
	Total	3 716	22 946	401	2 654
7204.30	Waste and scrap of tinned iron or steel				
	United States	1 438	827	3 042	753
	Other countries	209	72	–	–
	Total	1 647	899	3 042	753
8001.10	Tin, not alloyed, unwrought				
	United States	15	114	40	296
	Other countries	2	7	–	–
	Total	17	121	40	296
8001.20	Tin alloys, unwrought				
	United States	429	2 668	307	2 138
	Total	429	2 668	307	2 138
8002.00	Tin waste and scrap				
	United States	312	421	193	349
	Other countries	148	68	154	61
	Total	460	489	347	410
8003.00	Tin bars, rods, profiles and wire				
	United States	182	1 026	241	1 310
	Total	182	1 026	241	1 310
8004.00	Tin plates, sheets and strip, of a thickness exceeding 0.2 mm				
	United States	61	90	12	22
	Bangladesh	–	–	59	38
	Total	61	90	71	60
8005.20	Tin powders and flakes				
	South Korea	3	86	1	28
	Other countries	–	–	...	6
	Total	3	86	1	34
8007.00	Tin articles n.e.s.				
	United States	..	2 640	..	2 282
	Other countries	..	1 058	..	817
	Total	..	3 698	..	3 099

TABLE 1 (cont'd)

Item No.		1991		Jan.-Sept. 1992p	
		(tonnes)	($000)	(tonnes)	($000)
IMPORTS					
2609.00	Tin ores and concentrates	. . .	3	. . .	2
7204.30	Waste and scrap of tinned iron or steel	3 513	410	4 875	449
8001.10	Tin, not alloyed, unwrought	3 176	20 962	2 444	17 899
8001.20.10	Tin-antimony alloys	94	693	111	816
8001.20.20	Tin-lead-antimony alloys	15	120	9	73
8001.20.90	Other tin alloys	52	417	122	1 025
8003.00.10.10	Bars and rods, not alloyed	3	28	3	25
8003.00.50	Bars and rods, of other alloys; profiles; other wire	29	279	24	223
8004.00	Tin plates, sheets and strip, of a thickness exceeding 0.2 mm	45	325	21	221
8005.20.10	Powders, not alloyed	8	81	3	25
8005.20.20	Alloyed powders, flakes	2	37	8	142
8006.00	Tin tubes, pipes and tube or pipe fittings	15	170	9	95
8007.00.00.10	Other articles of tin, anodes for electro-plating	7	64	4	46

		1990	1991
		(tonnes)	
CONSUMPTION[1]			
	Tinplate and tinning	1 384	1 297
	Solder	1 918	1 598
	Babbit	96	97
	Bronze	106	69
	Other uses (including collapsible containers, foil, etc.)	96	85
	Total	3 600	3 146

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available or not applicable; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified;
p Preliminary; r Revised.
1 Available data as reported by consumers.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, TIN PRODUCTION, TRADE[1] AND CONSUMPTION, 1975, 1980, AND 1985-92

	Production[2]	Exports[3]	Imports[4]	Consumption[5]
		(tonnes)		
1975	319	1 052	4 487	4 315
1980	243	883	4 527	4 517
1985	119	358	3 696	3 511
1986	2 356	3 727	3 925	3 270
1987	3 388	2 778	3 792	3 780
1988	3 787	3 591	4 008	3 489
1989	3 479	2 790	3 862	3 567
1990	3 844	2 828	3 624	3 600
1991	4 392	3 716	3 176	3 146
1992p	–	401a	2 444a	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available; p Preliminary.
a Exports and imports are January-September figures.
1 Beginning in 1988, exports and imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. 2 Tin content of tin concentrates shipped plus tin content in lead-tin alloys produced. 3 Tin in ores and concentrates (HS class 2609.00). 4 Tin metal (HS class 8001.10).
5 Available data as reported by consumers; current coverage exceeds 90% whereas, until 1972, coverage was in the order of 80%-85%.

TABLE 3. WORLD TIN PRODUCTION, CONSUMPTION AND PRICES, 1984-92

	Production			Prices[2]	
	Tin in Concentrates	Metal[1]	Consumption	LME[3]	N.Y. Dealer
		(000 t)			(US$/lb)
1984	206	213	216	5.56	5.67
1985	197	213	216	5.57	5.25
1986	188	201	229	2.87	2.94
1987	186	203	229	3.10	3.15
1988	204	261	238	3.25	3.31
1989	224	260	238	3.93	3.97
1990	209	231	232	2.82	2.88
1991	179	196	212	2.54	2.59
1992	. .	. .	. .	2.77	2.83

Source: World Nonferrous Metal Statistics.
. . Not available.
1 From primary and secondary material. 2 "Metals Week." 3 London Metal Exchange. For 1987, 1988 and part of 1989, the "Europe Free Market" in-warehouse Rotterdam prices were used to calculate averages.

TABLE 4. WORLD CONSUMPTION[1] OF TIN METAL, 1988-91

	1988	1989	1990	1991p
	(tonnes)			
WESTERN WORLD				
United States	38 100	37 200	37 000	35 300
Japan	32 300	33 500	33 800	34 800
Germany	19 400	18 600	19 300	20 300
United Kingdom	10 200	10 200	10 400	10 200
South Korea	5 000	5 500	7 800	8 400
France	7 800	8 100	8 300	8 200
Netherlands	5 000	5 500	6 900	6 200
Taiwan	3 000	3 900	4 800	6 200
Hong Kong	3 000	2 500	5 000	5 800
Italy	6 000	5 900	6 100	5 200
Thailand	2 000	2 600	2 700	4 400
Other	47 700	48 500	41 000	28 800
Total, Western World	179 400	182 000	183 100	173 800
EASTERN BLOC				
C.I.S.	28 000	24 000	20 000	17 000
China	14 000	18 000	18 000	17 000
Other	16 400	14 400	10 800	4 600
Total, Eastern Bloc	58 400	56 400	48 800	38 600
Total, world	237 800	238 400	231 900	212 400

Source: World Bureau of Metal Statistics.
p Preliminary.
1 Tin refined from primary and secondary sources.

TABLE 5. WORLD PRODUCTION[1] OF TIN IN CONCENTRATES, 1988-91

	1988	1989	1990	1991p
		(tonnes)		
WESTERN WORLD				
Indonesia	30 600	31 600	30 200	30 100
Brazil	44 000	50 200	39 100	29 300
Malaysia	28 900	32 000	28 500	20 700
Bolivia	10 500	15 800	17 300	16 800
Thailand	14 000	14 700	14 600	10 900
Peru	4 400	5 100	5 100	6 600
Australia	7 000	7 800	7 400	5 700
Canada	3 800	3 400	3 800	4 400
Portugal	100	100	1 400	3 100
United Kingdom	3 500	4 000	3 400	2 300
Zaire	1 900	1 600	1 600	–
Other	6 200	6 200	4 900	3 500
Total, Western World	154 900	172 500	157 300	133 400
EASTERN BLOC				
China	30 000	33 000	35 800	33 700
C.I.S.	15 000	14 000	13 000	11 000
Other	4 000	4 000	3 100	1 100
Total, Eastern Bloc	49 000	51 000	51 900	45 800
Total, world	203 900	223 500	209 200	179 200

Source: World Nonferrous Metal Statistics.
– Nil; p Preliminary.
[1] Recoverable tin content of ores and concentrates produced.

TABLE 6. WORLD PRODUCTION[1] OF TIN METAL, 1988-91

	1988	1989	1990	1991p
		(tonnes)		
WESTERN WORLD				
Malaysia	47 400	51 900	49 000	42 700
Indonesia	28 400	30 400	30 400	30 400
Brazil	42 700	44 200	37 000	29 500
Bolivia	5 500	9 700	13 400	14 700
Thailand	14 700	14 600	15 500	11 300
United Kingdom	16 800	10 800	12 000	5 200
Netherlands	3 700	4 700	6 100	5 000
Mexico	3 100	4 400	5 000	4 000
Hong Kong	. .	. .	3 500	3 500
South Korea	2 500	2 400	2 500	2 300
Canada[2]	40 600	26 900	. .	. .
Other	12 300	14 800	11 500	8 200
Total, Western World	217 700	214 800	185 900	156 800
EASTERN BLOC				
China	24 000	28 300	28 000	26 600
C.I.S.	16 000	14 000	13 000	12 000
Other	3 500	3 200	3 600	600
Total, Eastern Bloc	43 500	43 500	44 600	39 200
Total, world	261 200	260 300	230 500	196 000

Source: World Nonferrous Metal Statistics.
. . Not available; p Preliminary.
[1] Tin refined from primary and secondary sources. [2] Tin in lead-tin alloys.

TABLE 7. MONTHLY AVERAGE TIN PRICES, 1991 AND 1992

	N.Y. Dealer		London Metal Exchange	
	1991	1992	1991	1992
	(US$/lb)			
January	2.59	2.54	2.55	2.49
February	2.57	2.59	2.33	2.55
March	2.55	2.62	2.50	2.56
April	2.59	2.71	2.52	2.65
May	2.64	2.85	2.59	2.78
June	2.65	3.08	2.59	3.01
July	2.62	3.23	2.57	3.18
August	2.61	3.14	2.56	3.08
September	2.57	3.06	2.53	3.02
October	2.56	2.66	2.52	2.73
November	2.54	2.65	2.50	2.60
December	2.55	2.66	2.50	2.62
Yearly average	2.59	2.83	2.54	2.77

Source: "Metals Week."

Uranium

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Overview

As a result of the break-up of the Soviet Union, the level of uncertainty in the world uranium market has continued. Persistent excess uranium inventories and the lingering apprehension regarding the impact of uranium availability from the former Soviet Union (FSU) cause uranium producers some concern about future market opportunities. However, Canada has maintained its position as the world's leading uranium supplier in the face of turbulent market conditions. In 1992, Canadian uranium output recovered from the lowest level (1991) in a decade, as the centre of production shifts increasingly from Ontario to the world-class, low-cost uranium deposits of Saskatchewan. With six new uranium mining projects under environmental review in Saskatchewan, Canada is well placed to compete in the global uranium market in the years ahead. However, many in the uranium industry sense that delays in the review process could impede the development of production capacity from certain of these projects to the late 1990s or beyond.

In Elliot Lake, Ontario, Denison Mines Limited closed its operation in March 1992 upon the completion of deliveries to Ontario Hydro, while Rio Algom Limited maintained production levels to meet its contract commitments to Ontario Hydro, which end in 1996. In Saskatchewan, output levels were maintained at the Key Lake Joint Venture and at the Cluff Mining facility, whereas production increased at the Rabbit Lake Joint Venture following a two-year shut-down.

In 1992, Canada's uranium marketers signed new export contracts for the delivery of about 3200 tonnes of uranium (tU). The average 1992 price of all deliveries for export was C$59/kgU, just below the 1991 price of C$61/kgU, but well under the 1990 price of C$71/kgU. Less than 1% of deliveries in 1992 were spot sales, as has been the case since 1989.

Domestic Production and Developments

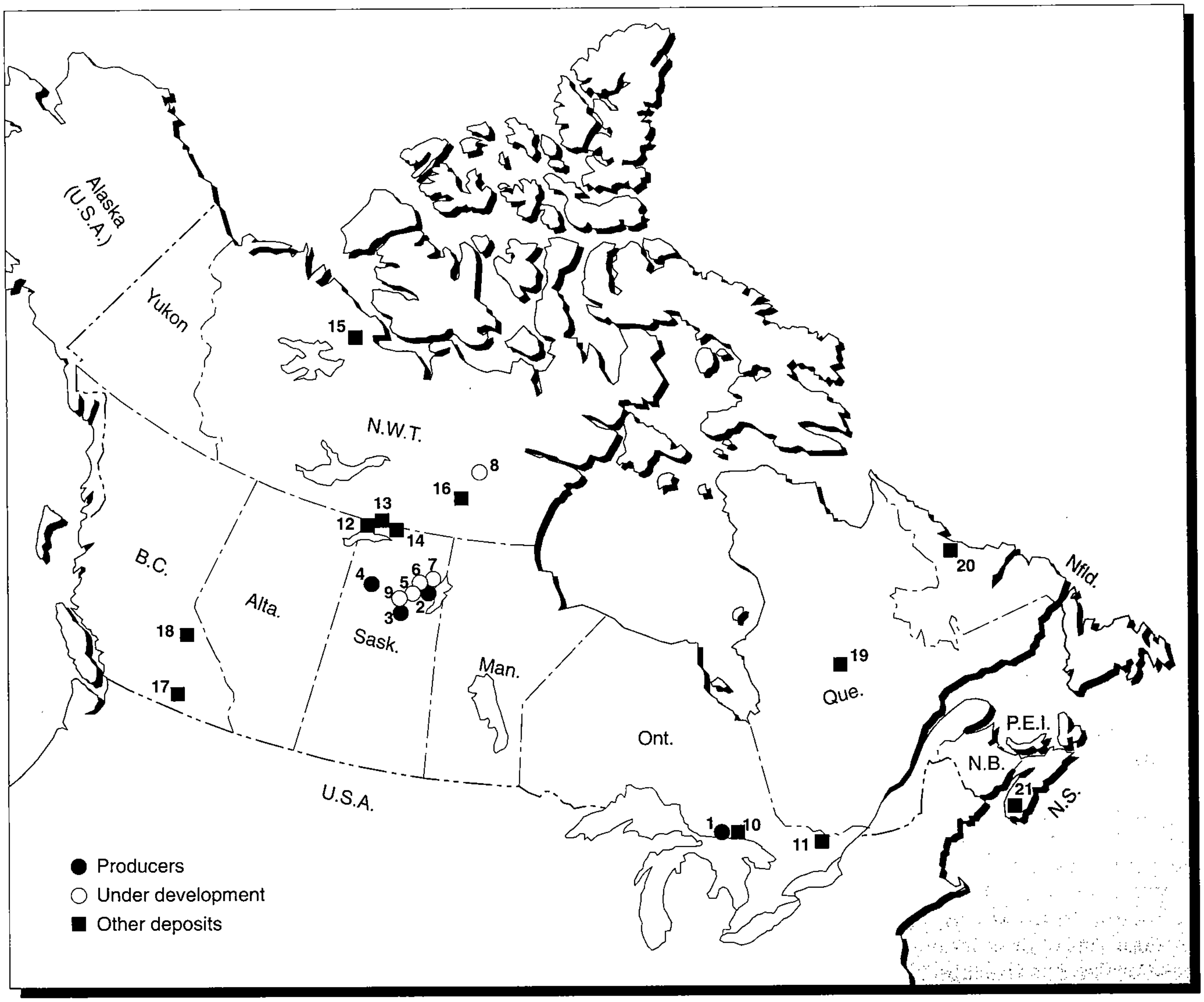
With installed production capability in excess of 10 000 tU annually, primary Canadian output in 1992 approached an estimated 9300 tU, up sharply from 8160 tU in 1991. Uranium ranks sixth among Canada's top 10 metal commodities in terms of production value. The preliminary estimate of mine shipments in 1992 under all domestic and export contracts was 9100 tU, valued at C$585 million; final 1991 shipments are reported at 8199 tU, worth $604 million. From late 1989 to late 1991, direct employment was almost halved, from 4280 to 2200 workers, due mainly to mine closures and workforce reductions in Elliot Lake; at the end of 1992, employment fell below 1500 workers, reflecting Denison's closure.

Table 1 shows the impact of continued mine closures at Elliot Lake on direct employment at Canada's uranium production centres, while Table 2 traces uranium shipments and values from 1987. The difference between annual production and shipment figures reflects producer inventory adjustments. As domestic requirements represent 15%-20% of current annual Canadian output, most of Canada's uranium production is available for export. Table 3 lists the operational characteristics of Canada's existing uranium production centres in Ontario and Saskatchewan as of 1991. Figure 1 locates Canada's existing producers and major uranium deposits, while Figure 2 illustrates the output and ownership share of Canada's uranium production centres in 1991.

Elliot Lake, Ontario

In 1991, Ontario Hydro notified Denison that its uranium supply contract would be terminated on January 1, 1993. An agreement was reached whereby Hydro deliveries for 1991 and 1992 would be accelerated, permitting Denison to maintain production and workforce levels until closure. Denison was able to do so by the selective mining of higher-grade ores, and by implementing an

Figure 1
Uranium Deposits in Canada, 1992



Numbers refer to locations on map above.

PRODUCERS

1. Elliot Lake
2. Rabbit Lake (incl. Eagle Point)
3. Key Lake
4. Cluff Lake

UNDER DEVELOPMENT

5. Cigar Lake
6. Midwest
7. McClean Lake
8. Kiggavik
9. McArthur River

OTHER DEPOSITS

10. Agnew Lake[1]
11. Bancroft[1]
12. Maurice Bay
13. Beaverlodge[1]
14. Fond-du-Lac
15. Dismal Lakes
16. LGT
17. Blizzard
18. Rexspar
19. Otish Mountains
20. Makkovik
21. Millet Brook

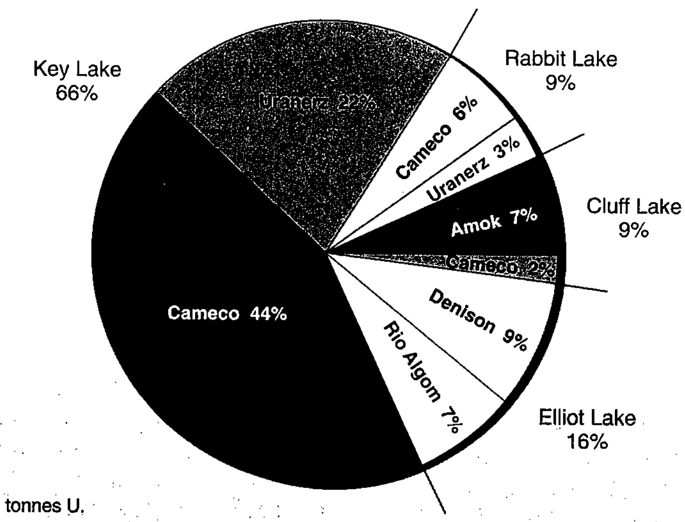
1 Past producers.
SOURCE: Uranium Division, Electricity Branch, Energy, Mines and Resources Canada.

incentive plan related to employee severance; estimated output for the year exceeded 250 tU. The last ore was hoisted from underground on March 11, and final concentrates were packed in the mill on March 24. The mine closed on May 31, 1992.

Similar to the Denison arrangement, Ontario Hydro announced in June 1991 that it had agreed to continue Rio Algom's current (Stanleigh mine) contract beyond 1993, but only until 1996 as opposed to the original 2020 date. Deliveries were

Figure 2

Canadian Uranium Production and Ownership, 1991



SOURCE: Uranium Division, Electricity Branch, Energy, Mines and Resources Canada.

increased in 1992 and will continue at the 1992 level until 1995; estimated output for the year exceeded 600 tU.

In June 1992, Rio Algom announced that The RTZ Corporation PLC would sell its 51.5% interest in Rio Algom by way of a public offering. The C$360 million sale, restricted to the Canadian market, resulted in a wide distribution of the company's almost 23 million shares without a new controlling shareholder. Made on an instalment basis, the sale was completed on June 25 and obliged purchasers to pay $16.10 per common share in three payments over the next two years. As a strong and independent Canadian company, Rio Algom can reinforce its operations and aggressively seek new opportunities worldwide.

The sale resulted from acquisitions by RTZ of the North American mineral businesses of BP Minerals, and its ownership of U.S. Borax and Indal, which created concern regarding the potential for conflict with the interests of Rio Algom. While Rio Algom and RTZ enjoyed a mutually beneficial association, the Boards of the two companies concluded that the sale of RTZ's holding was in the best interests of Rio Algom.

Ontario Hydro/ Denison Mines Dispute

With the cancellation of Denison's long-term contract by Ontario Hydro (noted above), a dispute arose that centred on whether or not Denison is to be entitled to consider accelerated depreciation and amortization charges in calculating its production costs for the period since notice of contract termination was received. Denison estimates that some $350 million is at stake, and that this will be needed to fulfil its decommissioning obligations at Elliot Lake. Denison had served a notice of arbitration regarding the calculation of certain prices, and Ontario Hydro responded by applying to an Ontario court to have the matter resolved in the courts. However, on June 3, the court found that the agreement had properly provided for the matter to be settled by arbitration and stayed the proceedings. While both sides claimed the support of "generally accepted accounting principles," Denison won its choice of forum for resolving those technical details. Certain key prices must now be determined by independent public accountants in accordance with the terms of the agreement.

Decommissioning Elliot Lake Uranium Tailings

Rio Algom and Denison Mines have each requested approval from the Atomic Energy Control Board (AECB) to begin decommissioning their waste management sites around the Elliot Lake area. Although site decommissioning studies have been submitted to the AECB, applications to proceed are not expected soon. In October 1992, the AECB decided that these decommissioning proposals should be referred to the Minister of the Environment for public review by a panel under the Environmental Assessment and Review Process (EARP), with input from the Government of Ontario. At year-end 1992, AECB staff were preparing the referral letter and the suggested terms of reference.

In February 1990, a Canada-Ontario Working Group on Uranium Tailings was formed to review governments' financial and long-term management responsibilities for the decommissioning of uranium mine and mill tailings; discussions are ongoing.

Athabasca Basin, Saskatchewan

After a two-year shut-down due to poor markets, the Rabbit Lake mill began ore processing in August 1991, relying on stockpiled ore from the Collins Bay B deposit. Capable of producing 5400 tU annually, the mill could reach nominal capacity in 1996; estimated output for 1992 exceeded 2100 tU. At the adjoining Eagle Point property, the 1.5-km ramp from surface had accessed the 180-m level by the end of July 1992, although the first horizontal drift was developed at the 120-m level. Test mining of the first stope using a non-entry method began in July, and test stoping will continue into 1993.

Once the ore stockpiled at Rabbit Lake is processed, and provided the necessary environmental approvals are received, the Rabbit Lake mill is scheduled to begin treating ore from the Eagle Point mine and then from the Collins Bay A and D zone deposits. With mineable resources estimated at 27 000 tU and an additional 20 000 tU classified as geological resources, production levels at Rabbit Lake are assured well into the next century.

At the Key Lake operation, the Deilmann open pit is being mined out at an accelerated rate for eventual use as a tailings disposal facility, subject to regulatory approval. Despite a scheduled shut-down for the month of January, estimated production in 1992 exceeded 5400 tU. With mineable reserves reportedly exceeding 35 000 tU in early 1992, the mine life could extend beyond 1997 at the early 1990s' rates of production. The Key Lake mill may be used to process ore from McArthur River, given project approval by the environmental review Panel, once Key Lake ore is exhausted (see below).

Following the successful C$130 million sale of Cameco shares in July 1991, the Province of Saskatchewan agreed to sell 5.33 million special warrants in September 1991 at C$14.75 each as the next step of the planned privatization of the company. A warrant entitled the holder to receive one common Cameco share and one half of a common share purchase warrant. All the shares involved in this transaction had been held by Saskatchewan Mining Development Corporation, the provincial Crown corporation that was merged with Eldorado Nuclear Limited in 1988 to form Cameco. On January 30, 1992, Cameco announced that Canada Eldor Inc., a corporation holding the Government of Canada's shares and wholly owned by Canada Development Investment Corporation (a federal Crown company), arranged to sell almost 6 million special warrants, priced at C$14.60 each, entitling the holder to receive one common share of Cameco held by Canada Eldor.

As of early 1992, there were some 52 million common shares issued and outstanding in Cameco. If the latest warrants transaction is fully exercised by October 1994, but before the exercise of outstanding common share purchase warrants previously issued by the Province of Saskatchewan, Cameco will be held 19.3% by the Government of Canada, 33.7% by the Province of Saskatchewan, and 47% by the public. If Cameco employees fully exercise their bond conversion rights by 1996, Cameco will be held 18.6% by the Government of Canada, 32.5% by the Province of Saskatchewan, and 48.9% by the public.

On June 10, 1992, Cameco announced changes in the organization of its Saskatoon head office and its Ontario conversion facilities that would eliminate 86 positions. This action resulted from ongoing initiatives to streamline the organization to improve efficiencies and reduce costs in order to meet the challenges of the increasingly competitive world uranium industry. The elimination of 42 positions in Saskatchewan and 44 in Ontario reduced Cameco's workforce to 804 in Saskatchewan and 276 in Ontario.

On June 11, Cameco announced the acquisition of 100% of AGIP Resources Ltd. by Cameco Resources Ltd. for $50 million. With AGIP's principal asset being a 10% interest in the McArthur River property, operator Cameco will own 56% of the project at the production stage.

With the depletion of the Dominique-Janine (DJ) North pit in December 1991, Cluff Mining plans to extend its DJ pit southward to prolong open-pit mining and to supplement production from its underground operation; resources associated with the DJ Extension are estimated at 5000 tU. As mining operations would extend 100 m into Cluff Lake and require a dam to be constructed, the extension proposal was referred for environmental review (see below). In 1992, estimated uranium production from the DJ North stockpile and the Dominique-Peter (D-P) underground mine exceeded 700 tU; the facility continues to operate on an alternate week basis due to market conditions. During 1992, Amok carried out extensive surface and underground drilling programs to delineate new resources in the D-P mine.

To consolidate operations, Cogema Canada Ltd. announced on January 1, 1993, an amalgamation with its subsidiary, Amok Ltd., under the Cogema Canada name; the new entity will act as manager of the Cluff Mining Partnership and Amok Ltd. will cease to exist. In a subsequent release, on February 1, 1993, Cameco announced the sale of its 20% interest in the Cluff Mining Partnership, as well as its interest in several exploration properties near the Cluff Lake site. The Cameco sale, subjected to a review by the federal government under the terms of the uranium non-resident ownership policy, was approved on January 29, 1993. Cameco's assets were acquired by Corona Grande Exploration Corporation, a wholly owned subsidiary of Cogema Canada. The transaction also assigned to Corona Grande a related uranium sales agreement between Cameco and Cogema. The transaction will result in Cameco recording a one-time, non-cash loss of some $84 million against 1992 net earnings, but the company will avoid development costs associated with the Cluff Lake expansion.

As Cameco's share of Cluff Lake output was only 3% of its 1992 production total and was essentially committed to Cogema, the equity sale will not affect Cameco's ability to meet its future marketing objectives or production targets. It will, however, allow Cameco to follow a strategy of retaining and pursuing only those investments which meet certain profit-generating criteria and in which Cameco has control.

Saskatchewan Environmental Assessment and Review Panels

In April 1991, the Minister of Energy, Mines and Resources (EMR) referred six proposals for new uranium mining facilities in Saskatchewan for public review by an independent panel, pursuant to the federal government's EARP Guidelines Order. A Saskatchewan/ Canada (Joint) Panel is reviewing five proposals, namely: Cluff Mining's extension of the South and West Dominique-Janine deposits, Denison's South McMahon Lake or Midwest project, Total Minatco Ltd.'s[1] McClean Lake project, Cigar Lake Mining Corporation's (CLMC) project at Cigar Lake, and Cameco's McArthur River project.

The Joint Panel released operational procedures in December 1991 to assist those wishing to participate in the review process by providing information about how the Panel will conduct its review.

A federal-only Panel is reviewing the sixth proposal, the expansion of Cameco's Rabbit Lake project by developing the Eagle Point/Collins Bay A & D deposits, where conditional approval has already been granted by Saskatchewan authorities. The Panel requested an update to the previously submitted Environmental Impact Statement (EIS), and this was completed in June 1992. The public review period ended in September, and Cameco anticipates public hearings early in 1993 with Panel recommendations possible in the fall.

On December 20, 1991, the EIS of the Midwest Joint Venture project was submitted to the Joint Panel for a 90-day public review, during which time the Panel accepted written comments on the completeness of the EIS. Based upon its review and the submitted comments, the Panel had to decide if sufficient data had been provided to proceed with public hearings or if additional information was required.

On January 7, the Chairman of the Joint Panel announced that scoping meetings for the Cigar Lake and McArthur River projects would begin on February 7, the main purpose being to provide review participants with an opportunity to identify for the Panel those issues or concerns that should be included in EIS guidelines issued to the proponents.

The Joint Panel received Minatco's EIS for McClean Lake on January 13, 1992, and Cluff Mining's EIS for its Dominique-Janine project on March 31, and set 90-day public reviews for the two proposals. However, on March 26, the Joint Panel announced that, in light of the number of concurrent review activities and the volume of material to be scrutinized, the deadline for public submission of comments regarding the Midwest and McClean Lake projects had been extended by 60 days (to May 29). These extensions caused some concern among the proponents, who feared that delays might lead to missed schedules and lost market opportunities. When the terms of reference were announced for the Joint Panel, it had been understood that Panel reports on the first three projects were expected to be finalized **within 18 months of the Panel's formation** (August 22, 1991), given that the EISs were acceptable. With the revision of the three EISs, however, the Joint Panel now expects to report **within 18 months of receiving the revised EISs**.

On April 24, the federal Minister of the Environment announced the awarding of $125 000 to assist

12 groups and 2 individuals to participate in the federal-only Panel reviewing Cameco's Rabbit Lake expansion. The funds, to help recipients review EISs prepared by the project proponents and prepare for and participate in the public hearings, were awarded as follows: \$55 000 to representatives of Indian bands of the Athabasca region, \$42 000 to environmental groups and individuals, \$13 000 to economic development interests, \$10 000 to an Inuit organization, and \$5000 to a Metis society. This funding was separate from and additional to the \$350 000 made available in 1991 by the federal and Saskatchewan governments for groups and individuals to take part in the environmental assessments conducted by the Joint Panel.

On June 1, the Joint Panel released Draft Guidelines to assist in the preparation of EISs for the McArthur River and Cigar Lake projects; they were very detailed and somewhat subjective. The responsible federal and provincial departments forwarded comments to the Secretariat of the Panel in July, noting the Panel's interpretation of its mandate, expressing apprehensions about delays in the process, and querying the possible impact on investment in Canada as perceived by foreign companies. In September, the Joint Panel issued Final Guidelines which more clearly distinguished the inputs requested from governments and the proponents.

On October 23, 1992, on behalf of the AECB, the Minister of EMR referred the proposed Underground Exploration Program (UEP) for the McArthur River uranium mining project to the Minister of the Environment. In turn, the UEP was referred by the federal and provincial environment ministers for public review by the existing Joint Panel. In undertaking this review, which the project proponents agreed to, the Joint Panel committed to recommend on the conditions, if any, under which the UEP should be allowed to proceed by January 15, 1993. The Panel did so by providing its report to the Federal Environmental Assessment Review Office (FEARO), which forwarded it to the Ministers of EMR and Saskatchewan Environment and Public Safety (SEPS), and to the AECB. The report was released to the public on January 18, 1993.

The report recommends that the UEP be allowed to proceed subject to certain conditions; most are fairly standard but two provisos could set precedents. The first is that a surface lease be negotiated that is acceptable to Saskatchewan, Cameco, a majority of First Nations peoples, and the affected communities. The second is that the surface lease include a revenue-sharing provision that contains an income protection mechanism for traditional land users. While the latter recommendation has implications for both levels of government, it is becoming clear that the environmental review process itself could increase, by a significant margin, the lead time and costs needed to bring many of these new projects on stream.

Additional Production Possibilities

In addition to the existing production centres, there are a number of uranium projects, noted above, at various stages of development that could be brought on stream over the next several years. The start-up date of any of these projects is contingent on the receipt of the necessary regulatory/environmental approvals, on developments in the international uranium market, and on economic decisions made by the project owners.

In mid-1990 at Cigar Lake, underground development was completed, which consisted of a shaft sunk to a depth of some 500 m and two lateral drifts, one in the sandstone above the orebody at the 420-m level and the other in the basement rocks at the 480-m level. Initial test mining of high-grade ore was successfully completed in 1991, wherein part of the orebody was first frozen and then a boxhole boring machine was used to remotely extract 53 t of ore grading almost 15% U.

During 1992, CLMC tested a newly developed jet-boring method, which uses high-pressure water jets. It proved effective in excavating more than 100 t of ore grading over 13% U. Underground test mining activities were essentially completed in late 1992, and CLMC began preparing its EIS for submission to the Joint Panel by mid-1994. Allowing an 18-month review, final recommendations could be made by the end of 1995. The project is jointly owned by Cameco (48.75%), Cogema Canada (36.375%), Idemitsu Uranium Exploration Canada Ltd. (12.875%), and Korea Electric Power Corporation (2%).

The McArthur River deposit, located 70 km northeast of Key Lake, is of sufficient size and grade to enable the Key Lake mill, where McArthur ore could to be treated, to operate well into the next century. Probable in-situ resources are estimated at 100 000 tU, with an average grade exceeding 4% U, and the ore composition is amenable to processing at Key Lake.

Further exploration and ore reserve definition is planned as part of the UEP schedule for 1993/94. If interim approvals are received and the required equipment and supplies can be brought to the site by winter road in early 1993, operator Cameco could complete underground work in 1994, submit its EIS by the end of the year and, with final approvals in 1996, be able to complete construction in time for uninterrupted milling at Key Lake in 1997.

The UEP shaft is to be sunk to a depth of 630 m with drifts from the 500-m level, and perhaps the 600-m level, to permit more detailed drilling. If the year-round access road and mine development are completed by 1996, production at the C$100 million project could begin in 1997 at 500 t/d of ore. With Cameco's 1992 purchase of AGIP's interest in McArthur River, the joint venture partners' ownership share at the production stage will be: Cameco, 56.435%; Uranerz Exploration and Mining Limited, 27.331%; Interuranium Canada Ltd., 9.063%; and Cogema Canada Limited, 7.171%.

In April 1992, Denison and Total Compagnie Minière of France (Total) entered into an agreement that would permit their respective Midwest and McClean Lake uranium projects to be developed as complementary uranium operations.[2] The agreement includes provisions for the mining, milling and marketing of uranium concentrates to customers of Denison and Total. If a production decision is made, subject to the fulfilment of several conditions and the receipt of the necessary consents, the Midwest ore may be milled in facilities at McClean Lake, which will reduce the potential environmental impact. Denison would acquire a joint venture interest in McClean Lake of about 22% and Total would fund Dension's share of the McClean Lake development. Total would also acquire a right to 70% of Denison's share of Midwest production. Until final complementary development approval is received, the Wolly project is owned 100% by Total Minatco, a wholly owned subsidiary of Total Minière, and the Midwest Joint Venture project is owned by Denison (45%), Uranerz (20%), Bow Valley Industries Ltd. (20%), and OURD (Canada) Co., Ltd. (15%), a subsidiary of Overseas Uranium Resources Development Corporation (OURD) of Japan.

Given the necessary regulatory/environmental approvals, complementary development at McClean Lake could begin in late 1993 with mill construction near the Jeb deposit and related site preparation, at which time mining at the Jeb open pit would commence. When depleted, the Jeb pit would be readied for tailings disposal in preparation for the mill start-up in mid-1995. A staged commissioning of the mill would see output rising to 2300 tU/y. After Jeb, the Sue C open pit would be mined, followed by the Sue A and B pits, then the McClean Lake underground orebodies, and finally, around 1998, the Midwest deposit. With mineable resources at Total Minatco's Wolly project estimated to contain 17 300 tU, including the various McClean Lake, Jeb and Sue deposits, and resources at the Midwest property totalling 14 000 tU, the mill could operate at nominal throughput levels until 2008.

The Kiggavik uranium project, located in the proposed Territory of Nunavut and to the west of Baker Lake, is held by Urangesellschaft Canada Limited,[3] CEGB Exploration (Canada) Ltd., and Daewoo Corporation of South Korea. An EARP review in 1990 pointed out deficiencies in the project EIS, and the proponents were allowed more time to respond to the request for additional information. Notwithstanding the EIS problems and the depressed uranium market outlook, continuation of the project has also been affected by recommendations of the Nunavut Planning Commission, an independent body established to develop a Land Use Plan for the Inuit land claims settlement area. Late in 1991, the Commission recommended completing the Kiggavik EARP review, but deferring uranium development until the Nunavut land claim resource management bodies are established and have reviewed the relevant issues not addressed by the EARP (see Government Initiatives).

EXPLORATION

In 1992, the Uranium Resource Appraisal Group (URAG) of EMR completed its eighteenth annual assessment of Canada's uranium supply capabilities and an associated survey of exploration activity. The results were reported[4] late in the year.

As in previous years, uranium exploration activity in 1991/92 was again concentrated in areas favourable for the occurrence of deposits associated with Proterozoic unconformities, most notably in the Athabasca Basin of northern Saskatchewan. Exploration expenditures of $44 million in 1991 were almost unchanged from 1990 ($45 million), despite low spot prices and limited market opportunities. While the recent expenditure levels are attributable mainly to the test mining program under way at Cigar Lake, uranium exploration at the less advanced projects in Saskatchewan was reported by the province at some $10 million for 1991. Combined exploration and surface development drilling in 1990 and 1991 reached 66 000 m and 67 000 m, respectively, of which well over 90% occurred in Saskatchewan.

In the 1991/92 field season, the number of companies participating in active exploration projects dropped to 19 from 27. Overall, some 65 exploration projects remained in good standing. Nine active operators[5] were responsible for spending the entire $44 million committed in 1991. In alphabetical order they were: Amok Ltd., Cameco Corporation, Cigar Lake Mining Corporation, Cogema Canada Limited, Cominco Limited, Minatco Ltd., PNC Exploration (Canada) Co. Ltd., Uranerz Exploration and Mining Limited, and Urangesellschaft Canada Limited. Table 4 summarizes uranium exploration activity in Canada from 1976 to 1991 and shows that, until the 1990/91 exploration season, the number of "million-dollar" projects has remained relatively constant since 1982.

Resources

Uranium supply from Canada in the next decade will come from "known" resources, estimates of which are divided into three major categories – measured, indicated and inferred – that reflect different levels of confidence in the reported quantities. Most of these resources are associated with deposits identified in Figure 1.

In its latest annual assessment of domestic uranium supply capabilities, EMR reported[4] that estimates of known uranium resources, as of January 1, 1992, were 459 000 tU, a 20% drop from January 1991 when resources totalled 594 000 tU, as shown in Table 5. Estimates of resources in the lower-cost categories rose slightly as a result of exploration successes at recently discovered deposits in northern Saskatchewan and the Northwest Territories, but the increase was more than offset by losses in the higher-cost categories resulting from the closure of three mines at Elliot Lake due to the depressed uranium market. Canada's uranium resource total may continue to be eroded due to the international uranium market situation, which precludes the exploration effort needed to sustain resource levels.

Supply Capability

Production capability from Canada's existing operations was bolstered in 1992 with the return to full-year operations at the Rabbit Lake facility. Output from Rabbit Lake was almost triple the 1991 level, and more than offset the production loss from the closure of Denison's mine early in 1992. However, Canadian output remained well below capability during the year as producers continued to avoid the spot market and gear output to their existing contract commitments. At most operations, significantly higher uranium prices will be required to bring production up to full capability, which is presently in excess of 10 000 tU.

Projections of Canadian uranium availability in the short term have been made based only on existing production centres. These assume a level of production that could be realistically achieved, under current circumstances, supported by known resources in the so-called low-cost category, that is, resources recoverable at a price of $100/kgU or less. No firm commitments have been made for the start-up of any production centres beyond those now in operation. Developments in the international uranium market and uncertainty regarding the costs associated with certain of the planned projects noted above make it difficult to project future production capability levels. Table 6 places Canada in the world context with respect to actual uranium production from 1985 to 1991 inclusive, and Figure 3 illustrates Canada's share of Western World output in 1991 in comparison with other major Western producers.

Government Initiatives

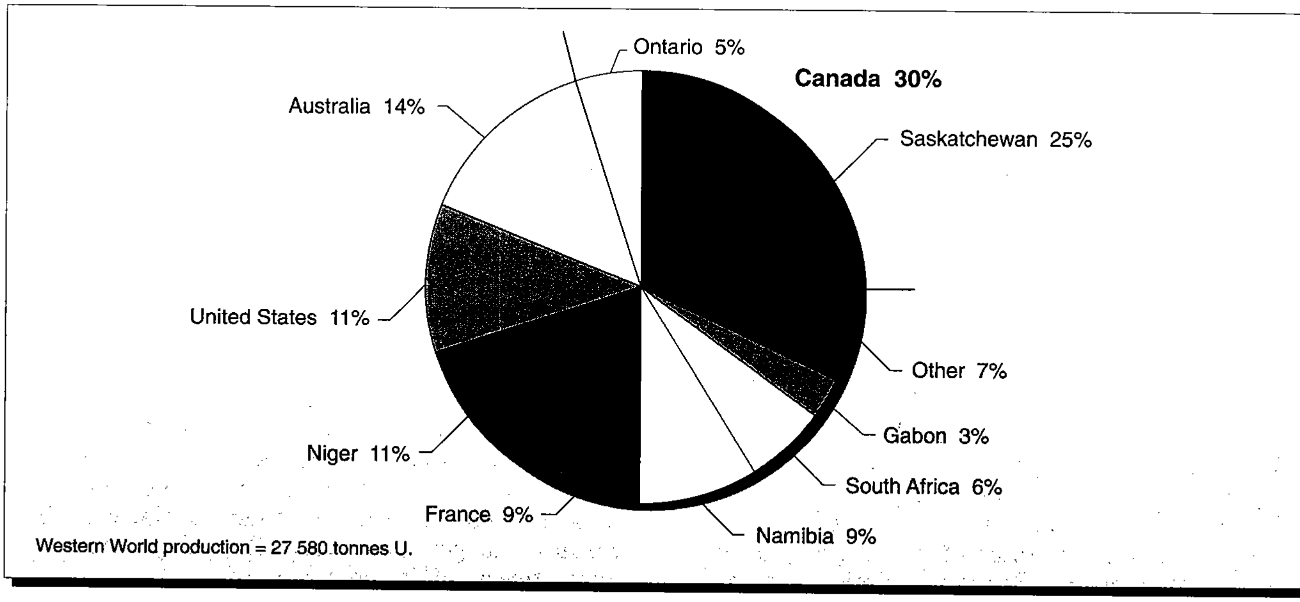
On May 4, 1992, the creation of an Inuit homeland moved a step closer to reality when the residents of the Northwest Territories voted in a plebiscite by a 54% majority to approve a western boundary for an Inuit-controlled domain called Nunavut, thereby starting a process to divide lands between the Inuit and Dene people. Of the more than 50 000 residents of the Northwest Territories, some 17 500 are Inuit living in the eastern Arctic. The discovery potential for uranium deposits within Nunavut has meant that this latest step toward Inuit self-government is being followed with keen interest by the uranium industry; the final stage to self-rule is scheduled for 1999.

On November 26, 1992, the federal government advised the uranium industry and the nuclear-electric utilities of a modification to the pricing component of Canada's uranium export policy. The objective of the change was to bring the policy into closer conformity with the government's commitment to freer trade. The previous enunciation of the policy, in May 1990, set out the pricing component consisting of the two requirements noted below:

- "The Canadian government will expect terms in export contracts to provide for an equitable balance of benefits and risks, and to be generally not less favourable than those being obtained in the same time period by competing Canadian and international producers for contracts of similar duration."

- "In the interests of promoting stable productivity and employment, each export contract should

Figure 3
Western World Uranium Production, 1991



NOTE: Total world production approximates 45 000 tonnes U.
SOURCE: Uranium Division, Electricity Branch, Energy, Mines and Resources Canada.

include mechanisms, such as escalating floor price provisions, which will help to reduce the impact of unexpected shifts in the market, and thereby contribute to a more predictable commercial environment for both the company and its employees."

However, in November 1992, Ministers eliminated the second requirement (above) with respect to all new contracts. In making the decision, Ministers noted that Canadian producers were well placed to compete on an equal footing with any in the world. Moreover, given the high level of competition in today's international market, the producers themselves were in the best position to determine the most appropriate way of protecting their investment base, using a mixed portfolio of contracts. The federal interdepartmental Uranium Exports Review Panel will continue to review contractual pricing terms on behalf of Ministers to ensure that the first requirement is being followed, and that export contracts are generally consistent with Canada's uranium export policy.

INTERNATIONAL DEVELOPMENTS

During 1992, all participants in the international uranium market were preoccupied with the impact of rapidly increasing sales of both enriched uranium product and uranium concentrates in Western markets by the FSU. The potential influx of highly enriched uranium (HEU) derived from the dismantling of nuclear weapons in the FSU loomed as an even greater threat.

In November 1991, a group of 13 U.S. uranium producers and the Oil, Chemical and Atomic Workers' International Union filed an anti-dumping petition against uranium from the Soviet Union in an effort to bring more order to the international market. On May 29, 1992, the International Trade Administration of the U.S. Department of Commerce (DOC) made a preliminary ruling that uranium from six republics of the FSU (Russia, Kazakhstan, Kyrghyzstan, Uzbekistan, Ukraine and Tajikistan) was being sold in the United States at less than fair value and established a provisional dumping margin (duty) of 115.82%.

On October 16, 1992, the DOC signed quantitative restraint agreements with the six republics, suspending the anti-dumping investigations against those countries. The suspension agreements specify quota limits on imports of uranium, which are tied to the market price of uranium in the United States. In addition to these quotas, certain long- term contracts signed before a critical date in the investigation were grandfathered.

The Euratom Supply Agency (ESA) also struggled with this difficult problem during 1992. The only leverage the ESA has had to deal with the matter has been the legal requirement that it formally approve all supply agreements entered into by European Community companies. The ESA has developed a policy, applied on a case-by-case basis, of monitoring contracts and requiring their adjustment when it considers a member country is over-committing to FSU-origin material. Some utilities have criticized the vagueness of the guidelines, which have been said to incorporate percentage quotas when prices are below a certain threshold. The detail of these guidelines has not officially been made public.

On August 31, 1992, the United States announced that it had initialled an agreement with Russia, to be negotiated in full over the ensuing 12 months, for the purchase by the Department of Energy (DOE) of HEU derived from nuclear warheads in the FSU. This purchase was to involve a minimum of 10 t of HEU annually over the first five years of the agreement, and a minimum of 30 t annually over the next fifteen years. Realistic technical assumptions indicate that the initial annual quantities would equate to about 2200 tU in natural uranium concentrates. The purchase was to be conducted in a budget-neutral fashion, financed from savings in DOE's uranium enrichment operations. The uranium was to be blended down into low-enriched uranium for use as commercial reactor fuel in such a way as to not disrupt commercial uranium markets. The contemplated HEU purchases were subsequently exempted from the quotas allocated to the various republics of the FSU under the anti-dumping suspension agreements.

MARKET OVERVIEW

Canada's uranium industry has maintained its position as the world's leading uranium supplier in the face of turbulent market conditions. In 1992, Canada's uranium marketers signed new export contracts for the delivery of about 3200 tU, destined to be exported to a broad range of consumer countries among those shown in Table 7; these 1992 sales, representing new business, do not reflect contract amendments and the exercising of quantity-flexibility options under existing contracts.

Table 7 shows, by country of buyer, the nominal amount of uranium under Canadian export contracts reviewed and accepted since 1974, and illustrates Canada's diverse export base. As of January 1, 1993, forward commitments under all export contracts and domestic contracts were in the order of 37 000 tU and 7000 tU, respectively. (The renegotiation of Ontario Hydro's contracts in 1991 reduced outstanding domestic commitments by a factor of 10.) The development of several new Saskatchewan orebodies now undergoing environmental review should form the basis of continued production well into the next century. Canada's uranium producers are very competitive and well placed to meet future demands. However, exports of commercial, and possibly military, uranium inventories from the FSU could continue to cloud the outlook in the near term.

Global mine production is considerably less than reactor requirements in spite of a large production surplus in the former Eastern Bloc countries. Accumulated inventories continue to find their way into the market. Russia is now believed to hold the major portion of these inventories, comprised of the accumulated inventories of several Eastern European countries and perhaps those of several FSU republics as well. There is also a growing prospect that recent disarmament initiatives will result in the potential availability of enormous quantities of additional uranium.

As noted above, the U.S. anti-dumping initiative has led to a series of agreements between the United States and six FSU republics. The European Community has established similar restrictions, but on a less formal basis. The United States is also negotiating with the Russians to acquire, over a 20-year period and in a market-neutral way, significant quantities of uranium derived from the dismantling of Russian nuclear weapons. If these agreements stay in place and have the anticipated effect on the market, they should result in an orderly flow of surplus uranium into the market over a lengthy period and allow spot market prices to rise gradually to a level which would support the world's most efficient producers, especially those in Saskatchewan.

In Canada, Ontario Hydro issued a request on July 8, 1992, for proposals for the supply of uranium concentrates covering its long-, medium- and short-term requirements. Consideration would be given to proposals from companies having ownership in uranium mining projects in Canada, the United States, Australia, and Namibia, which have substantial ore reserves and established production operations or assured ability to operate. Ontario Hydro developed a short list of the most competitive proposals and began negotiating contracts with several suppliers who were encouraged to be creative in offering alternate conditions if these improved on the basic proposal. Ontario Hydro's principal requirements were: major volume variability with annual deliveries increased by 15% or decreased by 30% at its option on not more than six months' notice; options that extend the contract(s) until at least December 31, 2001; and the right to delay deliveries in any year by up to nine months. It was expected that between 1200 and 1300 tU will need to be procured for the year 1996, and that some 1600-1700 tU will be required annually thereafter until 2002.

Prices

The gradual unfolding of the international events noted above has been interpreted as a positive development by Canadian uranium producers. It now appears that uranium from the FSU, including potential supplies from military sources, is likely to enter Western markets in a more orderly fashion over a longer period of time. The spot market responded by splitting into two segments with distinct price levels. Prices in markets that restricted the entry of uranium from the FSU (the United States and the European Community) quickly rose by about one third following the signing of the suspension agreements, although some of this gain disappeared by year-end. Prices in the unrestricted segment of the market continued on at about the levels they had shown through the first half of the year. Overall uranium price volatility diminished somewhat in 1992 as spot market sales declined. The NUEXCO[6] spot market price fluctuated between US$7.75 and $10.50/lb U_3O_8, settling at US$9.95/lb at year-end.

In Canada, the average price of all deliveries for export made during 1992 was C$59/kgU, or US$19/lb U_3O_8, just below the 1991 average. Less than 1% of Canada's deliveries for export in 1992 were spot sales, similar to that from 1989 to 1991, compared with a high of 35% in 1987, and the previous level of 1% in 1981. The average price of Canadian deliveries for export from 1974 to 1991 is shown in Table 8.

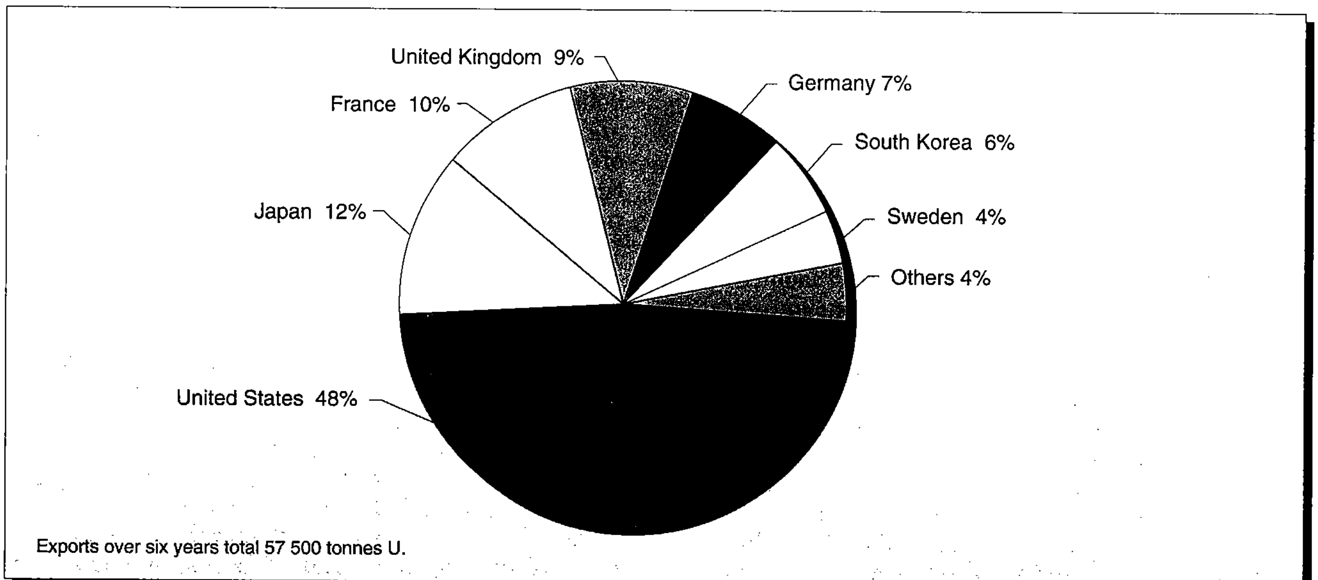
Table 9 shows actual exports of Canadian-origin natural uranium from 1985 to 1991 for Canada's principal export customers; actual exports in 1992 are not expected to match those of 1991. The destination of Canadian exports of uranium in concentrates on a cumulative basis (1986-91 inclusive) is shown in Figure 4, which highlights the importance of the United States.

Refining and Conversion

Cameco operates Canada's only uranium refining and conversion facilities, located at Blind River and Port Hope, Ontario, respectively. At Blind River, uranium concentrates are refined to uranium trioxide (UO_3), an intermediate product, and then trucked to Port Hope. There, the UO_3 is converted to either uranium hexafluoride (UF_6) for use in foreign light-water reactors following enrichment outside of Canada, or uranium dioxide (UO_2) for use in CANDU reactors.

Figure 4

Canadian Uranium Exports, by Country of Final Destination, 1986-91



SOURCE: Atomic Energy Control Board (AECB), Canada.

The Blind River refinery, with a nominal annual throughput capacity of some 10 000 tU as UO_3, processes uranium concentrates from several countries. In 1991, the transition to a revised operating schedule involved implementing a modified 10-day-up/4-day-down program. Under the new routine, which began in June 1991, the UO_3 plant operation was alternated with product weighing and sampling. Despite the depressed conversion market and Cameco's decision to limit production, output in 1991 was 9198 tU as UO_3, an increase of some 13% from the 1990 level of 8154 tU as UO_3.

At Port Hope, the two conversion facilities have a capacity of some 10 500 tU as UF_6 and 2500 tU as UO_2, respectively. The new production schedule, implemented in 1990, involves alternating the operation of the UO_2 and UF_6 plants, rather than simultaneous production. Under this routine, the UF_6 facility was shut down in May 1991, while the UO_2 plant operated until July. The UF_6 plant resumed operations in September and continued until February 1992. The transition to the new schedule has been successful, with the highest average daily throughputs achieved. Production in 1991 increased to 8983 tU, up 7% from 8398 tU in 1990; conversion output fell in 1992. As noted above, employment declined in June 1992, with the workforce at the Port Hope site then numbering 232.

In 1991, Cameco concluded a long-term contract for the supply of UO_2 conversion services to Ontario Hydro, its major customer for such services. For the period 1992 through 1996, Cameco has UF_6 conversion contracts totalling some 21 000 tU under numerous long-term agreements, and commitments for the 10 years beyond 1992 totalling 28 400 tU as UF_6.

In the United States, Allied-Signal Inc. and General Atomics announced on November 23 the establishment of a new company called ConverDyn, which will be owned equally by the two companies. The undertaking would see General Atomics' subsidiary, Sequoyah Fuels Corporation, place its troubled Oklahoma uranium conversion facility on indefinite stand-by until market conditions improved, and ConverDyn would lease the full production capacity of Allied's Illinois facility to fulfil all existing Allied-Signal and Sequoyah conversion contracts. However, a series of regulatory transgressions that caused the Oklahoma facility to be repeatedly shut down by the U.S. Nuclear Regulatory Commission eventually led to a decision that the plant would not re-open. This consolidation will better balance supply and demand in the Western World conversion business such that all four Western converters, including Cameco, stand to gain.

Nuclear Power Developments

Domestic

Developments in Canada had an important impact on the domestic nuclear program during 1992. At the end of the year, the combined generating capacity of Canada's 20 in-service CANDU reactors was about 13 675 megawatts electric (MWe) (see Table 10). In mid-1992, over 15% of Canada's electric power was nuclear-generated; in Ontario, nuclear-generated electricity at mid-year exceeded 46%, and in New Brunswick it was over 26%. The average capacity factor for the first nine months of 1992 for all CANDU 6 reactors was 90.4%, and their cumulative lifetime capacity factor to September 30, 1992, was 85%.

At Ontario Hydro's Darlington Nuclear Generating Station (NGS) east of Toronto, the fuel bundle problem in the new 881-MWe units was resolved by changing impellors in the main circulating pumps from a 5-vane to a 7-vane design. Unit 1 was restarted on July 13 and declared in-service on November 14, 1992, while Unit 2 was restarted on September 8; it had been declared in-service in December 1990. At year-end, Units 1, 2 and 3 were running at full power, and Unit 4 had been loaded with fuel, with criticality expected in February 1993.

Units 1, 2 and 3 at Ontario Hydro's Pickering NGS east of Toronto underwent successful retubing programs during the 1980s, and are among the top performing nuclear units in Canada with an average capacity factor of 87% for the January-September 1992 period. Retubing of Unit 4 is nearing completion.

At Ontario Hydro's Bruce NGS northwest of Toronto, boiler tube repairs continued into 1992 on Units 1 and 2 as part of a multi-million dollar rehabilitation of the entire station, but the plan to replace pressure tubes in Units 1 and 2, as part of a $1.2 billion project beginning in early 1994, could be put on hold by the Ontario government (see below).

Ontario Hydro's Demand/Supply Update released in January 1992 resulted in a substantial deferral in the "need" date for new base-load capacity and indicated a surplus of generating capacity of about 5000 MWe in the mid-term. Since the release of the Update, the utility has been involved in a detailed analysis of its capital expenditures program. On October 19, 1992, Ontario Hydro's Board of Directors approved a plan which reduces capital expenditures by more than $7 billion over the next 10 years. Most of the capital cost reductions will be realized by deferring planned generating and transmission projects and some energy management programs. The Ontario Hydro analysis presented in the plan to the Board indicated a net benefit in both economics and customer rates of proceeding with the planned nuclear rehabilitation program at the four-unit Bruce A plant. The alternative would be to shut down one or all four of the Bruce A units. The Board has requested a more in-depth review of the economics of the rehabilitation plan; the review will take about six months.

The New Brunswick Power Corporation's Point Lepreau NGS continues to perform exceptionally well, with a gross lifetime capacity factor to the end of September 1992 of 93%. The utility continues to view nuclear power as an important option for long-term electricity supply, but because of the decline in electricity demand and forecasts showing that new base-load capacity will not be needed until the year 2005, discussions toward the utility's proposed purchase of a CANDU 3 reactor have been put on hold.

In 1991, Atomic Energy of Canada Limited (AECL) and SaskPower signed a Memorandum of Understanding (MOU) which called for the formation of a new corporation in Saskatchewan, jointly owned by both parties, to explore nuclear industrial opportunities in the province, specifically the construction of a CANDU 3 reactor. Although the newly elected New Democratic Party government of Saskatchewan cancelled the MOU in March 1992, a new MOU with AECL was signed on December 21, 1992. The new MOU will enable AECL and Saskatchewan to work jointly on the design of the new CANDU 3 reactor and study the potential for establishing other nuclear businesses and facilities in the province. The five-year agreement calls for the transfer of AECL's design, engineering and marketing offices for CANDU 3, including 140 positions, to Saskatoon from Mississauga, Ontario. It does not commit Saskatchewan to purchase a reactor.

International

On the international front, the Canadian government announced on September 18, 1992, that AECL had successfully marketed two more CANDU nuclear power plants to South Korea in a deal that will result in C$500 million in contracts for Canadian companies. AECL received an invitation in December 1991 to bid on an additional two CANDU 6 reactors for South Korea, namely Wolsong 3 and 4, which are scheduled to come into service in 1998 and 1999, respectively. Wolsong 1 has been operating since 1983, and Wolsong 2 is currently under construction and scheduled to commence operation in 1997. The four Wolsong CANDU 6 reactors will each have a generating capacity of up to 700 MWe.

In 1992, Canada continued active participation in a variety of international activities focussed on the safety of Soviet-designed reactors in FSU countries. Canada chairs Working Group V under the European Energy Charter, which was charged with drafting the Nuclear Energy Protocol; when completed, the Protocol will codify good practices in areas of nuclear safety, cooperation and trade, including non-proliferation policies already in practice in Western countries. In May 1992, then EMR Minister the Honourable Jake Epp visited Russia and signed an MOU on nuclear cooperation with his Russian counterpart.

Canada is also active in various programs encouraging bilateral and multilateral nuclear safety initiatives. Bilateral initiatives (under way and proposed) include commercial programs, as well as assistance programs, in the areas of reactor safety and regulation. Some progress has been made on the implementation of the C$30 million Canadian Nuclear Safety Initiative (CNSI), and an AECL team visited Russia to scope out the Assessment Phase of the initiative. In addition, Canada is making a major contribution in the former Eastern Bloc in its work with Romania, and discussions have started with regulatory authorities in Russia, Ukraine and Lithuania regarding regulatory training.

In the latest (1992) "Red Book," published jointly by the Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development (OECD) and the International Atomic Energy Agency (IAEA), attention is drawn to the fact that world nuclear electricity generation has grown by 143% over the last decade. While there have been some setbacks in certain national programs, growth has been strong with more than 80 new nuclear plants brought on line since the Chernobyl disaster in 1986. Construction began on five new reactors in 1989, bringing to 83 the total number under construction in 1991.

OUTLOOK

Despite the collapse of the Soviet Union and the continued uncertainty in the international uranium market, Canada's uranium industry remains the world's leading uranium supplier. In 1992, uranium production recovered in Canada from the lowest level (1991) in a decade to some 9300 tU. With a firm baseload of long-term supply contracts with customers in the United States, Western Europe and the Far East, Canada's uranium producers are well positioned to compete with the world's foremost uranium suppliers. In addition, Canada's uranium export policy is evolving with changing market conditions, and is as well suited to today's competitive international market as it will be in the future.

While Canada should be able to maintain its leading position in the face of turbulent market conditions, the centre of domestic uranium production is shifting increasingly from Ontario to the world-class, low-cost uranium deposits of Saskatchewan. New Saskatchewan orebodies presently undergoing environmental review should form the basis of continued production well into the next century, although exports of commercial, and possibly military, uranium inventories from the FSU could cloud the outlook well into the 1990s.

Canada's uranium producers are very competitive and well placed to meet future demands. In the long term, there is significant potential for the discovery of additional uranium resources in Canada. Policies are in place to encourage investment in the industry and to maintain Canada's role as a reliable and very competitive supplier to its trading partners. Given adequate market incentives, Canada's uranium industry has the capability to maintain its position as the world's leading supplier of uranium for years to come.

REFERENCES

1 On January 14, 1992, Minatco Ltd. became known as Total Minatco Ltd.

2 Denison also agreed to transfer a 70% interest to Total over the next four years in its Koongarra uranium project in Australia; the value of all considerations, estimated at $25 million, is to be dedicated to uranium development activities in Saskatchewan.

3 On June 2, 1992, about 70% of Urangesellschaft mbH (UG) of Germany was acquired by Cogema of France. In addition to its Kiggavik interests and a 25% share in the Gas Hills, Wyoming, in-situ uranium venture in the United States, UG is involved, through minor participation interests, in other uranium properties in Niger, Namibia, and Australia.

4 "Canada Remains Western World's Leading Uranium Supplier" - News Release 92/106, EMR Canada, November 12, 1992.

5 In certain cases, the identified operator has reported the total expenditures of a joint-venture effort. Therefore, contributions by other parties not responding to the URAG survey are accounted for in the $45 million total.

6 NUEXCO, a Colorado-based uranium brokerage firm, originally called the Nuclear Exchange Corporation, publishes a monthly spot-market price. However, following the suspension agreements ending the anti-dumping investigation, NUEXCO established a second spot price applicable to the restricted U.S. market, where most of the spot transactions occur. It is this second price that is referred to in the text above.

Note: Information in this review was current as of February 1, 1993.

TABLE 1. URANIUM PRODUCTION IN CANADA AND WORK FORCE SUMMARY, 1990 AND 1991

Province and Producer	Total Work Force[1] (Dec. 31) 1990	1991	Annual Output[2] (tU) 1990	1991
ATHABASCA BASIN, SASKATCHEWAN				
Cluff Mining (Amok, 80%; Cameco, 20%)	145	119	771	717
Key Lake JV (Cameco, 67%; Uranerz, 33%)	370	389	4 976	5 421
Rabbit Lake JV[3] (Cameco, 67%; Uranerz, 33%)	230	209	–	745
Subtotal	745	717	5 747	6 883
ELLIOT LAKE, ONTARIO				
Denison Mines Limited	1 300	902	1 319	757
Rio Algom Limited				
Quirke[3]	–	–	774	–
Panel[3]	–	–	440	–
Stanleigh	450	576	449	520
Subtotal	1 750	1 478	2 982	1 277
Total	2 495	2 195	8 729	8 160

Sources: Company annual reports; Atomic Energy Control Board open files.
– Nil.
1 Figures (rounded) are for company employees only; on-site contractors are not included.
2 Primary output only. In 1991, an additional 44 tU was recovered by the Elliot Lake producers from Cameco's refinery/conversion facility by-products, compared with about 50 tU in 1990, 31 tU in 1989, and 73 tU in 1988. These amounts are NOT included in the Canadian totals of primary uranium production. 3 The Rabbit Lake mill, closed throughout 1990, was restarted in August 1991; the Quirke and Panel operations were permanently closed in August 1990.

TABLE 2. VALUE[1] OF URANIUM SHIPMENTS[2] BY PROVINCE, 1987-92

	Unit	1987	1988	1989	1990	1991	1992p
Ontario producer shipments	tU	4 901	3 872	4 099	4 597	1 288	1 033
Value of shipments	$ million	581	446	501	627	271	202
Saskatchewan producer shipments	tU	8 711	8 194	6 896	5 123	6 911	8 069
Value of shipments	$ million	601	572	412	261	333	382
Total producer shipments	tU	13 612	12 066	10 995	9 720	8 199	9 102
Total value of shipments	$ million	1 182	1 018	913	888	604	584

p Preliminary.
1 Value of shipments includes the value of uranium recovered from the refinery/conversion facility by-products, noted in Table 1, which are not included in primary production. 2 Shipments in tonnes of uranium (tU), contained in concentrate, from ore-processing plants.

TABLE 3. OPERATIONAL CHARACTERISTICS OF EXISTING CANADIAN URANIUM PRODUCTION CENTRES, 1991

Company/ Facility Name	Ore-Processing Plant[1] Capacity Nameplate/ Actual	Recovery Overall	Annual Throughput Ore Total	Ore Grade
	(t/d)	(%)	(t)	(%)
Cluff Mining/ (Amok operator) Cluff Lake	+ 900/ 710	97	119 000	0.66
Denison Mines Limited/ Elliot Lake	7 700/ 5 000[e]	94[e]	1 058 000	0.08
Rabbit Lake JV (Cameco operator)/ Rabbit Lake	2000 1 860[a]	93	155 000	0.6
Key Lake JV (Cameco operator)/ Key Lake	+ 800/ + 820[e]	99	262 000	2.0
Rio Algom Limited/ Elliot Lake Stanleigh	+ 4 500/2 965	95	685 000	0.08

Sources: Corporate annual reports; Atomic Energy Control Board open files.
[e] Estimated.
[a] Mill restarted July 31, 1991.
[1] Figures are rounded.

TABLE 4. URANIUM EXPLORATION ACTIVITY IN CANADA, 1976-91

Year	Expenditures[1]	Drilling[2]	Million-Dollar Projects[3]
	($ million)	(km)	(number)
1976	44	155	4
1978	90	334	7
1980	128	503	24
1982	71	247	13
1984	35	197	12
1986	33	162	11
1987	37	164	12
1988	59	201	11
1989	58	158	11
1990	45	66	6
1991	44	67	4

[1] Direct exploration and drilling expenditures in current dollars. [2] Exploration and surface development drilling; excludes development drilling on producing properties. [3] Number of projects where direct exploration and drilling expenditures exceeded $1 million in current dollars.

TABLE 5. ESTIMATES OF CANADA'S URANIUM RESOURCES RECOVERABLE FROM MINEABLE ORE,[1] JANUARY 1, 1991, AND JANUARY 1, 1992

Price Ranges Within Which Mineable Ore is Assessed[2]	Measured		Indicated		Inferred	
	1/1/91	1/1/92	1/1/91	1/1/92	1/1/91	1/1/92
	(000 tU)					
Up to $100/kgU	29	35	117	240	149	30
$100 to $150/kgU	3	1	65	84	80	60
Subtotal	32	36	182	324	229	90
$150 to $300/kgU	17	0.1	40	8	94	0.9
Total	49	36	222	332	323	91

[1] Actual or expected losses in mining recovery and ore processing have been accounted for; these factors were individually applied to resources tributary to existing or prospective production centres. In underground operations, mineable ore is generally 75% to 85% of the ore-in-place; higher mining recoveries are achievable in open-pit operations. Ore-processing recoveries in Canada normally range from 90% to 97%; Canada's weighted average mill recovery for existing conventional uranium operations was 96% in 1991. [2] The Canadian dollar 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. The price of $100/kgU was used by URAG to illustrate those resources that were of economic interest to Canada in 1990 and 1991.
Note: $1/lb U_3O_8 = $2.6/kgU.

TABLE 6. PRODUCTION OF URANIUM IN CONCENTRATES BY MAJOR PRODUCING COUNTRIES, 1985-91

	1985	1986	1987	1988	1989	1990	1991
	(tonnes U)						
Canada[1]	10 880	11 720	12 440	12 470	11 350	8 780	8 200
United States	4 350	5 200	5 000	5 190	5 320	3 420	3 060
South Africa	4 880	4 610	3 960	3 850	2 950	2 530	1 710
Namibia	3 600	3 300	3 540	3 600	3 100	3 210	2 450
Australia	3 250	4 150	3 780	3 530	3 660	3 530	3 780
Niger	3 180	3 110	3 000	2 970	2 990	2 830	2 960
France	3 200	3 250	3 380	3 390	3 240	2 830	2 480
Gabon	940	900	800	930	850	710	690
Other[2]	900	870	890	910	940	3 800	2 250
Total[3]	35 180	37 110	36 790	36 840	34 400	31 640	27 580

Sources: *Uranium: Resources, Production and Demand*, a report jointly produced by the Nuclear Energy Agency of the OECD and the International Atomic Energy Agency, and miscellaneous corporate, national and international reports.
[1] Canadian figures from 1988 onward include uranium recovered from refinery/conversion facility by-products, and differ from primary production figures shown elsewhere. [2] Includes Argentina, Belgium, Brazil, Germany (West), India, Israel, Japan, Portugal, Spain and Yugoslavia; for 1990 and 1991, Pakistan, Hungary and Germany (East) are included. [3] Totals are of the listed figures only.
Note: Country figures are rounded to the nearest 10 tU.

TABLE 7. CANADIAN URANIUM UNDER EXPORT CONTRACTS[1]

Country of Buyer[2]	Tonnes U
Argentina[3]	49
Belgium	3 110
Finland	3 049
France	9 845
Germany	14 331
Italy	1 115
Japan	21 178
South Korea	8 042
Spain	3 559
Sweden	8 897
Switzerland	154
United Kingdom	7 039
United States	76 336
Total	156 704

[1] The nominal quantity of uranium in all contracts reviewed and accepted under Canadian uranium export policy since September 5, 1974. Country totals are adjusted to reflect new and amended contracts, and the exercising of quantity-flexibility options, as of December 31, 1992. [2] In most cases, indicates country of end-user. [3] Initially as manufactured fuel bundles for Argentina's CANDU reactor.

TABLE 8. CANADIAN URANIUM EXPORT PRICE,[1] 1974-92

Year	Average Export Prices: Current Dollars	Average Export Prices: Constant 1992 Dollars	Spot Sale Portion of Deliveries
	($kg/U[2])		(%)
1974	39	108	n.r.
1975	52	131	n.r.
1976	104	240	n.r.
1977	110	239	n.r.
1978	125	256	n.r.
1979	130	242	n.r.
1980	135	227	n.r.
1981	110	167	1
1982	113	158	1.5
1983	98	131	10
1984	90	116	26
1985	91	115	20
1986	89	109	21
1987	79	93	35
1988	79	89	13
1989	74	79	<1
1990	71	74	<1
1991	61	62	<2
1992	59	59	<1

n.r. Not reported.
[1] EMR's Uranium Resource Appraisal Group (URAG) derives the Export Price figure annually. It is based on the average price under all export contracts made by Canadian producers for deliveries in the given year; prices are rounded.
[2] $/kgU x 0.38465 = $/lb U_3O_8.
Note: The constant dollar values are derived using the Implicit Price Index for Gross Domestic Product.

TABLE 9. EXPORTS OF URANIUM OF CANADIAN ORIGIN, 1985-91

Country of Final Destination	1985	1986	1987	1988	1989	1990	1991
	(tonnes of contained uranium[1])						
Argentina	–	–	–	–	–	–	19
Belgium	157	63	–	153	190	–	–
Finland	81	116	142	151	71	83	–
France	612	1 013	1 438	964	696	799	822
Germany	269	654	1 317	806	615	220	459
Indonesia	–	–	–	–	1	–	–
Italy	53	301	293	–	46	–	–
Japan	1 799	816	1 317	717	1 729	2 005	399
Netherlands	–	85	40	–	–	–	–
South Korea	194	402	828	874	635	339	215
Spain	–	150	150	100	97	–	–
Sweden	514	449	377	783	497	285	91
Turkey	–	2	–	–	–	–	–
United Kingdom	685	700	824	1 204	871	882	498
United States	3 524	3 692	6 063	4 682	3 950	4 035	5 307
Total	7 888	8 443	12 789	10 434	9 398	8 648	7 810

Source: Atomic Energy Control Board.
– Nil.
1 Some of this uranium was first exported to an intermediate country, for conversion and/or enrichment, prior to transfer to the country of final destination.

TABLE 10. NUCLEAR POWER PLANTS IN CANADA[1]

Reactors	Owners	Net Capacity	In-Service Dates
		(MWe)	
Pickering 1 to 4	Ontario Hydro	2 060	1971-73
Bruce 1 to 4	Ontario Hydro	3 076	1977-79
Point Lepreau	NB Power[2]	635	1983
Gentilly 2	Hydro-Québec	638	1983
Pickering 5 to 8	Ontario Hydro	2 064	1983-86
Bruce 5 to 8	Ontario Hydro	3 394	1984-87
Darlington 1 to 4	Ontario Hydro	3 524	1990-93[f]
Total net capacity (MWe) expected by 1993		15 391	

f Forecast.
1 As of January 1992. 2 The New Brunswick Power Corporation.

Wollastonite

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Wollastonite is a relatively new mineral that is receiving an increasing amount of attention for new uses and applications. It is a brilliant white to gray or brown calcium metasilicate, $CaSiO_3$, with a composition when pure of 48.3% CaO and 51.7% SiO_2. It occurs predominantly as a contact metamorphic deposit forming between limestones and igneous rocks, often associated with garnet, diopside, epidote, calcite and quartz. Wollastonite occurs in coarse-bladed masses usually as acicular or fibrous forms even in the smallest particles. The fibre lengths are commonly in the ratio of 7 or 8 to 1; this is referred to as the "aspect ratio," and is the basis for many of its uses.

Canadian Occurrences

In eastern Canada, a deposit of wollastonite occurs at Lime Hill, 20 km northeast of Port Hawkesbury on Cape Breton Island, Nova Scotia. In Quebec, an extensive deposit of banded wollastonite-diopside skarn occurs near Lac St-Jean; initial sampling has indicated that the wollastonite aspect ratio is 15 to 1. The principal wollastonite deposit in Ontario occurs about 3 km from the town of Deloro, near Marmora in Hastings County, about 175 km northeast of Toronto. The wollastonite occurs in a skarn of silicified dolomite. A substantial deposit also occurs in Olden Township about 6 km south of Mount Grove, Ontario; initial sampling indicated aspect ratios to be between 10 to 1 and 12 to 1. A deposit also occurs at Seeley's Bay, near Kingston, Ontario; drilling on the property started in June 1992.

There are several potentially economic wollastonite skarn deposits in British Columbia, which have been recently documented. Five areas are described: Sechelt, Little Billy mine, Fintry Point, Silence Lake mine, and Horsethief Creek. The Sechelt and Little Billy Mine deposits occur in the southeast portion of the province near Vancouver, and the Fintry Point, Silence Lake, and Horsethief Creek deposits occur in the southwest portion. In the Yukon Territory, a wollastonite deposit has recently been discovered approximately 400 km from the port town of Haines, Alaska.

Canadian Production and Trade

Wollastonite is not produced in Canada, and import and export statistical data for wollastonite in Canada are not reported. It is anticipated, however, that production of wollastonite will commence in either Ontario or Quebec before 1995. The North American market, which includes Canada, the United States and Mexico, consumes about 100 000-110 000 t/y. Consumption by application in these countries as reported at the *Industrial Minerals '92* seminar in Toronto is ceramics, 25%-30%; plastics, 25%-30%; friction products, 10%-15%; paints, 10%-15%; and miscellaneous applications, 10%-20%.

World Production

Production of wollastonite increased during the 1980s as the small number of producers increased their capacities. Production levels are predicted to continue their upward trend during the 1990s as the number of producers increases. The supply of wollastonite has been dominated by the two U.S. producers, NYCO and R.T. Vanderbilt, but their share of the world market has decreased from 85% in 1976 to an estimated 35% in 1990. The total world production in 1990 was approximately 385 000 t, of which the U.S. proportion was 35% and China's 25%.

United States

NYCO has approved a US$14 million investment to increase its wollastonite production capacity by 50% to about 120 000 t/y by 1995. The four-year program will include modernization and expansion of the company's 40-year-old processing plant at Willsboro, New York; new primary and secondary crushing equipment will be installed and statistical process control will be added. Feed ore for the processing plant is supplied by NYCO's existing mine at Lewis, New York, and plans for the new mine at Oak Hill, New York, are on schedule. Despite a decrease in its share of the world market, NYCO is still the largest single exporter, supplying approximately 40 000 t in 1990, mostly to Western Europe. The total estimated U.S. production rose 8.2% between 1987 and 1992.

USES

Wollastonite is used in ceramic, filler and flux applications because of its unique physical, chemical and electrical properties. The highly acicular material can contribute to strengthening the structural characteristics in a filler system, and the powdered material can prove advantageous for use as an inert high-brightness filler or fluxing additive in either ceramic or metallurgical applications.

The largest volume of wollastonite used in the ceramics industry is consumed in wall-tile bodies and coating-glaze formulations, although smaller volumes are sometimes used in sanitary ware, earthenware, and various specialized ceramic-body applications. Wollastonite used in refractory applications is used in load-bearing refractories, in metal-casting plasters, in investment castings and a variety of other casting processes. It may also be added to structural clay products, such as sewer pipe and building brick, to prevent chipping during handling.

The paint industry uses wollastonite in high-quality paints and bright-coloured paints, especially the pastel shades. It is used in exterior paints where it increases weathering resistance; in latex paints, wollastonite increases brightness and caulking reinforcement in the paint formulation. When employed in specialty paints, particularly industrial anti-corrosive coatings and textured paint, the acicular nature of wollastonite gives it a distinct advantage over cheaper minerals.

The resin-plastics industry uses wollastonite as a performance filler. It can also be used as an extender in vinyl plastisols and linoleum, and as a non-moisture absorbent filler in thermosetting, thermoplastic moulding compounds, and casting resins. Surface-coated wollastonite, which increases compatibility between the filler and the resin-plastic media, also contributes to the physical, chemical and electrical properties of the finished product.

Wollastonite is also used for a variety of other applications: in specialized ultra-high frequency electronic equipment such as high-temperature porcelains and high-tension circuit breakers; in ceramic artware; as a filler in grinding wheel-bonding formulations, ceramic-bonded abrasives and abrasive wheels; in wollastonite-phosphate cement for such applications as decorative cement, insulating cement and flame-resistant coatings; in porcelain enamels; and in emulsion paints to add burnish resistance and acoustical properties to the surface of ceiling tiles. Wollastonite can replace limestone in the manufacture of glass since it not only acts as a source of lime, but also adds silica to the melt. It is often used as a metallurgical flux and as a coating on welding rods to ease flux applications. Minor applications include joint cements, laminates, marking compounds, matches, oil filters, plywood, urethanes and wallboard.

WOLLASTONITE AS AN ASBESTOS SUBSTITUTE

There is a growing market for wollastonite as a replacement for asbestos in some end uses because of health concerns associated with asbestos; however, wollastonite will only be able to act as an asbestos substitute in short fibre applications. Wollastonite is acicular enough to be used as a semi-fibrous filler in insulating boards and panels; it also has very good heat-resistant properties. These panels are used in the nonferrous smelting industries, particularly the aluminum industry. Other uses include heat containment in ovens and dryers, secondary insulation, and high-temperature ducting. Wollastonite is also used to replace asbestos in other uses such as in flooring tiles and other plastics, in coatings and roofing insulation, and a limited application in brake linings for disc brakes and semi-metallic brakes, and other friction products. The application of wollastonite in PVC floor tiles and insulating boards is likely to experience the greatest increase in wollastonite consumption.

SYNTHETIC WOLLASTONITE

Synthetic wollastonite is manufactured in countries that either do not possess the natural mineral or for whom the cost of importing natural wollastonite is uneconomic. The sintering process developed at Wülfrath in Germany is the most economic. The process requires quartz flour and finely ground limestone or dolomite, which are mixed and heated in a rotary kiln to a temperature below the melting point of wollastonite. The main use of synthetic wollastonite is in ceramic applications, such as earthenware, in which it substantially reduces the expansion due to water and increases the strength of the fired earthenware. Synthetic wollastonite is also used in fast-firing bodies for wall tiles, porcelain and sanitaryware, as a rheological additive for resins and paints, as a reinforcing agent for different polymer matrices, as a carrier for dry liquids, as a component in asbestos-free friction materials, as a carrier in chemical and biochemical catalytic reactions, and in flooring and roofing felt.

PRICES

Prices at the end of 1992 quoted in *Industrial Minerals* for wollastonite per tonne, f.o.b., were approximately US$187 for acicular, minus 75 microns; US$234 for minus 44 microns; US$258 for minus 38 microns; US$315 for 15:1-20:1 aspect ratio; and US$644 for ground minus 10 microns. Prices for bulk f.o.b. plant were US$160 for minus 75 microns, and US$202 for minus 44 micron material. Specialized coated grades vary from approximately US$700 to $1000/t. There was a 6%-10% price increase for most grades between 1991 and 1992.

OUTLOOK

It seems that the wollastonite industry is set to experience strong growth in the 1990s. The chief areas will be in fine-particle size, high-aspect ratio, and chemically modified grades. Market sectors which are perceived as growth areas include plastics and substitution for asbestos in some applications. Wollastonite, however, faces competition from manufactured carbon fibres and calcium sulphate whiskers that have been developed primarily for the asbestos replacement market. The U.S. consumption of wollastonite in asbestos replacement, as reported in unpublished sources, is about 10 000 t/y.

High-aspect-ratio wollastonite is expected to be a major competitor to short-milled glass fibres on a cost basis, and fine-particle-size grades will have major applications in electronics, plateable plastics, and powder coatings. Wollastonite is expected to perform well in plastics; overall, the market for this application is expected to grow by about 5%. Intense and sustained technical support will be required to create such a market for wollastonite. In penetrating the plastics market, wollastonite producers and processors are increasingly finding that their products need to be chemically modified in order to satisfy customer and end-product requirements, and so enhance their market prospects in such applications as engineering thermoplastics. A potential producer will have to offer an extremely high-quality, cost-effective product or exploit a niche market if it is to compete with established producers.

Note: Information in this review was current as of February 1, 1993.

Zinc

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Price volatility characterized zinc markets throughout much of 1992. Speculative activity, as well as fears of labour disputes at Canadian smelters, kept prices fairly buoyant throughout much of the year. Rapid price declines late in the year were caused by reduced threats of strikes, record stock levels and weak demand due to a continuing recession. The average price for Special High Grade zinc on the London Metal Exchange (LME) was US56¢/lb, up from US51¢/lb in 1991.

Western World zinc consumption totalled 5 358 000 t in 1992, down slightly from the total in 1991. The stronger demand in North America was overshadowed by weaker consumption in Europe and Japan. Mine production was 5 581 000 t, marginally higher than in 1991. Significant increases in Canada and India were offset by decreases in Europe, Australia and Peru. Zinc metal production was 5 346 000 t, slightly lower than the total in 1991.

Zinc stocks grew throughout 1992 and, at the end of the year, were 995 000 t as imports from Eastern Bloc countries continued to arrive in LME warehouses. A large surplus of zinc metal is forecast for 1993. Mine production cutbacks initiated in late 1992 will probably continue in 1993 to reduce concentrate surpluses which have resulted in higher smelter treatment charges.

Increased demand in 1993 is unlikely to offset high stock levels which overhang the zinc market. The price of zinc is forecast to fall further to average US53¢/lb in 1993.

Canadian Developments

Canadian mine production in 1992 totalled 1 324 000 t, an increase of 176 000 t from 1991. The increase was due to the absence of labour disputes at Canadian mines. Cutbacks in mine production late in the year, however, were in response to low zinc prices and a large world surplus of concentrates. Canada remained the world's largest producer of zinc concentrate, accounting for 24% of the Western World's supply in 1992.

Three mines closed in 1992 due to an exhaustion of ore reserves. In 1993, further cutbacks are expected in response to an oversupply of concentrates and low zinc prices. No new zinc mines opened in Canada in 1992.

Canadian metal production in 1992 totalled 670 000 t, a 1% increase over 1991. Canadian zinc smelters were not affected by labour disputes or major production problems.

British Columbia

In January, Cominco Ltd. announced that it would implement a restructuring of its Trail smelter operations in order to reduce annual costs by $50 million. The plan was to include the reduction of 500 jobs at Trail in 1992, as well as initiatives to reduce energy, transportation and other costs. The company also indicated that it would seek a reduction in municipal and provincial taxes.

In August, Cominco announced that it would advance by 18 months the move to a land-based disposal system for treated tail slag, ending the practice of discharging this material into the Columbia River. The tail slag is a product of the fuming of slags from lead smelting operations for the recovery of additional lead, zinc and other metals.

Minnova Inc. closed its polymetallic Samatosum mine near Barrière in September due to an exhaustion of reserves. Minnova commenced a reclamation program at the mine site. The open-pit/underground mine had a capacity of 5000 t/y of zinc in concentrate.

Curragh Inc. received a Mine Development Certificate from the B.C. government which will allow the company to develop the Stronsay lead-zinc deposit north of Mackenzie. The proposed underground mine and associated milling facility would process 3500 t/d of ore to produce 100 000 t/y of zinc in concentrate. Initiation of the project will be conditional on financing by Curragh.

Yukon

Curragh Inc. began stripping its Grum lead-zinc orebody near Faro in April. Reserves at the Vangorda and Faro mines will be exhausted by early 1993 after which mining will shift to the Grum orebody. The Yukon government has provided a C$5 million loan to Curragh towards the stripping at Grum. Curragh also received C$60 million for the sale of its 20% interest in Asturiana de Zinc SA.

Curragh closed its Sa Dena Hes mine near Watson Lake on December 2 and its Faro operations on December 19, 1992. Both operations were scheduled to re-open in early February 1993. The company stated weak lead and zinc prices and an oversupply on world concentrate markets as reasons for the temporary closures. The Faro operations were also closed for three weeks in October for maintenance purposes.

Northwest Territories

Minnova Inc. and its partner, Metall Mining Corporation, continued exploration of the Izok Lake volcanogenic massive sulphide deposit 360 km north of Yellowknife. Reserves, mostly in the probable category, now stand at 13.6 Mt grading 2.5% copper, 14.6% zinc, 1.6% lead, 77.7 g/t silver and 0.1 g/t gold. The partners are carrying out metallurgical sampling and environmental and transportation studies in preparation for a feasibility study on putting the deposit into production. During the summer field season, the satellite Inukshuk massive sulphide deposit was discovered.

Manitoba

Hudson Bay Mining and Smelting Co., Limited (HBMS) closed its Spruce Point copper-zinc mine near Snow Lake in March due to an exhaustion of reserves. The mine had a capacity of 5800 t/y of zinc in concentrate. The closure left only two mines at Snow Lake to supply the 28 000-t/y Snow Lake concentrator. Reserves at these two mines (the Stall Lake underground mine and the Chisel open-pit) are due to run out within two years, whereupon HBMS has indicated that it will close its entire Snow Lake operations. A committee has been put in place to commence the closure procedures.

HBMS continued with the modernization of its Flin Flon smelting complex during the year. The new zinc pressure leach plant is scheduled to start up by June 1993. This would allow the company to meet new sulphur dioxide emission standards that take effect at the end of 1993. Because of cost overruns for the construction of the zinc plant, HBMS indicated in November that it intended to delay improvements to its copper smelter for approximately 8-12 months.

Quebec

Development work continued on the Louvicourt copper-zinc massive sulphide deposit near Val-d'Or. Aur Resources Inc. reached an agreement with Teck Corporation whereby Teck can earn a 25% interest in the deposit by paying Aur C$15 million and contributing C$55 million toward the C$326 million development cost. This will leave Aur with a 30% interest in the project. The remaining 45% is owned by Noranda subsidiary Novicourt Inc. The 5000-t/d mine is expected to come on stream in late 1994, producing 28 000 t/y of zinc in concentrate.

Audrey Resources Inc. and partner Minnova Inc. closed their Mobrun copper-zinc mine near Rouyn-Noranda due to an exhaustion of mineable reserves in the upper levels of the mine. A $23 million underground exploration program was approved to deepen the shaft beneath the current workings and to test the 1100 and C lenses. Proven and probable reserves on the property are estimated at 9.6 Mt grading 0.7% copper, 5.1% zinc, 28 g/t silver and 1.6 g/t gold. In late September, Cambior inc. obtained a 65% interest in Audrey. Cambior also acquired a majority interest in VSM Exploration Inc. which, along with Serem-Quebec Inc., owns the Grevet copper-zinc project near Lebel-sur-Quévillon.

Breakwater Resources Ltd. announced in December that it would re-open its Estrades mine near Joutel in March 1993. The mine, which contains a reserve of 276 000 t grading 13.6% zinc, 1.3% lead, 0.9% copper, 215 g/t silver and 7.5 g/t gold, was closed and placed on care and maintenance in June 1991 due to low metal prices. Zinc and copper concentrates are to be produced on a custom milling basis at Noranda's Mattagami mill, and Breakwater also plans to recover 220-250 kg/y of gold with the installation of a gold circuit.

BP Resources Canada Limited sold its 61% interest in the Selbaie zinc-copper mine near Joutel to partner Billiton Metals Canada Inc. Billiton now completely owns the open- pit/underground mine and 6700-t/d mill.

In April, Noranda Inc. announced that it would restructure its wholly owned subsidiary, Canadian Electrolytic Zinc Limited (CEZ), into a separate self-managed unit. In November, workers at CEZ's 230 000-t/y electrolytic zinc refinery ratified a new three-year labour contract.

New Brunswick

Arimetco International Inc. acquired a 35% interest in Breakwater Resources Ltd. It also acquired 50% of Breakwater's Caribou mine near Bathurst by assuming 50% of the mine's debt. Breakwater closed the Caribou mine in October 1990 due to low metal prices. Arimetco plans to set up a pilot plant to test a low-temperature ammonia leach and solvent extraction-electrowinning process on Caribou bulk concentrates. The company hopes to solve metallurgical difficulties associated with the complex Caribou ores.

Recent improvements in productivity at Brunswick Mining and Smelting Corporation Limited's Brunswick mine have resulted in increased mill throughput and concentrate production. Daily throughput rose to 10 400 t/d for the third quarter of 1992 compared to 9700 t/d in 1991. Operating costs have also been significantly reduced.

Nova Scotia

Dundee-Palliser Resources Inc. acquired an option until February 1, 1993, to purchase the Gays River zinc-lead mine from Westminer Canada Limited. Westminer suspended operations at the mine in May 1991 after experiencing groundwater and ground stability problems.

World Developments

Western World mine production was 5 581 000 t, very similar to the total of 1991. Increases in Canada and India were more than offset by decreases in Europe, Australia and Peru.

Europe

European output of zinc concentrates was down for the fifth consecutive year. In 1992, Europe accounted for only 14% of the Western World total. In Germany, closure of the Hilfe Gottes and Meggan mines more than offset the openings in Sweden of the Petiknas and Louisa mines, for a total capacity loss of 42 000 t/y of zinc in concentrate.

Lac Minerals Ltd. acquired the 52.5% stake of Chevron Minerals Ltd. in the Lisheen zinc-lead deposit in Ireland. The deposit has proven and probable reserves of 25 Mt grading 12% zinc and 2% lead.

In Eastern Europe, the Bulgarian government announced that it will close 20 unprofitable lead-zinc mines over the next three years. Bulgarian mines were affected by a seven-day strike in March. In 1991, production from Bulgarian mines totalled 31 000 t/y of zinc in concentrate.

Australia

Australian mine production reached 1 025 000 t in 1992, which represented 18% of Western World output. The total was 2% lower than the record level of 1991. Pasminco Ltd. initiated a cost-cutting program at its Broken Hill operations in New South Wales. The company reduced employment levels and closed the North Broken Hill concentrator as well as timbered stopes at the North mine. Pasminco also announced the discovery of a new, shallow lead-zinc orebody near the North mine.

MIM Holdings Limited announced in December that it would reduce mine production of lead and zinc at its Mt. Isa/Hilton complex by 15% in response to weak market conditions. However, the company indicated that it would still go ahead with the development of its McArthur River zinc-lead-silver deposit in the Northern Territory at a cost of US$175 million. The mine, which would be in full production in 1996, should produce 160 000 t/y of zinc in concentrate. MIM holds a 72% stake in the project with the balance being held by several Japanese partners.

Also in the Northern Territory, Aztec Mining Co. Ltd. deferred an $A67 million expansion at its Woodcutters lead-zinc mine. The commissioning of a new heavy media plant, along with changes to the flotation circuit and expanded mine production, would have increased zinc concentrate production by 21 000 t/y to 105 000 t/y. The company stated that it would operate at reduced capacity until a sustained improvement in lead and zinc prices took place.

In Queensland, the Thalanga mine of Pancontinental Mining Ltd. reached its full capacity of 42 000 t/y of zinc in concentrate. BHP Minerals Ltd. announced the discovery of the Cannington lead-zinc deposit which, to date, has been identified to contain in excess of 20 Mt grading 10.2% lead, 3.3% zinc and 470 g/t silver. A prefeasibility study on the deposit is under way. Meanwhile, CRA Ltd. continued exploration on its Century deposit, estimated to contain 116 Mt grading 10% zinc, 1.5% lead and 35 g/t silver.

Denehurst Ltd. and Macquarie Resources Ltd. commenced underground mining at the Wilga copper-zinc deposit in Victoria. The mine will initially produce 1000-2000 t/y of zinc. Zinc production is planned to increase to 25 000 t/y after five to seven years.

United States

The United States produced 545 000 t of zinc in concentrate in 1992, marginally higher than in 1991. This represented 10% of the Western World total. Three new mines opened during the year, increasing the capacity of zinc in concentrate by 29 000 t/y. Union Zinc Inc. re-opened its Idol zinc mine in Tennessee in April. Also in April, Formosa Resources Inc. brought its Silver Butte zinc-copper mine in Oregon on stream. In Washington, Equinox Resources Ltd. re-opened its Van Stone zinc-lead mine in August. The mine was closed in late 1991 due to low metal prices. The three openings increased U.S. zinc capacity by 32 000 t/y of zinc in concentrate.

Asarco Incorporated experienced a 23-day strike at its New Market mine in Tennessee in March. The mine produced 17 000 t of zinc in concentrate in 1991.

On October 1, 1992, the U.S. Senate passed the Defense Authorization Bill providing for the disposal of inventories of 27 metals in the National Defense Stockpile. The Bill allows for the disposal of the entire stockpile of 344 000 t of zinc, along with other metals, over five years. The Bill also called for the establishment of a Market Impact Committee to give recommendations on disposing of these metals in a way that would not disrupt metal markets.

Peru

Peru's mine production was 600 000 t in 1992, representing 11% of Western World production. The Peruvian total was a decrease of 4% from the 1990 level. Closures and cutbacks at privately owned mines more than offset increased production by state-owned Centromin Peru S.A.

China

Construction of the Lanping mine in Yunnan Province commenced during the year. With a planned capacity of 60 000 t/y of zinc in concentrate, the mine will be the largest lead-zinc mine in China. The open-pit mine is scheduled to start production in 1995. Rail and highway links are being constructed to reach the mine.

Also under way is an expansion of the Changba zinc-lead mine in Gansu Province, which will raise capacity by 38 000 t/y to 57 000 t/y of zinc in concentrate.

Morocco

The Hajar zinc-lead-copper mine of Compagnie Minière de Guemassa, which opened in 1990/91, reached its full capacity of 72 000 t/y of zinc in concentrate during the year. In addition, the Djebel Aouam mine of Société Minière de Djebel Aouam is currently undergoing an expansion which will be completed in 1993. The expansion will increase its zinc-in-concentrate capacity by 2700 t/y to 5400 t/y.

SMELTING

Western World refined zinc metal production in 1992 totalled 5 346 000 t, slightly less than the record level attained in 1991. Decreases in Europe, Mexico and Peru were largely offset by increases in Asia, particularly in India and the Republic of Korea.

Europe

European zinc metal production in 1992 was 2 171 000 t, 1% lower than in 1991. Increases in Spain and Germany were more than offset by declines in Belgium and Yugoslavia. In Spain, increased production came from Asturiana de Zinc S.A.'s 320 000-t/y San Juan de Nieva smelter, which reached capacity in 1992 after completing an expansion in 1991. In Germany, Ruhr-Zink GmbH completed a 60 000-t/y expansion of its Datteln electrolytic refinery to bring total capacity to 200 000 t/y of refined zinc.

Belgium's Acec-Union Minière SA initiated a rationalization program, which included closure of its Overpelt zinc refinery, early in the year. This resulted in a loss in capacity of 120 000 t/y of refined zinc. Belgium's zinc production fell by 30% from its 1991 level.

United Nations sanctions imposed on Serbia and Montenegro resulted in reduced zinc metal production in the former Yugoslavia as the main producer, Kombinat Olova i Cinka "Trepca," experienced a shortage of fuel, machinery and spare parts. Zinc metal production dropped by over 30% from the 1991 level. In November, some sanctions were temporarily lifted to allow for repair of the dam that is retaining the tailings pond of the closed Brskovo lead-zinc mine. The dam was eroded during heavy flooding of the Tara River and its rupture would have had severe environmental consequences.

Budelco B.V. has submitted a plan to the Dutch government to treat contaminated water at the site of its 205 000-t/y zinc smelter by installing a hydro-geological containment system. Bacteria will be used to precipitate heavy metals in the contaminated water. The Dutch government has also demanded that, effective in 1995, the company be able to treat jarosite residues stored at the plant site or face closure. Pasminco Ltd. has deferred the sale of its 50% ownership in the Budelco smelter pending a resolution of the problem.

Mexico

Force majeure was declared at Industrial Minera Mexico S.A. de C.V.'s San Luis Potosi zinc refinery in March due to an 11-week strike which ended on May 19. The force majeure remained in effect throughout much of the year as a fire, which started just after the strike concluded, destroyed a transformer at the plant. The 113 000-t/y refinery was back in production in September at reduced capacity. Mexico's zinc metal production in 1992 was 20% lower than in 1991.

Met-Mex Penoles SA de CV announced the go-ahead of a two-step expansion at its Torreon lead-zinc-silver smelting complex. The first stage was to expand zinc smelting capacity by 25 000 t/y to 130 000 t/y of refined zinc by the end of 1992. The second phase would bring capacity up to a possible 180 000 t/y by the end of 1995.

United States

Zinc Corporation of America closed its zinc oxide facility in Palmerton, Pennsylvania, in October but indicated that it would be expanding its Monaca, Pennsylvania, plant. The net loss of capacity would be 15 000 t/y of zinc oxide. Meanwhile, Midwest Zinc Co. re-opened the former Pasco zinc oxide plant in Tennessee in September. The plant has a capacity of 16 000 t/y of zinc oxide.

Plazmet Inc. opened its 6000-t/y secondary zinc plant in Texas. The plant will produce Good Ordinary Brand (GOB) zinc.

Japan

Japan remained the world's leading producer of refined zinc, with a total of 729 000 t, accounting for 14% of the Western World total in 1992. No major production problems were reported at Japan's eight zinc smelters and the Japanese market was in oversupply, resulting in increased metal exports.

Pacific Zinc Corp., a joint venture between Nippon Mining & Metals Co. Ltd. (50%), MIM Japan KK (40%), and Mitsui Mining and Smelting Co. Ltd. (10%), announced that it would go ahead with the construction of a new Imperial Smelting Furnace (ISF) lead-zinc smelter which would have a capacity of 120 000 t/y of refined zinc. The smelter, to be built alongside the existing Hachinohe smelter of Hachinohe Smelting Co. Ltd., is expected to be completed in 1994 but must still await the approval of Japan's Fair Trade Commission.

Peru

Peruvian zinc production in 1992 was 116 000 t, 25% lower than in 1991. Minero Peru Comercial S.A.'s 102 000-t/y Cajamarquilla smelter operated at an estimated 75% of capacity during 1992 due to power restrictions throughout much of the year caused by severe droughts. In March, the smelter suffered damage to a transformer. Force majeure was declared on zinc sales in February and remained in effect throughout the year.

India

Hindustan Zinc Ltd. achieved design capacity of 70 000 t/y of refined zinc at its Chanderiya ISF smelter, although some production problems caused a temporary closure at the end of 1992. Combined with the commissioning of the company's Rampura-Agucha mine, India is now self-sufficient in zinc and has become a net exporter.

China

China has announced plans for a major increase in zinc smelting capacity. The new Baiyin smelter of North West Lead and Zinc Smelter is expected to reach its full capacity of 100 000 t/y of refined zinc in 1993. In addition, the state-owned Shaoguan ISF smelter is undergoing a 60 000-t/y expansion and modernization which is expected to raise capacity to 120 000 t/y in 1993.

Thailand

Padaeng Industry Co. Ltd. announced in January that it would undertake a US$60 million modification and expansion program at its Tak smelter in northern Thailand. The program would enable the smelter to process zinc sulphide in addition to the presently used zinc silicate. Its capacity would expand to 120 000 t/y from the current 70 000 t/y of zinc. Padeang Industry also plans to construct a new 80 000-t/y zinc smelter in Thailand in a joint venture with Metallgesellschaft AG. Both projects are scheduled to be completed by 1996.

SECONDARY ZINC

Zinc from secondary sources has become increasingly important in recent years. Figures from the International Lead and Zinc Study Group (ILZSG) indicate that the total recovery of zinc from secondary materials in the Western World in 1991 was 1.83 Mt. Secondary zinc includes high-purity refined zinc, remelted zinc of a purity less than 98.5% zinc, and scrap zinc used in the production of zinc alloys.

With the increasing use of zinc-galvanized steel in the automobile and construction industries, secondary zinc from Electric Arc Furnace dusts has become a significant source of zinc. These dusts contain various elements in a form that renders the dusts inappropriate for disposal in standard landfill sites. Due to the environmental conditions in a landfill, acid generation could result in the mobilization of some deleterious elements and compounds such as cadmium. Consequently, authorities direct that Electric Arc Furnace dusts are to be put into landfills for hazardous wastes. The decreasing space available at such sites and the associated increases in disposal costs have provided a further incentive for recycling. In recent years, technologies for recycling these zinc-bearing materials have been developed.

The Waelz kiln is the most common method of processing Electric Arc Furnace dusts. Waelz oxides are treated in Imperial Smelting Furnaces for the production of refined zinc. The requirement of Waelz kilns to be near their feed source, i.e., near steel mill complexes, would suggest that treatment of these dusts will be most important in the United States, Japan and Western Europe. ILZSG figures indicate that these areas currently have a capacity to produce just over 200 000 t/y of zinc from such dusts, or approximately 89% of Western World Electric Arc Furnace dust treatment capacity.

Canada does not currently process Electric Arc Furnace dusts, although the construction of facilities to do so is being considered. Canada's secondary zinc facilities, operated by Federated Genco Ltd. and Purity Zinc Metals Co. Ltd., have a capacity to produce 13 000 t/y of remelted zinc.

CONSUMPTION AND USES

Western World consumption of zinc fell to 5 358 000 t in 1992, a decrease of 1% from the record level in 1991. Despite improved demand in North America and continued strong consumption in most parts of Asia, European and Japanese demand fell by 2% and 7% respectively. The German and Japanese economies, which remained strong in 1991, began to weaken in 1992 under the impact of the recession.

The use of zinc for galvanizing has grown steadily in recent years and this trend is expected to continue in the future. Galvanizing represented 48% of zinc consumption in 1991. Zinc is used extensively in the automotive and construction industries for corrosion protection and remains the most cost-effective means of protecting steel against corrosion. The galvanization of steel is the fastest growing usage of zinc and has grown steadily in recent years at the expense of almost all other end uses. This trend is expected to continue in the future.

Galvanized steel is used in automobile construction to protect steel from corrosion. The brightest prospects for galvanized steel in the automobile industry are currently in Asia. Japanese and other Asian manufacturers are using increasing amounts of galvanized sheet in response to demands for increased corrosion protection. In North America, where galvanized steel is already extensively used in automobile construction, the application of dual-sided galvanized steel has become increasingly important for exposed body surfaces.

Dofasco Inc. and Japanese partners National Steel Corporation and Nippon Kokan KK began construction of a new 360 000-t/y hot-dipped galvanizing line at Windsor, Ontario, during the year. The plant, which is expected to open in February 1993, will have the capability to produce dual-sided galvanized steel sheet as well as galvannealed steel. Stelco Inc.'s Z-line galvanizing facility in Hamilton also has this capability.

Galvanized steel is also used in construction for structural components, roofing, siding and reinforcement bars. Zinc and zinc-aluminum thermally sprayed coatings are utilized for long-term corrosion protection of large steel structures such as bridges and hydro-electric transmission towers. At the end of 1991, the U.S. government passed a highways bill authorizing the expenditure of US$108 billion over six years on infrastructure construction and repair in the United States. This initiative, along with an economic package announced by the Japanese government of ¥8600 billion for road and airport construction, is expected to initiate consumption growth for galvanized steel in this sector.

A number of zinc alloy coatings have been developed over the years which have superior qualities over pure zinc in specific applications. These include Galfan (90% zinc and 5% aluminum, with the remainder comprised of rare earth elements) and Galvalume (55% aluminum, 43.4% zinc and 1.6% silicon), as well as zinc-iron and zinc-nickel alloys. Galfan, for example, exhibits higher formability and paintability than other coatings, and zinc-nickel alloys reduce the reactivity of high silicon steels.

The manufacture of brass and bronze is the second most important use of zinc, accounting for 1 078 000 t or 19% of consumption in 1991. These alloys are used in plumbing fittings, heating and air conditioning components, and other products. Consumption of brass and bronze is highly dependent upon the performance of the construction industry.

The third most important use of zinc, accounting for 14% of consumption in 1991, is in the die-casting industry for products such as builders' hardware and automobile fittings. The goal of weight reduction in automobiles for increased fuel efficiency has led to a reduction in the use of zinc die-castings. The amount of zinc in automobiles has decreased from an average of 23 kg in the early 1970s to 10 kg in the early 1990s. The development of new alloys and manufacturing techniques, such as thin-walled die-casting, has taken place in recent years to make zinc alloy castings more competitive relative to plastics and other substitute materials.

The balance of zinc consumption is for such items as zinc semi-manufactures, oxides, chemicals and zinc dust. Zinc oxide is an important component in the manufacture of tires and other rubber products.

Rolled zinc has been a popular roofing material in parts of Europe for many years. Eight Canadian zinc producers joined together to sponsor the zinc façade for the Canadian Pavilion at Expo '92 in Seville, Spain. The 3200-m^2 façade was covered with 1-m^2 sheets (about 50 t) of preweathered zinc. One of the main purposes for using rolled zinc for the façade was to make architects and building designers aware of zinc's construction possibilities.

Increased research has been conducted in recent years on the use of zinc in batteries. A zinc-air battery for use in personal computers has recently been developed. This battery uses atmospheric air to generate an electrochemical reaction, instead of oxygen like the standard nickel-cadmium battery uses. The zinc-air battery is said to last three times longer than the nickel-cadmium battery and is easily recyclable.

Zinc powder is used in the production of mercury-free alkaline batteries. Zinc Corporation of America and Mitsui Mining & Smelting Co. Ltd. recently formed a joint venture to produce high-quality zinc powder at ZCA's Monaca, Pennsylvania, smelting complex for the U.S. battery market.

International Lead and Zinc Study Group

The International Lead and Zinc Study Group was formed in 1959 to improve market information and to provide opportunities for regular intergovernmental consultations on lead and zinc markets. Particular attention is given to providing regular and frequent information on supply and demand and on the outlook for lead and zinc.

The Study Group is headquartered in London, England. Its membership includes most major lead and zinc-producing and consuming countries. While it has an extensive information-gathering and dissemination role, the Group has no market intervention powers. It holds a general session each year in the fall. Member countries' delegations include industry representatives as advisors. Canada has been an active member since its inception.

The 37th Session of the Study Group was held in Vienna, Austria, in October 1992 and was attended by representatives of 27 member countries, as well as by observers from several nations and organizations. The 1992 session examined statistical trends, current mine and smelter projects, and the economic outlook for lead and zinc. In addition, trade and environmental issues, such as the transboundary movement of hazardous recyclables, environmental regulations, and developments in recycling, were discussed.

Prices and Stocks

Zinc metal stocks on the LME rose to record levels in response to steady metal production, a continued weak world economy, and increased exports from

Eastern Bloc countries. Despite these events, zinc prices remained surprisingly strong throughout much of the year. The average price on the LME for 1992 was US56.2¢/lb.

Zinc prices began the year at US53.5¢/lb. Prices in January and February remained in the 50¢-53¢ range due to continuing poor demand and rising stock levels. In March the zinc market experienced increasing volatility as prices rose despite little change in the situation of oversupply and low demand. Much of the volatility was introduced by speculative activity on the LME and short covering for June and July option dates. Zinc reached its high for the year of 65.9¢/lb on June 2.

With a cash-to-three-month price backwardation of almost US$200/t developing in June, the LME intervened on June 15 to set daily backwardation limits and zinc prices fell to 58.5¢/lb on June 22. The price rose again, however, throughout the summer, ranging from 60¢ to 65¢/lb. In October, prices fell again in response to increasing metal stocks, a poor outlook for demand, and diminished threats of strikes at major zinc refiners in Canada. The zinc price reached its low for the year of 45.9¢/lb on November 9 and closed the year at 48.0¢/lb.

Zinc stocks stood at 657 000 t at the end of 1991, representing 6.3 weeks of consumption. Stocks rose throughout the year, predominantly due to increased metal exports by Eastern Bloc countries which ended up in LME warehouses in Europe. At the end of 1992, stocks stood at 995 000 t, representing almost 10 weeks of consumption, and included a record 487 600 t on the LME.

HEALTH AND THE ENVIRONMENT

The modernization of Hudson Bay Mining and Smelting Co., Limited's smelter in Flin Flon to install zinc pressure leach (ZPL) technology continued throughout 1992. The ZPL circuit, due to come on stream in the first quarter of 1993, captures sulphur in its elemental form instead of sulphur dioxide. The creation of elemental sulphur in the zinc plant will result in a 25% reduction in sulphur dioxide emissions for the Flin Flon complex, allowing it to meet Manitoba's sulphur dioxide emission regulations.

OUTLOOK

The world economy is expected to make a modest recovery from the recession in 1993. Although economic performance will be strong, the weakening of the German and Japanese economies seen in 1992 will continue throughout much of 1993. Western World zinc consumption in 1993 is expected to be about 3% higher than in 1992 and to reach record levels.

Despite cutbacks by producers, particularly in Australia and Canada, Western World mine production is expected to approach the 1992 total. A large surplus of zinc concentrates will likely occur in 1993.

Zinc metal production is predicted to reach record levels. Increases in Brazil and Germany and a return to normal production levels in Mexico will more than offset the loss of 120 000 t of capacity brought about by the closure of the Overpelt refinery in Belgium in 1992. A small surplus of refined metal over consumption, combined with significant exports by Eastern Bloc countries, will likely lead to a substantial surplus of zinc metal in 1993.

Increased demand in 1993 is unlikely to offset existing record stock levels and a further decline in zinc prices is expected. The average price of zinc in 1993 is forecast to be about US53¢/lb.

In the longer term, consumption of zinc is expected to increase by 2.5%/y through the end of the decade. Growth will be strong in the galvanized steel sector, especially for sheet and strip galvanizing. Increased requirements for corrosion protection for both vehicles and infrastructure will bolster zinc demand. Galvanizing demand will more than offset losses in die-casting, where substitution by other materials will continue to weaken the demand for zinc.

In 1993, Canadian mine production should be marginally lower than in 1992 with some cutbacks in production in response to weak zinc prices. Several labour contracts are scheduled for renewal in 1993, and further losses due to strikes are a possibility. Canadian metal production in 1993 is forecast to be slightly higher than in 1992, primarily due to smelter technology and process improvements.

Mine closures are expected in the Northwest Territories and Ontario in the mid-1990s, but the loss of production will be partially offset by new mine openings in Quebec and British Columbia. Improved zinc prices may stimulate increased exploration in the mid-1990s which, if successful, will help replenish Canada's diminishing reserve base and lead to new mine development late in the decade.

Note: Information in this review was current as of February 1, 1993.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
2603.00	Copper ores and concentrates						
2603.00.00.30	Zinc content	Free	Free	Free	Free	Free	Free
2607.00	Lead ores and concentrates						
2607.00.00.30	Zinc content	Free	Free	Free	1¢/kg on lead content	Free	Free
2608.00	Zinc ores and concentrates						
2608.00.00.30	Zinc content	Free	Free	Free	1¢/kg on lead content	Free	Free
2616.10	Silver ores and concentrates	Free	Free	Free	Free	Free	Free
2616.10.00.30	Zinc content	Free	Free	Free	Free	Free	Free
26.20	Ash and residues (other than from the manufacture of iron or steel), containing metals or metallic compounds containing mainly zinc						
2620.11	Hard zinc spelter	Free	Free	Free	0.9%	Free	Free
2817.00	Zinc oxide; zinc peroxide	10.5%	Free	5.2%	Free	11%	6.5%
28.33	Sulphates; alums; peroxosulphates (persulphates)						
2833.26	Of zinc	9.2%	6%	Free	0.3%	9%	5.8%
79.01	Unwrought zinc						
	Zinc, not alloyed						
7901.11	Containing by weight 99.99% or more of zinc	Free	Free	Free	0.9%	3.5%	8 yen/kg
7901.12	Containing by weight less than 99.99% of zinc	Free	Free	Free	11.4%	3.5%	8 yen/kg
7901.20	Zinc alloys						
7901.20.10	Containing by weight 90% or more but less than 97.5% of zinc	Free	Free	Free	11.4%	3.5%	7.2-7.8 yen/kg
7901.20.20	Containing by weight less than 90% of zinc	17.5%	11.5%	8.7%	11.4%	3.5%	7.2-7.8 yen/kg
7902.00	Zinc waste and scrap	Free	Free	Free	Free	Free	1.9%
79.03	Zinc dust, powders and flakes						
7903.10	Zinc dust	Free	Free	Free	0.4¢/kg	4.4%	5.8%
7903.90	Other						
7903.90.10	Powders, not alloyed	4%	Free	2.0%	0.4¢/kg	4.4%	5.8%
7903.90.20	Alloyed powders; flakes	10.2%	6.5%	5.1%	5.7%	4.4%	5.8%

TARIFFS (cont'd)

Item No.	Description	Canada			United States	EEC	Japan[1]
		MFN	GPT	USA	Canada	MFN	MFN
7904.00	Zinc bars, rods, profiles and wires						
7904.00.10	Bars, rods or profiles, containing by weight 90% or more of zinc	Free	Free	Free	2.5%	8%	4.8%
7904.00.21	Bars, rods or profiles; wire, coated or covered	10.2%	6.5%	5.1%	2.5%	8%	4.8%
7904.00.22	Wire, not coated or covered	8%	5%	4.0%	2.5%	8%	4.8%
7905.00	Zinc plates, sheets, strip and foil containing by weight 90% or more of zinc						
7905.00.11	Of a thickness exceeding 0.15 mm but less than 4.75 mm, for making offset printing plates; of a thickness exceeding 0.15 mm but less than 4.75 mm, not polished, coated on one side with acid-resisting material, imported for use by grinders and polishers, to be prepared for use in photo-engraving	Free	Free	Free	2.5%	8%	7.2%
7905.00.19	Other	5.5%	3.5%	2.7%	2.5%	8%	7.2%
7905.00.20	Containing by weight less than 90% of zinc	10.2%	6.5%	5.1%	2.5%	8%	7.2%
7906.00	Zinc tubes, pipes and tube or pipe fittings (for example, couplings, elbows, sleeves)	10.2%	6.5%	5.1%	2.2%	8%	4.8%
79.07	Other articles of zinc						
7907.10	Gutters, roof capping, skylight frames and other fabricated building components	10.2%	6.5%	5.1%	3.4%	7%	4.9%
7907.90	Other						
7907.90.10	Anodes for electroplating	Free	Free	Free	2.0%-3.4%	7%	5.8%
7907.90.20	Discs or slugs, containing by weight 90% or more of zinc	5.5%	3.5%	2.7%	2.0%-3.4%	7%	5.8%
7907.90.90	Other	10.2%	6.5%	5.1%	2.0%-3.4%	7%	5.8%
7907.90.90.11	Not alloyed	10.2%	6.5%	5.1%	2.0%-3.4%	7%	5.8%
7907.90.90.12	Alloyed	10.2%	6.5%	5.1%	2.0%-3.4%	7%	5.8%

Sources: Customs Tariff, effective January 1993, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, 1992; Official Journal of the European Communities, Vol. 35, No. L268, 1992, "Conventional" column; Custom Tariff Schedules of Japan, 1992.
[1] GATT rate is shown; lower tariff rates may apply circumstantially.
Note: Where there is a tariff "range," a complete match of the HS code was not available; therefore, the high and low for the product in question is shown.

TABLE 1. CANADA, ZINC PRODUCTION AND TRADE, 1991 AND 1992, AND CONSUMPTION, 1989-91

Item No.		1991		1992p	
		(tonnes)	($000)	(tonnes)	($000)
PRODUCTION					
	All forms[1]				
	Newfoundland	–	–	–	–
	Nova Scotia	x	x	x	x
	New Brunswick	209 790	268 322	294 978	426 833
	Quebec	117 404	150 160	101 832	147 351
	Ontario	213 599	273 193	190 822	276 120
	Manitoba	88 486	113 173	85 263	123 376
	Saskatchewan	x	x	x	x
	British Columbia	125 980	161 129	130 088	188 238
	Yukon	149 487	191 194	209 263	302 804
	Northwest Territories	173 154	221 464	180 708	261 484
	Total	1 083 008	1 385 167	1 193 607	1 727 150
	Mine output[2]	1 156 582	..	1 323 958	..
	Refined[3]	660 552	..	670 000	..
EXPORTS				(Jan.-Sept.)	
2608.00.30	Zinc content in zinc ores and concentrates				
	Germany	113 805	74 362	84 431	74 436
	Belgium	98 869	58 590	82 948	58 319
	Spain	99 280	74 661	72 258	58 083
	Italy	50 709	31 398	68 177	52 713
	Japan	44 518	34 646	48 942	43 247
	South Korea	44 105	32 463	35 527	30 868
	France	43 223	24 980	35 809	29 820
	Finland	14 839	11 619	22 992	22 234
	Netherlands	23 448	13 009	28 657	16 663
	Norway	12 254	7 159	16 173	15 345
	Other countries	17 701	12 700	52 951	24 622
	Total	562 751	375 587	548 865	426 350
2600.00	Zinc content in other ores and concentrates[4]	4 064	639	4 881	910
2620.11	Ash and residues containing hard zinc spelter				
	India	366	156	496	283
	Taiwan	–	–	150	149
	Belgium	49	27	–	–
	South Korea	1 055	28	–	–
	Total	1 470	211	646	432
2620.19	Ash and residues containing mainly zinc, n.e.s.				
	United States	5 711	4 049	7 917	6 622
	Taiwan	493	482	1 151	1 116
	India	747	596	258	233
	South Korea	264	298	90	112
	United Kingdom	450	339	124	56
	France	345	159	70	30
	Other countries	243	186	–	–
	Total	8 253	6 109	9 610	8 169
2817.00	Zinc oxide; zinc peroxide				
	United States	21 098	27 210	15 103	23 646
	U.S.S.R.	306	401	–	–
	Other countries	44	88	61	94
	Total	21 448	27 699	15 164	23 740
2833.26	Zinc sulphate	15	9	–	–
7901.11	Zinc, not alloyed, unwrought, containing by weight 99.99% or more of zinc				
	United States	244 311	328 512	192 268	293 034
	Taiwan	11 170	16 285	5 676	8 667
	Japan	5 196	7 402	2 363	3 319
	Italy	1 076	1 643	–	–
	Singapore	856	1 398	–	–
	Norway	1 001	1 040	–	–
	Israel	635	945	76	112
	Kenya	398	567	800	1 197
	Germany	252	505	–	–
	People's Republic of China	200	250	–	–
	Belgium	161	221	299	412
	Other countries	442	698	59	97
	Total	265 698	359 466	201 541	306 838

TABLE 1 (cont'd)

Item No.		1991 (tonnes)	1991 ($000)	Jan.-Sept. 1992p (tonnes)	Jan.-Sept. 1992p ($000)
EXPORTS (cont'd)					
7901.12	Zinc, not alloyed, unwrought, containing by weight less than 99.99% of zinc				
	United States	146 559	199 107	121 393	186 392
	Taiwan	36 042	46 080	19 881	28 722
	Japan	16 731	21 327	9 281	13 791
	Indonesia	10 640	13 335	6 729	9 583
	Italy	5 889	9 000	6 122	8 722
	Philippines	7 696	10 391	5 045	7 201
	Germany	790	975	3 012	4 568
	Malaysia	3 631	4 575	1 608	2 416
	Brazil	5 990	7 768	978	1 632
	Norway	3 654	5 807	1 042	1 518
	Hong Kong	2 191	2 979	799	1 151
	Portugal	1 558	2 292	798	1 141
	Sri Lanka	713	927	615	924
	Ecuador	962	1 404	394	627
	India	1 441	1 870	298	395
	Pakistan	–	–	238	376
	Jamaica	–	–	249	371
	Singapore	2 872	3 758	179	275
	Israel	256	351	152	223
	Belgium	3 130	4 564	99	140
	Other countries	4 063	5 511	113	169
	Total	254 808	342 021	179 025	270 337
7901.20	Zinc alloys, unwrought				
	Hong Kong	3 537	4 958	2 149	3 401
	Taiwan	2 065	3 064	576	965
	Japan	590	856	556	923
	Thailand	576	788	499	763
	People's Republic of China	–	–	199	313
	Indonesia	216	290	99	165
	Singapore	20	29	73	121
	Philippines	1 084	1 493	58	90
	Other countries	41	51	41	92
	Total	8 129	11 529	4 250	6 833
7902.00	Zinc waste and scrap				
	United States	28 241	14 477	19 836	10 876
	Taiwan	4 231	3 628	2 969	2 525
	People's Republic of China	492	124	22	7
	Other countries	362	267	197	108
	Total	33 326	18 496	23 024	13 516
7903.10	Zinc dust				
	United States	5 204	9 498	4 595	9 106
	Other countries	143	336	237	249
	Total	5 347	9 834	4 832	9 355
7903.90	Zinc powders and flakes				
	United States	6 442	9 809	4 527	8 296
	Singapore	424	761	412	791
	Other countries	53	92	107	200
	Total	6 919	10 662	5 046	9 287
7904.00	Zinc bars, rods, profiles and wire				
	United States	116	593	92	256
	Other countries	–	–	20	21
	Total	116	593	112	277
7905.00	Zinc plates, sheets, strip and foil				
	United States	80	299	31	113
	Other countries	102	98	–	–
	Total	182	397	31	113
7906.00	Zinc pipes or tubes and fittings				
	United States	67	369	...	4
	Total	67	369	...	4
7907.90	Articles of zinc, n.e.s.				
	United States	927	5 327	799	4 495
	United Kingdom	33	103	16	135
	Other countries	174	299	14	120
	Total	1 134	5 729	829	4 750

TABLE 1 (cont'd)

Item No.		1991 (tonnes)	1991 ($000)	Jan.-Sept. 1992p (tonnes)	Jan.-Sept. 1992p ($000)
IMPORTS					
2608.00.00.30	Zinc content in zinc ores and concentrates	176 805	112 046	95 883	72 282
2603.00.00.30	Zinc content in copper ores and concentrates	–	–	201	351
2607.00.00.30	Zinc content in lead ores and concentrates	614	689	4	5
2620.19	Ash and residues containing mainly zinc, n.e.s.	472	254	807	592
2817.00	Zinc oxides; zinc peroxide	3 159	3 543	3 147	3 973
2833.26	Zinc sulphate	3 424	1 831	2 293	1 312
7901.11	Zinc, not alloyed, unwrought, containing by weight 99.99% or more of zinc	532	756	14	23
7901.12	Zinc, not alloyed, unwrought, containing by weight less than 99.99% of zinc	384	551	322	541
7901.20	Zinc alloys, unwrought	3 771	5 567	3 813	5 915
7902.00	Zinc waste and scrap	655	670	1 049	1 084
7903.10	Zinc dust	343	577	125	236
7903.90	Zinc powders and flakes	243	500	230	438
7904.00	Zinc bars, rods, profiles and wire	1 253	2 128	479	973
7905.00	Zinc plates, sheets, strip and foil	916	2 362	466	1 282
7906.00	Zinc pipes or tubes and fittings	1 099	3 949	1 014	3 583
7907.90	Articles of zinc, n.e.s.	2 174	6 897	1 670	5 548
	Total	195 844	142 320	111 517	98 138

	1989			1990			1991		
	Primary	Secondary	Total	Primary	Secondary	Total	Primary	Secondary	Total
	(tonnes)								
CONSUMPTION5									
Zinc used for or in the production of:									
Copper alloys (brass, bronze, etc.)	3 552	–	3 552	x	x	3 529	x	x	3 547
Galvanizing: electro	3 724r	–	3 724r	x	x	2 243	x	x	2 047
hot dip	73 439r	x	x	x	x	61 090	x	x	52 266
Zinc die-cast alloy	24 439r	x	x	x	x	24 336	x	x	22 065
Other products (including rolled and ribbon zinc, zinc oxides)	33 538	x	x	x	x	32 189	x	x	22 295
Total	138 692r	6 590r	145 282r	117 959r	5 428r	123 387r	98 505	3 715	102 220
Consumer stocks, year-end	13 344r	327	13 671r	10 086r	1 098	11 184r	7 373	287	7 660

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified; p Preliminary; r Revised; x Confidential.
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 Includes HS classes 2603.00.30 and 2607.00.30. 5 Consumer survey does not represent 100% of Canadian consumption and is therefore consistently less than apparent consumption.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, ZINC PRODUCTION, EXPORTS[1] AND DOMESTIC SHIPMENTS, 1975, 1980 AND 1985-92

	Production		Exports		
	All Forms[2]	Refined[3]	In Ores and Concentrates	Refined	Total
			(tonnes)		
1975	1 055 151	426 902	705 088	247 474	952 562
1980	883 697	591 565	434 178	471 949	906 127
1985	1 049 275	692 406	396 103	555 621	951 724
1986	988 173	570 981	450 249	427 176	877 425
1987	1 157 936	609 909	613 185	441 227	1 054 412
1988	1 370 000	703 206	816 884	551 521	1 368 405
1989	1 272 854	669 677	614 223	495 061	1 109 284
1990	1 179 372	591 786	716 185	452 251r	1 168 436r
1991	1 083 008	660 552	566 815	520 506	1 087 321
1992p	1 193 607	670 000	553 746	380 566	934 312

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; r Revised.
1 Beginning in 1988, exports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Ores and concentrates include HS classes 2608.00.30, 2603.00.30 and 2607.00.30. Refined includes HS classes 7901.11 and 7901.12. 2 New refined zinc produced from domestic primary materials (concentrates, slags, residues, etc.) plus estimated recoverable zinc in ores and concentrates shipped for export.
3 Refined zinc produced from domestic and imported ores.

TABLE 3. WESTERN WORLD, PRIMARY ZINC STATISTICS, 1988-92

	1988	1989	1990	1991	1992p
			(000 tonnes)		
Mine production (zinc content)	5 052	5 094	5 382	5 579	5 581
Metal production	5 239	5 215	5 176	5 385	5 346
Metal consumption	5 264	5 191	5 219	5 403	5 358

Source: International Lead and Zinc Study Group.
p Preliminary.

TABLE 4. WESTERN WORLD ZINC MINE PRODUCTION, 1989-92

	1989	1990	1991	1992p
		(000 tonnes)		
EUROPE				
Finland	58	52	55	31
Germany	64	59	54	14
Ireland	169	166	188	199
Spain	266	257	265	202
Sweden	163	158	157	170
Yugoslavia	75	76	74	40
Others	203	182	131	121
Subtotal	998	950	924	777
AFRICA				
Namibia	39	41	36	36
South Africa	77	75	64	79
Zaire	73	62	45	36
Others	60	64	57	46
Subtotal	249	242	202	197
OCEANIA				
Australia	811	884	1 048	1 025
AMERICAS				
Bolivia	75	104	130	120
Canada	1 216	1 203	1 148	1 314
Mexico	284	307	317	325
Peru	598	584	623	600
United States	288	543	548	545
Others	195	206	211	225
Subtotal	2 656	2 947	2 977	3 129
ASIA				
India	65	70	102	147
Japan	132	127	133	132
Thailand	91	81	87	67
Others	92	81	106	107
Subtotal	380	359	428	453
Total, Western World	5 094	5 382	5 579	5 581

Source: International Lead and Zinc Study Group.
p Preliminary.

TABLE 5. WESTERN WORLD ZINC METAL PRODUCTION, 1989-92

	1989	1990	1991	1992p
		(000 tonnes)		
EUROPE				
Belgium	285	290	298	217
Finland	162	175	170	171
France	266	264	299	305
Germany	353	338	346	380
Italy	246	248	256	256
Netherlands	203	207	201	205
Spain	257	257	274	350
Others	353	365	350	287
Subtotal	2 125	2 144	2 194	2 171
AFRICA				
South Africa	85	92	92	82
Zaire	54	38	29	20
Others	41	35	36	37
Subtotal	180	165	157	139
AMERICAS				
Argentina	31	31	36	33
Brazil	156	150	158	164
Canada	670	592	661	670
Mexico	194	199	189	152
Peru	138	118	154	116
United States	358	358	377	375
Subtotal	1 547	1 448	1 575	1 510
ASIA				
Japan	665	687	731	729
Korea, Republic of	240	259	232	243
Others	164	170	170	220
Subtotal	1 069	1 116	1 133	1 192
OCEANIA				
Australia	294	303	326	334
Total, Western World	5 215	5 176	5 385	5 346

Source: International Lead and Zinc Study Group.
p Preliminary.

TABLE 6. WESTERN WORLD ZINC CONSUMPTION, 1989-92

	1989	1990	1991	1992 Jan.-Nov.
		(000 tonnes)		
EUROPE				
Belgium	175	185	200	177
France	279	284	289	236
Germany	453	484	540	499
Italy	262	275	283	274
Spain	116	125	129	113
United Kingdom	195	193	184	175
Others	366	351	380	306
Subtotal	1 846	1 897	2 005	1 780
AFRICA				
South Africa	98	85	91	80
Others	63	65	70	69
Subtotal	161	150	161	149
OCEANIA				
Australia	88	114	113	105
New Zealand	23	16	17	14
Subtotal	111	130	130	119
AMERICAS				
Brazil	155	125	114	95
Canada	148	123	121	116
Mexico	105	111	107	99
United States	1 060	992	933	954
Others	129	120	127	112
Subtotal	1 597	1 471	1 402	1 376
ASIA				
India	135	130	130	121
Japan	769	814	845	718
Korea, Republic of	196	230	269	238
Others	376	397	461	429
Subtotal	1 476	1 571	1 705	1 506
Total, Western World	5 191	5 219	5 403	4 930

Source: International Lead and Zinc Study Group.

TABLE 7. CANADA, ZINC METAL CAPACITY, 1992

Company and Location	Annual Rated Capacity
	(000 tonnes of slab zinc)
PRIMARY	
Canadian Electrolytic Zinc Limited (CEZ) Valleyfield, Quebec	230
Falconbridge Limited Timmins, Ontario	133
Hudson Bay Mining and Smelting Co., Limited (HBMS) Flin Flon, Manitoba	82
Cominco Ltd. Trail, British Columbia	300
Total primary, Canada	745
SECONDARY	
Federated Genco Ltd. Burlington, Ontario	9
Purity Zinc Metals Co. Ltd. Stoney Creek, Ontario	8
Total secondary, Canada	17

TABLE 8. MONTHLY AVERAGE ZINC PRICES, 1991 AND 1992

	North American Special High Grade	LME Special High Grade Settlement
	(US¢/lb)	
1992		
January	54.4	52.4
February	52.9	51.3
March	56.9	55.1
April	60.5	59.2
May	63.2	62.3
June	63.8	62.9
July	62.4	59.9
August	65.0	61.7
September	65.4	62.1
October	56.0	52.8
November	50.0	47.5
December	50.1	48.0
Year average	58.4	56.2
1991		
January	58.1	54.7
February	55.9	53.9
March	56.1	54.4
April	57.6	57.0
May	49.8	49.5
June	48.4	48.2
July	48.7	48.2
August	48.4	47.4
September	49.8	46.4
October	48.6	45.1
November	54.6	49.6
December	57.3	53.9
Year average	52.8	50.6

Sources: Metals Week; Reuters.

Principal Canadian Nonferrous and Precious Metal Mine Production in 1991

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PRINCIPAL CANADIAN NONFERROUS AND PRECIOUS METAL MINE PRODUCTION IN 1991

Company and Mine/Mill Location	Capacity	Grades of Ore Milled						Ore Milled	Metal Contained in All Concentrates Produced					
		Cu	Ni	Pb	Zn	Ag	Au		Copper	Nickel	Lead	Zinc	Silver	Gold
	(tonnes per day)	(percent)				(grams/tonne)		(tonnes)	(tonnes)				(kilograms)	
NEWFOUNDLAND														
Hope Brook Gold Inc. Hope Brook mine Couteau Bay	3 495	–	–	–	–	0.34	4.42	362 874	–	–	–	–	88	1 360
NOVA SCOTIA														
Rio Algom Limited East Kemptville mine Yarmouth	9 000	0.03	–	–	0.14	0.14	–	3 175 147	145	–	–	648	231	–
Westminer Canada Limited Gays River mine Gays River	1 250	–	–	3.40	8.80	10.29	–	58 060	–	–	1 886	4 751	50	–
NEW BRUNSWICK														
Brunswick Mining and Smelting Corporation Limited No. 12 mine Bathurst	10 250	0.40	–	3.30	8.40	102.00	–	2 531 000	8 207	–	50 349	178 288	157 348	1 373
Noranda Inc. Heath Steele and Stratmat mines Bathurst	2 700	0.54	–	2.63	6.91	55.65	–	970 688	3 913	–	15 479	56 153	30 683	–
NovaGold Resources Inc. Murray Brook mine Bathurst	1 043	–	–	–	–	70.29	1.61	453 592	–	–	–	–	5 420	621
Stratabound Minerals Corporation CNE mine Newcastle	250	–	–	4.58	11.34	144.00	–	14 559	–	–	558	1 571	1 733	–
QUEBEC														
Agnico-Eagle Mines Limited Joutel Division Joutel	1 630	–	–	–	–	1.90	6.46	347 156	–	–	–	–	528	2 244
LaRonde mine Cadillac	1 815	0.35	–	–	–	10.05	6.75	591 840	1 770	–	–	–	5 119	3 634
American Barrick Resources Corporation Camflo Division Val-d'Or	1 210	–	–	–	–	0.41	4.29	311 268	–	–	–	–	112	1 223
Audrey Resources Inc. Mobrun mine Rouyn-Noranda	1 450	0.95	–	–	2.80	26.74	2.50	485 344	3 744	–	–	10 716	3 402	559

Aur Resources Inc. Kierens, Norlartic and Lamaque mines Val-d'Or	–	–	–	–	–	0.59	5.03	269 730	–	–	–	–	147	1 259
Aur Resources Inc. – Belmoral Mines Ltd. joint venture Ferderber mine and Dumont mines Val-d'Or	1 360	–	–	–	–	0.96	6.70	230 200	–	–	–	–	174	1 421
Aurizon Mines Ltd. Sleeping Giant mine Val-d'Or	816	–	–	–	–	10.29	10.11	74 752	–	–	–	–	558	738
BP Resources Canada Limited Les Mines Selbaie OP and UG mines Joutel	5 000	1.16	–	0.11	1.96	41.25	0.58	2 857 632	31 429	–	2 058	50 145	83 011	1 333
Breakwater Resources Ltd.– Brookline Minerals Inc. joint venture Estrades mine Joutel	700	0.95	–	0.90	11.3	156	5.0	104 000	919	–	758	11 258	11 957	403
Cambior inc. Lucien C. Béliveau and Chimo mines Val-d'Or	2 200	–	–	–	–	0.31	3.12	725 399	–	–	–	–	191	2 126
Pierre Beauchemin mine Rouyn-Noranda	1 020	–	–	–	–	1.13	6.17	187 000	–	–	–	–	190	993
Campbell Resources Inc. Joe Mann mine Chibougamau	3 175	0.25	–	–	–	4.77	10.15	299 371	666	–	–	–	998	2 765
Inco Gold Company Casa Berardi East and West mines La Sarre	1 800	–	–	–	–	2.61	7.89	537 053	–	–	–	–	1 182	3 701
LAC Minerals Ltd.– Cambior inc. joint venture Doyon mine Cadillac	3 150	–	–	–	–	1.37	7.30	1 136 294	–	–	–	–	1 340	8 002
Francoeur mine Rouyn-Noranda	360	–	–	–	–	0.80	7.49	84 380	–	–	–	–	60	600
LAC Minerals Ltd. Bousquet No. 1 mine Cadillac	1 590	–	–	–	–	1.37	6.30	338 380	–	–	–	–	396	1 966
Bousquet No. 2 mine Malartic	1 995	1.5	–	–	–	29.14	14.95	390 000	5 155	–	–	–	10 046	5 632

PRINCIPAL CANADIAN NONFERROUS AND PRECIOUS METAL MINE PRODUCTION IN 1991 (cont'd)

Company and Mine/Mill Location	Capacity	Grades of Ore Milled						Ore Milled	Metal Contained in All Concentrates Produced					
		Cu	Ni	Pb	Zn	Ag	Au		Copper	Nickel	Lead	Zinc	Silver	
	(tonnes per day)	(percent)				(grams/tonne)		(tonnes)	(tonnes)				(kilograms)	
QUEBEC (cont'd)														
Minnova Inc. Lake Dufault Division Ansil mine Noranda	1 450	7.45	–	–	0.06	28.23	2.72	440 065	32 089	–	–	192	9 293	1 072
Lac Shortt Division Desmaraisville	1 150	–	–	–	–	0.15	4.10	367 002	–	–	–	–	50	1 414
Opemiska Division Perry and Springer mines Chapais	2 812	3.00	–	–	–	21.40	2.00	198 000	5 678	–	–	–	3 627	341
Noranda Minerals Inc. Division Mines Gaspé E zone Murdochville	10 000	2.28	–	–	–	13.30	0.07	1 161 196	25 085	–	–	–	14 134	19
Matagami Division Îsle Dieu and Norita mines Mattagami Lake	2 175	0.91	–	0.47	15.81	91.89	1.61	457 221	3 896	–	1 769	69 257	30 980	571
Noranda Minerals Inc.– Cambior Inc. joint venture Silidor mine Rouyn-Noranda	1 100	–	–	–	–	1.10	5.48	423 200	–	–	–	–	418	2 059
Placer Dome Inc. Sigma mine	1 406	–	–	–	–	1.20	6.00	480 808	–	–	–	–	464	2 766
Kiena mine Val-d'Or	1 250	–	–	–	–	0.79	4.77	486 000	–	–	–	–	341	2 210
Republic Goldfields Inc. and American Barrick Resources Corporation Malartic mine Val-d'Or	450	–	–	–	–	0.34	3.87	88 800	–	–	–	–	32	342
Ronrico Explorations Limited and Louvicourt Gold Mines Inc. Simkar mine	300	–	–	–	–	1.03	8.54	48 300	–	–	–	–	44	374
Westminer Canada Limited Copper Rand and Portage mines Chibougamau	3 085	1.44	–	–	–	6.72	4.08	519 817	7 279	–	–	–	2 305	1 930
ONTARIO														
American Barrick Resources Corporation Holt-McDermott mine Kirkland Lake	1 360	–	–	–	–	0.48	3.46	594 405	–	–	–	–	242	1 889
Canamax Resources Inc. Bell Creek mine Timmins	400	–	–	–	–	0.45	6.69	124 284	–	–	–	–	47	776

Dickenson Mines Limited Arthur White mine Red Lake	910	–	–	–	–	1.03	9.94	286 670	–	–	–	–	230	2 320
Eastmaque Gold Mines Ltd. Kirkland Lake and Toburn mine tailings Kirkland Lake	2 000	–	–	–	–	1.37	1.61	706 697	–	–	–	–	384	455
Falconbridge Limited Sudbury operations (7 mines)	9 580	1.47	1.56	–	–	6.89	0.17	2 614 500	36 940	38 971	–	–	15 977	392
Timmins operations Kidd Creek mines	13 500	3.20	–	0.10	4.00	65.14	–	3 764 817	118 252	–	3 257	135 996	199 979	–
Hoyle Pond mine	600	–	–	–	–	0.24	18.51	99 790	–	–	–	–	22	1 761
GSR Mining Corp. Kerr and Buffonta mines	1 360	–	–	–	–	1.71	4.45	269 400	–	–	–	–	368	1 079
Custom milling Virginiatown	750	–	–	–	–	1.37	1.71	166 000	–	–	–	–	182	255
Hemlo Gold Mines Inc. Golden Giant mine Marathon	3 200	–	–	–	–	0.60	12.37	1 154 846	–	–	–	–	624	13 791
Inco Limited Sudbury and Shebandowan operations	57 520	1.04	1.25	–	–	5.46	0.32	10 353 700	101 750	98 711	–	–	39 570	2 052
International Corona Corporation Renabie mine Wawa	635	–	–	–	–	2.09	10.25	112 088	–	–	–	–	199	1 050
LAC Minerals Ltd. Golden Patricia mine Pickle Lake	350	–	–	–	–	2.76	19.71	125 191	–	–	–	–	334	2 379
LAC Minerals Ltd. Macassa Division Macassa mine	455	–	–	–	–	2.40	17.21	152 407	–	–	–	–	285	2 514
Lake Shore tailings operation Kirkland Lake	680	–	–	–	–	0.34	2.61	237 682	–	–	–	–	41	423
Minnova Inc. Winston Lake mine Winston Lake	1 000	1.20	–	–	16.40	38.73	1.70	347 452	3 968	–	–	55 142	4 925	344
Muscocho Explorations Ltd. Magino mine Wawa	365	–	–	–	–	0.69	4.16	216 817	–	–	–	–	22	752
Noranda Inc. Geco Division Manitouwadge	3 630	1.34	–	–	4.12	42.51	0.14	1 243 750	15 861	–	–	48 252	40 511	86
Lyon Lake Division Ignace	2 720	0.8	–	1.24	7.86	162.17	0.55	61 689	455	–	636	4 568	8 583	19

PRINCIPAL CANADIAN NONFERROUS AND PRECIOUS METAL MINE PRODUCTION IN 1991 (cont'd)

Company and Mine/Mill Location	Capacity	Grades of Ore Milled						Ore Milled	Metal Contained in All Concentrates Produced					
		Cu	Ni	Pb	Zn	Ag	Au		Copper	Nickel	Lead	Zinc	Silver	
	(tonnes per day)	(percent)				(grams/tonne)		(tonnes)	(tonnes)				(kilograms)	
ONTARIO (cont'd)														
Placer Dome Inc.														
Campbell mine	1 360	–	–	–	–	1.71	21.91	390 089	–	–	–	–	602	8 103
Red Lake														
Detour Lake mine	2 800	–	–	–	–	1.78	4.90	801 951	–	–	–	–	1 232	3 718
N.E. Ontario														
Dome mine	3 400	–	–	–	–	0.58	4.08	1 145 321	–	–	–	–	603	4 495
South Porcupine														
Dona Lake mine	500	–	–	–	–	0.86	8.19	162 386	–	–	–	–	124	1 285
Pickle Lake														
Royal Oak Mines Inc.	3 266	–	–	–	–	1.71	2.88	1 106 765	–	–	–	–	434	2 878
Timmins Division														
St. Andrew Goldfields Ltd.														
Stock Twp. mine	680	–	–	–	–	0.85	5.73	132 200	–	–	–	–	96	703
Hislop East and Taylor mines	400	–	–	–	–	0.96	7.02	56 500	–	–	–	–	46	368
Timmins														
Teck-Corona Corporation joint venture														
David Bell mine	1 000	–	–	–	–	0.89	19.54	470 200	–	–	–	–	377	8 803
Williams mine	6 000	–	–	–	–	0.69	7.78	2 185 354	–	–	–	–	1 074	16 133
Hemlo														
Timmins Nickel Inc.	725	–	2.26	–	–	–	–	122 470	–	2 175	–	–	–	–
Redstone and Langmuir No. 1 mines														
Timmins														
MANITOBA														
Hudson Bay Mining and Smelting Co., Limited (8 mines), including Flin Flon, Saskatchewan portion	10 520	2.01	–	0.24	4.87	21.14	1.77	1 963 148	36 550	–	3 902	87 441	33 361	2 602
Ruttan mine	7 200	1.22	–	–	1.21	11.31	0.45	1 774 453	20 131	–	–	17 813	12 446	412
Leaf Rapids														
Hudson Bay–Outokumpu Mines Ltd. joint venture	1 905	0.68	1.87	–	–	–	–	544 311	3 401	8 741	–	–	–	–
Namew Lake mine														
Flin Flon														
Inco Limited	14 025	0.17	2.32	–	–	5.14	0.10	2 296 085	3 616	49 272	–	–	7 085	184
Thompson UG, OP, and Birchtree mines														
Thompson district														
SASKATCHEWAN														
Cameco Corporation	200	–	–	–	–	7.89	19.54	79 617	–	–	–	–	471	1 521
Jasper mine														
La Ronge														

Claude Resources Inc. Seabee mine	454	–	–	–	–	3.43	12.17	16 107	–	–	–	–	39	177
International Corona Corporation Jolu mine La Ronge	400	–	–	–	–	0.34	11.52	118 840	–	–	–	–	36	1 342
BRITISH COLUMBIA														
Bethlehem Resources Corporation – Goldnev Resources Inc. joint venture Goldstream mine	1 100	3.94	–	–	2.66	–	–	253 105	9 182	–	–	–	–	–
BHP - Utah Mines Ltd. Island Copper mine Port Hardy	49 895	0.38	–	–	–	1.75	0.10	18 461 209	58 085	–	–	–	16 348	887
Cheni Gold Mines Inc. Lawyers mine North Central, B.C.	500	–	–	–	–	169.06	7.34	175 165	–	–	–	–	22 416	1 199
Cominco Ltd.														
Snip mine	270	–	–	–	–	–	30.51	122 651	–	–	–	–	–	3 409
Sullivan mine Kimberley	9 070	–	–	5.30	6.70	39.09	–	1 688 271	–	–	76 779	100 623	56 490	–
Highland Valley Copper Ltd. (Partnership of Cominco Ltd.–Rio Algom Limited–Teck Corporation) Logan Lake	132 995	0.44	–	–	–	3.09	0.03	46 299 988	177 397	–	–	–	71 434	457
International Corona Corporation Nickel Plate mine Hedley	3 175	–	–	–	–	0.93	2.91	1 153 939	–	–	–	–	678	2 847
International Shasta Resources Ltd. Shasta mine North Central, B.C.	180	–	–	–	–	0.27	4.85	52 617	–	–	–	–	13	234
Minnova Inc. Samatosum mine Adams Lake	450	0.82	–	1.14	2.19	690.00	1.28	177 615	1 363	–	1 624	3 402	120 533	185
MinVen Gold Corporation Blackdome mine Williams Lake	180	–	–	–	–	171.43	34.63	2 177	–	–	–	–	314	67
Noranda Minerals Inc. Bell Copper mine Babine Lake	15 420	0.70	–	–	–	0.93	0.31	4 871 582	25 594	–	–	–	3 543	1 017
North American Metals Corp. Golden Bear mine Telegraph Creek	360	–	–	–	–	5.83	17.11	111 584	–	–	–	–	519	1 701

PRINCIPAL CANADIAN NONFERROUS AND PRECIOUS METAL MINE PRODUCTION IN 1991 (cont'd)

Company and Mine/Mill Location	Capacity	Grades of Ore Milled						Ore Milled	Metal Contained in All Concentrates Produced					
		Cu	Ni	Pb	Zn	Ag	Au		Copper	Nickel	Lead	Zinc	Silver	
	(tonnes per day)	(percent)				(grams/tonne)		(tonnes)	(tonnes)				(kilograms)	
BRITISH COLUMBIA (cont'd)														
Placer Dome Inc.														
Equity Silver mine	9 000	0.22	–	–	–	86.50	0.89	3 313 039	5 031	–	–	–	176 538	1 731
Houston														
Gibraltar mine	36 290	0.31	–	–	–	1.03	–	11 923 129	28 872	–	–	–	5 509	–
Waste rock operation	19 960	0.11	–	–	–	–	–	9 979 032	3 331	–	–	–	–	–
McLeese Lake														
Princeton Mining														
Corporation	22 680	0.48	–	–	–	2.95	0.13	3 850 999	14 511	–	–	–	5 703	237
Similco mine														
Princeton														
Teck Corporation	10 000	0.48	–	–	–	0.70	0.37	2 009 414	7 755	–	–	–	1 036	569
Ajax mine														
Kamloops														
Timmins Nickel Inc. and														
Habsburg Resources Inc.	320	–	–	–	–	113.90	25.13	3 205	–	–	–	–	124	78
Dome Mountain mine														
Smithers														
Treminco Resources Ltd.	110	–	–	5.00	6.00	394.29	–	23 224	–	–	1 074	1 785	8 696	–
Silvana mine														
New Denver														
Westmin Resources Limited														
H-W, Lynx mines	3 990	1.71	–	0.19	3.29	26.20	2.09	1 081 400	16 978	–	1 626	31 290	19 547	963
Buttle Lake														
Premier Gold & SB mines	2 000	–	–	–	–	52.46	3.43	629 407	–	–	–	–	14 754	1 985
Stewart														
YUKON TERRITORY														
Curragh Resources Inc.														
Faro and Vangorda mines	10 000	–	–	3.00	4.50	44.57	0.10	4 126 783	–	–	103 230	153 804	89 448	148
Faro														
Sa Dena Hes mine	1 500	–	–	8.10	12.10	100.11	–	172 345	–	–	13 129	18 833	12 943	–
Watson Lake														
NORTHWEST TERRITORIES														
Cominco Ltd.	2 070	–	–	3.20	12.50	–	–	1 069 299	–	–	33 391	130 297	–	–
Polaris mine														
Little Cornwallis Island														
Echo Bay Mines Ltd.	1 960	–	–	–	–	2.06	10.87	659 822	–	–	–	–	1 107	6 746
Lupin mine														
Contwoyto Lake														
Nanisivik Mines Ltd.	1 890	–	–	0.40	8.10	36.00	–	704 792	–	–	2 286	54 914	18 900	–
Nanisivik mine														
Baffin Island														

NERCO Minerals Company Con mine Yellowknife	1 090	–	–	–	–	3.05	12.31	332 030	–	–	–	–	897	3 829
NorthWest Gold Corp. Colomac mine	9 070	–	–	–	–	0.55	2.19	1 088 622	–	–	–	–	358	2 245
Royal Oak Resources Ltd. Yellowknife Division Giant mine Yellowknife	1 090	–	–	–	–	1.95	9.39	390 065	–	–	–	–	601	3 176
Treminco Resources Ltd. Ptarmigan and Tom mines Yellowknife	227	–	–	–	–	6.86	11.31	52 617	–	–	–	–	222	567
Total Canada	585 130	0.49	0.11	0.22	0.77	10.74	1.07	171 983 237	818 998	197 870	313 791	1 227 139	1 395 864	174 389

OP Open-pit; UG Underground.
– Nil.
Notes: Not included in the above are several small mine/mill operations and operations that were not officially in production in 1991, or for which no information was available to enable the completion of a reliable production assessment. The overall contribution to the Canadian production total in 1991 from these omitted operations is estimated to be less than one percent.

Statistical Report

This statistical summary of the mineral industry in Canada has been compiled by the staff of the Mineral and Metal Statistics Division, Mineral Policy Sector, Energy, Mines and Resources Canada (EMR), under the general direction of Teri Newman, A/Director. This report was prepared by Laurie Morrison, Lorraine Ralph, Kosta Kokkinos and Despo Makris.

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Statistics contained in this summary are obtained from a variety of sources. Principal sources include the statistical survey program of EMR, Statistics Canada and Labour Canada. The statistical survey program of the Mineral and Metal Statistics Division of EMR is conducted jointly with the provincial governments and Statistics Canada in order to minimize the reporting burden on the mineral industry. The cooperation of the companies providing information is greatly appreciated. Sources for the international mineral statistics include the U.S. Bureau of Mines, the American Bureau of Metal Statistics, the World Bureau of Metal Statistics, "Metals Week," "Northern Miner," Metallgesellschaft, and the "Engineering and Mining Journal."

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CANADA, GENERAL ECONOMIC INDICATORS, 1982-91

		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991p
Gross domestic product, current dollars	$ millions	374 442	405 717	444 735	477 988	505 666	551 597	605 906r	649 916r	667 843r	674 388
Gross domestic product, constant dollars (1986 = 100)	"	425 970	439 448	467 167	489 437	505 666	526 730	552 958r	565 779r	563 060r	553 457
Mining's gross domestic product (1986 = 100)	"	15 003	15 959	18 122	18 919	17 595	18 723r	20536r	19 982r	19 926r	20 126
Manufacturing's gross domestic product (1986 = 100)	"	67 921	72 311	81 622	86 218	86 857r	90 031r	94 643r	95 830r	90 947r	84 929
Industrial production's gross domestic product (1986 = 100)	"	96 204	102 436	114 883	121 273	120 364r	126 231r	132 918r	132 361r	126 807r	121 680
Value of manufacturing industry shipment	"	187 409	203 019	229 848	248 673	253 343	272 037	297 692r	308 987r	297 132r	277 824
Value of mineral production	"	33 831	38 539	43 789	44 730	32 446	36 361	36 955	39 333	40 778	35 205
Merchandise exports	"	84 393	90 556	111 330	119 061	120 318	126 340r	138 742r	141 768r	146 482r	141 701
Merchandise imports	"	66 739	73 098	91 493	102 669	110 374	115 119	128 321	134 637r	136 660r	135 948
Balance of payments, current account	"	2 004	2 102	1 686	-3 095	-11 394	-11 601	-15 493r	-22 886r	-25 709r	-29 249
Corporation profits before taxes	"	26 848	37 072	45 855	49 490	45 355	56 571	64 667r	60 414r	45 548r	31 800
Business investment, current dollars	"	70 808	70 832	73 309	81 312	88 993	103 831	119 100r	130 638r	124 805r	115 907
Business investment, constant dollars (1986 = 100)	"	74 967	74 742	75 869	82 863	88 993	99 693	110 794r	117 047r	110 999r	105 810
Population	000s	24 583	24 787	25 978r	25 165	25 353	25 617	25 909	26 240	26 610r	27 000
Labour force	"	11 926	12 109	12 316	12 532	12 746	13 011	13 276	13 504	13 681	13 757
Employed	"	10 618	10 675	10 932	11 221	11 531	11 861	12 245	12 486	12 572	12 340
Unemployed	"	1 308	1 434	1 384	1 311	1 215	1 150	1 031	1 018	1 109	1 417
Unemployment rate	percent	11.0	11.8	11.2	10.5	9.5	8.8	7.8	7.5	8.1	10.3
Labour income	$ millions	209 402	219 386	236 257	254 777	271 853	295 691r	324 412r	349 960r	368 627r	379 029
Consumer price index	1986 = 100	83.7r	89.4r	92.4r	96.0r	100.0	104.0r	108.6r	114.0r	119.5r	126.2

Source: Statistics Canada, Catalogue Nos. 11-210 and 26-202.
p Preliminary; r Revised.

TABLE 1. MINERAL PRODUCTION OF CANADA, 1990, 1991 AND 1992, AND AVERAGE, 1988-92

	Unit of Measure	1990		1991		1992p		Average 1988-92	
	(000)	(Quantity)	($000)	(Quantity)	($000)	(Quantity)	($000)	(Quantity)	($000)
METALS									
Antimony	kg	565	1 188	429	897	276	574	1 452	3 542
Bismuth	kg	74	664	60	446	89	589	112	1 365
Cadmium	kg	1 334	11 588	1 549	7 724	1 328	3 240	1 517	16 465
Calcium	kg	x	x	x	x	x	x	203	2 052
Cesium, pollucite	kg	x	x	x	x	x	x	174	506
Cobalt	kg	2 184	49 563	2 171	77 549	2 219	136 886	2 263	70 974
Columbium (niobium) (Cb_2O_5)	kg	x	x	x	x	x	x	3 395	21 682
Copper	kg	771 433	2 428 935	780 362	2 112 152	744 687	2 062 873	751 879	2 277 255
Germanium	kg	4	1 083	–	–	–	–	2	528
Gold	g	167 373	2 407 654	176 126	2 349 872	157 554	2 086 803	159 072	2 298 435
Ilmenite	t	554	x	x	x	x	x	475	21 751
Indium	g	x	x	x	x	x	x	15 583	3 767
Iron ore	t	35 670	1 258 792	35 421	1 228 188	32 772	1 129 371	36 648	1 261 759
Iron remelt	t	728	x	x	x	x	x	751	188 879
Lead	kg	233 372	279 346	248 102	210 886	318 515	230 923	284 005	271 373
Lithium	kg	x	x	x	x	x	x	958	4 245
Magnesium	kg	x	x	x	x	x	x	5 566	20 525
Molybdenum	kg	12 188	84 721	11 437	65 928	9 602	62 866	12 061	89 270
Nickel	kg	195 004	2 027 917	188 098	1 807 619	189 051	1 679 853	193 290	2 269 617
Platinum group	g	11 123	189 423	11 123	150 155	10 505	117 099	11 032	157 864
Rare earths	t	–	–	–	–	–	–	. . .	x
Rhenium	kg	x	x	x	x	x	x	1	1 229
Rubidium	kg	x	x	x	x	x	x	3	33
Selenium	kg	369	6 867	227	3 937	286	4 715	283	5 689
Silver	kg	1 381	249 746	1 261	187 676	1 147	173 219	1 309	254 330
Strontium	kg	x	x	x	x	x	x	x	x
Tantalum (Ta_2O_5)	kg	100	8 762	114	10 254	65	5 222	79	7 295
Tellurium	kg	12	994	16	1 128	26	1 982	16	1 140
Tin	kg	3 844	28 449	4 392	25 241	–	–	3 100	24 754
Tungsten (WO_3)	kg	–	–	–	–	–	–	–	–
Uranium (U)	kg	9 720	887 975	8 162	595 467	9 057	575 587	10 000	798 076
Vanadium	kg	x	x	x	x	–	–	8	36
Yttrium (Y_2O_3)	kg	x	x	–	–	–	–	45	1 780
Zinc	kg	1 179 372	2 272 649	1 083 008	1 385 167	1 193 607	1 727 150	1 219 768	2 077 752
Total metals			12 499 965		10 473 055		10 209 192		12 154 512
NONMETALS									
Arsenious trioxide	t	x	240	–	–	–	–	3	779
Asbestos	t	686	272 102	686	271 030	601	235 760	679	263 827
Barite	t	44	3 130	47	3 013	32	2 854	43	3 216
Fluorspar	t	x	x	–	–	–	–	23	2 996
Gemstones	kg	452	918	542	663	515	582	580	1 509
Graphite	t	x	x	x	x	x	x	10	8 074
Gypsum	t	7 978	80 080	6 727	71 654	6 892	79 206	7 718	80 461
Magnesite	t	x	x	x	x	x	x	178	23 864
Marl	t	x	x	x	x	x	x	1	17
Mica	t	x	x	x	x	x	x	17	6 602
Nepheline syenite	t	533	23 651	486	25 105	566	28 711	535	24 464
Peat	t	775	89 735	833	100 133	856	108 199	804	96 113
Potash (K_2O)	t	7 345	964 920	7 087	931 932	7 324	963 260	7 385	1 009 077
Potassium sulphate	t	x	x	x	x	x	x	2	722
Salt	t	11 191	240 890	11 871	259 166	11 100	253 802	11 202	255 240
Serpentine	t	x	x	x	x	x	x	4	588
Soapstone, talc and pyrophyllite	t	131	13 895	115	13 278	122	13 481	132	14 357
Sodium sulphate	t	347	27 088	335	25 457	280	21 038	324	24 989
Sulphur in smelter gas	t	790	81 229	749	89 187	774	79 155	796	84 332
Sulphur, elemental	t	5 822	368 864	6 180	335 381	6 350	131 385	6 017	339 835
Titanium dioxide	t	x	x	x	x	x	x	689	248 281
Tremolite	t	x	x	x	x	x	x	. . .	49
Total nonmetals			2 492 168		2 381 705		2 199 379		2 489 391
FUELS									
Coal	t	68 332	1 823 700	71 133	1 916 780	64 550	1 663 300	69 037	1 823 038
Natural gas	000m³	98 771	5 692 025	105 244	5 394 073	118 925	5 607 705	101 994	5 459 028
Natural gas by-products	m³	23 863	2 370 767	24 919	2 178 094	26 551	2 296 825	24 189	2 011 921
Petroleum, crude	m³	90 279	13 103 383	89 788	10 456 364	93 997	11 251 095	91 702	10 968 334
Total fuels			22 989 875		19 945 311		20 818 925		20 262 321
STRUCTURAL MATERIALS									
Clay products	$	. .	136 029	. .	119 838	. .	117 326	. .	154 011
Cement	t	11 745	991 442	9 372	810 769	8 484	739 211	10 908	894 543
Lime	t	2 341	188 283	2 375	193 541	2 383	182 834	1 924	191 580
Sand and gravel	t	244 316	817 317	216 264	741 326	201 082	637 035	189 912	787 131
Stone	t	111 355r	663 354r	87 826	539 654	81 639	507 645	104 056	603 165
Total structural materials			2 796 426r		2 405 128		2 184 052		2 630 431
Total all minerals			40 778 434r		35 205 199		35 411 548		37 536 655

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available; . . . Amount too small to be expressed; p Preliminary; r Revised; x Confidential.
Notes: Numbers may not add to totals due to rounding. Confidential values are included in totals.

TABLE 2. CANADA, VALUE OF MINERAL PRODUCTION, PER CAPITA VALUE OF MINERAL PRODUCTION, AND POPULATION, 1963-92

	Metallics	Industrial Minerals	Fuels	Other Minerals[1]	Total	Per Capita Value of Mineral Production	Population of Canada
			($ millions)			($)	(000)
1963	1 510	632	885		3 027	159.91	18 931
1964	1 702	691	973		3 365	174.44	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	214.98	20 378
1968	2 493	886	1 343		4 722	228.12	20 701
1969	2 378	893	1 465		4 736	225.51	21 001
1970	3 073	931	1 718		5 722	268.68	21 297
1971	2 940	1 008	2 014		5 963	276.46	21 568
1972	2 956	1 085	2 368		6 408	293.92	21 802
1973	3 850	1 292	3 227		8 370	379.69	22 043
1974	4 821	1 731	5 202		11 753	525.55	22 364
1975	4 795	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	794.24	23 258
1978	5 698	2 986	11 578		20 261	863.05	23 476
1979	7 951	3 514	14 617		26 081	1 101.83	23 671
1980	9 697	4 201	17 944		31 842	1 330.29	23 936
1981	8 753	4 485	19 046	136	32 420	1 331.86	24 342
1982	6 874	3 703	23 038	216	33 831	1 373.37	24 634
1983	7 399	3 741	27 154	245	38 539	1 548.68	24 885
1984	8 670	4 318	30 399	401	43 789	1 742.92	25 124
1985	8 709	4 859	31 120	41	44 730	1 763.79	25 360
1986	8 798	4 863	18 763	22	32 446	1 279.77	25 353
1987	10 962	5 125	20 274	–	36 361	1 419.39	25 617
1988	13 608	5 574	17 773	–	36 955	1 426.33	25 909
1989	13 982	5 566	19 785	–	39 333	1 498.97	26 240
1990	12 500	5 289r	22 990	–	40 778r	1 532.87r	26 603
1991	10 473	4 787	19 945	–	35 205	1 303.88	27 000
1992p	10 209	4 383	20 819	–	35 412	1 291.97	27 409

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; p Preliminary; r Revised.
[1] 1981-86: Other minerals may include arsenious trioxide, bentonite, calcium, cesium, cobalt, diatomite, ilmenite, indium, iron remelt, lithium, marl, magnesium, niobium, perlite, rhenium, serpentine, sodium antimonate, strontium, tin, tungsten or yttrium, for which the value of production may be confidential in that year. Beginning in 1987, this category was discontinued.
Notes: Beginning in 1986, bentonite, diatomite and sodium antimonate are reported in industrial minerals. Numbers may not add to totals due to rounding.

TABLE 3. CANADA, VALUE OF MINERAL PRODUCTION BY PROVINCE, TERRITORY AND MINERAL CLASS, 1992P

	Metals		Industrial Minerals		Fuels		Total	
	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)
Alberta	464	. . .	386 756	8.8	16 691 427	80.2	17 078 646	48.2
Ontario	3 562 432	34.9	1 143 493	26.1	74 528	0.4	4 780 453	13.5
British Columbia	1 447 125	14.2	399 826	9.1	1 600 734	7.7	3 447 686	9.7
Saskatchewan	407 985	4.0	849 239	19.4	1 795 431	8.6	3 052 656	8.6
Quebec	1 629 749	16.0	1 000 692	22.8	–	–	2 630 441	7.4
Manitoba	956 456	9.4	92 496	2.1	87 078	0.4	1 136 029	3.2
New Brunswick	568 207	5.6	285 616	6.5	32 000	0.2	885 822	2.5
Newfoundland	697 565	6.8	37 737	0.9	–	–	735 302	2.1
Northwest Territories	476 160	4.7	6 758	0.2	170 397	0.8	653 315	1.8
Nova Scotia	402	. . .	172 181	3.9	367 330	1.8	539 913	1.5
Yukon	462 648	4.5	5 223	0.1	–	–	467 871	1.3
Prince Edward Island	–	–	3 414	0.1	–	–	3 414	. . .
Total	10 209 192	100.0	4 383 431	100.0	20 818 925	100.0	35 411 548	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . . Amount too small to be expressed; P Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 3a. CANADA, VALUE OF MINERAL PRODUCTION BY PROVINCE, TERRITORY AND MINERAL CLASS, 1991

	Metals		Industrial Minerals		Fuels		Total	
	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)
Alberta	3 010	. . .	601 292	12.6	15 768 629	79.1	16 372 931	46.5
Ontario	3 783 916	36.1	1 236 575	25.8	80 973	0.4	5 101 464	14.5
British Columbia	1 522 200	14.5	449 063	9.4	1 879 908	9.4	3 851 171	10.9
Quebec	1 887 985	18.0	1 042 025	21.8	–	–	2 930 011	8.3
Saskatchewan	373 026	3.6	866 494	18.1	1 623 466	8.1	2 862 986	8.1
Manitoba	947 610	9.0	88 694	1.9	90 884	0.5	1 127 188	3.2
Newfoundland	734 397	7.0	37 872	0.8	–	–	772 269	2.2
Northwest Territories	477 572	4.6	11 527	0.2	222 026	1.1	711 126	2.0
New Brunswick	375 427	3.6	261 863	5.5	34 185	0.2	671 475	1.9
Nova Scotia	32 425	0.3	182 950	3.8	245 240	1.2	460 615	1.3
Yukon	335 486	3.2	5 217	0.1	–	–	340 703	1.0
Prince Edward Island	–	–	3 261	0.1	–	–	3 261	. . .
Total	10 473 055	100.0	4 786 833	100.0	19 945 311	100.0	35 205 199	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . . Amount too small to be expressed.
Note: Numbers may not add to totals due to rounding.

TABLE 4. CANADA, VALUE OF MINERAL PRODUCTION BY PROVINCE AND TERRITORY, 1986-92

	1986	1987	1988	1989	1990	1991	1992p
				($ millions)			
Alberta	16 331	17 080	15 062	16 456	19 111r	16 373	17 079
Ontario	4 825	5 652	6 895	7 308	6 446	5 101	4 780
British Columbia	3 160	3 615	3 943	4 123	3 954	3 851	3 448
Saskatchewan	2 525	3 151	3 043	3 017	3 183	2 863	3 053
Quebec	2 191	2 780	2 712	2 878	3 037	2 930	2 630
Manitoba	764	1 000	1 627	1 668	1 311r	1 127	1 136
New Brunswick	502	624	911	859	878	671	886
Newfoundland	817	743	865	897	866	772	735
Northwest Territories	788	870	957	1 149	988	711	653
Nova Scotia	367	407	446	442	459	461	540
Yukon	176	437	492	534	542	341	468
Prince Edward Island	2	3	2	2	3	3	3
Total	32 446	36 361	36 955	39 333	40 778r	35 205	35 412

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; r Revised.
Note: Numbers may not add to totals due to rounding.

TABLE 5. CANADA, PERCENTAGE CONTRIBUTION OF PROVINCES AND TERRITORIES TO TOTAL VALUE OF MINERAL PRODUCTION, 1986-92

	1986	1987	1988	1989	1990	1991	1992p
Alberta	50.3	47.0	40.8	41.8	46.9r	46.5	48.2
Ontario	14.9	15.5	18.7	18.6	15.8	14.5	13.5
British Columbia	9.7	9.9	10.7	10.5	9.7	10.9	9.7
Saskatchewan	7.8	8.7	8.2	7.7	7.8	8.1	8.6
Quebec	6.8	7.6	7.3	7.3	7.4	8.3	7.4
Manitoba	2.4	2.8	4.4	4.2	3.2r	3.2	3.2
New Brunswick	1.5	1.7	2.5	2.2	2.2	1.9	2.5
Newfoundland	2.5	2.0	2.3	2.3	2.1	2.2	2.1
Northwest Territories	2.4	2.4	2.6	2.9	2.4	2.0	1.8
Nova Scotia	1.1	1.1	1.2	1.1	1.1	1.3	1.5
Yukon	0.5	1.2	1.3	1.4	1.3	1.0	1.3
Prince Edward Island	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada.
. . . Amount too small to be expressed; p Preliminary; r Revised.
Note: Numbers may not add to totals due to rounding.

TABLE 6. CANADA, PRODUCTION OF LEADING MINERALS, 1991 AND 1992

		Volume		Percent Change	Value		Percent Change
		1991	1992p	1991/1992	1991	1992p	1991/1992
		(000 tonnes except where noted)			($ millions)		
METALS							
Gold	kg	176 125.9	157 554.0	–10.5	2 349.9	2 086.8	–11.2
Copper		780.4	744.7	–4.6	2 112.2	2 062.9	–2.3
Zinc		1 083.0	1 193.6	10.2	1 385.2	1 727.1	24.7
Nickel		188.1	189.1	0.5	1 807.6	1 679.9	–7.1
Iron ore		35 421.2	32 771.9	–7.5	1 228.2	1 129.4	–8.0
Uranium	tU	8 161.7	9 057.5	11.0	595.5	575.6	–3.3
Lead		248.1	318.5	28.4	210.9	230.9	9.5
Silver	t	1 261.4	1 147.4	–9.0	187.7	173.2	–7.7
Cobalt		2.2	2.2	2.2	77.5	136.9	76.5
Platinum group	kg	11 122.6	10 504.7	–5.6	150.2	117.1	–22.0
NONMETALS							
Potash (K_2O)		7 087.0	7 324.2	3.3	931.9	963.3	3.4
Salt		11 870.9	11 100.4	–6.5	259.2	253.8	–2.1
Asbestos		686.0	601.3	–12.4	271.0	235.8	–13.0
Sulphur, elemental		6 180.0	6 349.7	2.7	335.4	131.4	–60.8
Peat		833.1	855.6	2.7	100.1	108.2	8.1
Gypsum		6 727.2	6 891.9	2.4	71.7	79.2	10.5
STRUCTURALS							
Cement		9 372.2	8 483.7	–9.5	810.8	739.2	–8.8
Sand and gravel		216 263.9	201 081.8	–7.0	741.3	637.0	–14.1
Stone		87 825.7	81 639.1	–7.0	539.7	507.6	–5.9
Lime		2 375.3	2 383.3	0.3	193.5	182.8	–5.5
Clay products		..	..	..	119.8	117.3	–2.1
FUELS							
Petroleum	000 m^3	89 788.4	93 997.1	4.7	10 456.4	11 251.1	7.6
Natural gas	million m^3	105 243.7	118 925.4	13.0	5 394.1	5 607.7	4.0
Natural gas by-products	000 m^3	24 918.8	26 551.4	6.6	2 178.1	2 296.8	5.5
Coal		71 133.0	64 550.0	–9.3	1 916.8	1 663.3	–13.2

Sources: Energy, Mines and Resources Canada; Statistics Canada.
.. Not available; p Preliminary.
Note: Figures have been rounded.

TABLE 7. VALUE OF LEADING MINERALS IN THE PROVINCES, TERRITORIES AND CANADA, 1991 AND 1992

	Value of Production			
	1991	1992p	Change 1992/1991	1992p Proportion of Provincial Total
	($ millions)		(percent)	
NEWFOUNDLAND				
Iron ore	714.9	680.2	–4.9	92.5
Gold	x	x	x	x
Cement	x	x	x	x
Sand and gravel	11.4	11.6	1.8	1.6
Stone	7.7	4.9	–36.4	0.7
Asbestos	3.3	4.6	39.4	0.6
Total	772.3	735.3	–4.8	100.0
PRINCE EDWARD ISLAND				
Sand and gravel	3.3	3.4	3.0	100.0
Total	3.3	3.4	3.0	100.0
NOVA SCOTIA				
Coal	245.2	265.0	8.1	49.1
Petroleum, crude	–	102.3	. .	18.9
Gypsum	49.9	55.2	10.6	10.2
Salt	x	x	x	x
Cement	x	x	x	x
Sand and gravel	21.7	20.4	–6.0	3.8
Stone	24.8	19.8	–20.2	3.7
Total	460.6	539.9	17.2	100.0
NEW BRUNSWICK				
Zinc	268.3	426.8	59.1	48.2
Potash (K_2O)	x	x	x	x
Lead	44.2	56.1	26.9	6.3
Copper	28.4	43.2	52.1	4.9
Silver	23.6	36.1	53.0	4.1
Total	671.5	885.8	31.9	100.0
QUEBEC				
Gold	692.8	590.0	–14.8	22.4
Iron ore	x	x	x	x
Copper	308.4	255.2	–17.3	9.7
Titanium dioxide	x	x	x	x
Asbestos	226.3	224.8	–0.7	8.5
Stone	208.8	205.8	–1.4	7.8
Total	2 930.0	2 630.4	–10.2	100.0
ONTARIO				
Nickel	1 219.3	1 112.9	–8.7	23.3
Gold	1 029.6	979.2	–4.9	20.5
Copper	708.9	716.2	1.0	15.0
Cement	348.6	305.9	–12.2	6.4
Zinc	273.2	276.1	1.1	5.8
Stone	238.4	218.6	–8.3	4.6
Total	5 101.5	4 780.5	–6.3	100.0
MANITOBA				
Nickel	588.3	567.0	–3.6	49.9
Copper	148.5	167.8	13.0	14.8
Zinc	113.2	123.4	9.0	10.9
Petroleum, crude	90.3	86.3	–4.4	7.6
Total	1 127.2	1 136.0	0.8	100.0

TABLE 7 (cont'd)

	Value of Production			
	1991	1992p	Change 1992/1991	1992p Proportion of Provincial Total
	($ millions)		(percent)	
SASKATCHEWAN				
Petroleum, crude	1 186.5	1 392.6	17.4	45.6
Potash (K_2O)	x	x	x	x
Uranium (U)	332.8	382.5	14.9	12.5
Natural gas	332.3	297.6	–10.4	9.7
Total	2 863.0	3 052.7	6.6	100.0
ALBERTA				
Petroleum, crude	8 675.4	9 231.4	6.4	54.1
Natural gas	4 435.4	4 674.5	5.4	27.4
Natural gas by-products	2 103.8	2 213.4	5.2	13.0
Coal	554.0	572.1	3.3	3.3
Sulphur, elemental	304.0	115.2	–62.1	0.7
Total	16 372.9	17 078.6	4.3	100.0
BRITISH COLUMBIA				
Copper	916.6	880.1	–4.0	25.5
Coal	990.0	700.0	–29.3	20.3
Natural gas	564.4	568.9	0.8	16.5
Petroleum, crude	266.1	262.4	–1.4	7.6
Gold	244.6	202.1	–17.4	5.9
Zinc	161.1	188.2	16.8	5.5
Cement	x	x	x	x
Total	3 851.2	3 447.7	–10.5	100.0
YUKON				
Zinc	191.2	302.8	58.4	64.7
Lead	79.8	91.3	14.4	19.5
Gold	51.6	50.7	–1.7	10.8
Silver	12.9	17.8	38.0	3.8
Total	340.7	467.9	37.3	100.0
NORTHWEST TERRITORIES				
Zinc	221.5	261.5	18.1	40.0
Gold	223.5	182.8	–18.2	28.0
Petroleum, crude	202.3	142.5	–30.0	21.8
Lead	30.1	28.4	–5.6	4.3
Total	711.1	653.3	–8.1	100.0
CANADA				(Proportion of Canadian Total)
Petroleum, crude	10 456.4	11 251.1	7.6	31.8
Natural gas	5 394.1	5 607.7	4.0	15.8
Natural gas by-products	2 178.1	2 296.8	5.4	6.5
Gold	2 349.9	2 086.8	–11.2	5.9
Copper	2 112.2	2 062.9	–2.3	5.8
Zinc	1 385.2	1 727.1	24.7	4.9
Nickel	1 807.6	1 679.9	–7.1	4.7
Coal	1 916.8	1 663.3	–13.2	4.7
Iron ore	1 228.2	1 129.4	–8.0	3.2
Potash (K_2O)	931.9	963.3	3.4	2.7
Grand total	35 205.2	35 411.5	0.6	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not applicable; p Preliminary; x Confidential.

TABLE 8. PRODUCTION OF LEADING MINERALS, BY PROVINCE AND TERRITORY IN CANADA, 1992p

	Unit of Measure	Nfld.	P.E.I.	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskat-chewan	Alberta	British Columbia	Yukon	N.W.T.	Total Canada
	(000)													
Petroleum, crude	m^3	–	–	621	–	–	222	667	13 437	75 071	2 028	–	1 951	93 997
	$	–	–	102 330	–	–	33 558	86 306	1 392 577	9 231 416	262 412	–	142 496	11 251 095
Natural gas	000 m^3	–	–	–	–	–	433	–	6 214	97 616	14 065	–	598	118 925
	$	–	–	–	–	–	40 970	–	297 574	4 674 540	568 911	–	25 710	5 607 705
Natural gas by-products	m^3	–	–	–	–	–	–	9	124	25 588	801	–	30	26 551
	$	–	–	–	–	–	–	772	11 080	2 213 371	69 411	–	2 191	2 296 825
Gold	g	x	–	–	x	44 544	73 928	2 629	1 834	35	15 261	3 831	13 799	157 554
	$	x	–	–	x	589 985	979 183	34 818	24 290	464	202 130	50 747	182 773	2 086 803
Copper	kg	–	–	–	15 597	92 114	258 547	60 581	120	–	317 729	–	–	744 687
	$	–	–	–	43 206	255 167	716 205	167 816	332	–	880 148	–	–	2 062 873
Zinc	kg	–	–	x	294 978	101 832	190 822	85 263	x	–	130 088	209 263	180 708	1 193 607
	$	–	–	x	426 833	147 351	276 120	123 376	x	–	188 238	302 804	261 484	1 727 150
Nickel	kg	–	–	–	–	–	124 181	64 871	–	–	–	–	–	189 051
	$	–	–	–	–	–	1 112 874	566 978	–	–	–	–	–	1 679 853
Coal	t	–	–	4 500	400	–	–	–	9 350	33 350	16 950	–	–	64 550
	$	–	–	265 000	32 000	–	–	–	94 200	572 100	700 000	–	–	1 663 300
Iron ore	t	18 399	–	–	–	13 861	450	–	–	–	62	–	–	32 772
	$	680 247	–	–	–	x	x	–	–	–	1 292	–	–	1 129 371
Potash (K_2O)	t	–	–	–	x	–	–	–	x	–	–	–	–	7 324
	$	–	–	–	x	–	–	–	x	–	–	–	–	963 260
Cement	t	x	–	x	–	1 610	3 344	x	x	x	x	–	–	8 484
	$	x	–	x	–	94 339	305 906	x	x	x	x	–	–	739 211
Sand and gravel	t	2 859	1 144	5 402	7 045	30 721	62 329	7 475	5 627	35 689	39 883	1 691	1 217	201 082
	$	11 583	3 414	20 443	14 616	93 255	206 465	28 241	21 018	101 364	128 024	5 223	3 390	637 035
Uranium (U)	kg	–	–	–	–	–	988	–	8 069	–	–	–	–	9 057
	$	–	–	–	–	–	193 076	–	382 511	–	–	–	–	575 587
Stone	t	930	–	4 210	2 234	31 634	36 075	1 728	–	347	3 724	–	757	81 639
	$	4 947	–	19 799	13 404	205 775	218 572	8 705	–	4 309	28 766	–	3 368	507 645
Salt	t	–	–	x	x	x	6 648	–	544	1 245	–	–	–	11 100
	$	–	–	x	x	x	140 544	–	25 173	15 324	–	–	–	253 802
Asbestos	t	14	–	–	–	574	–	–	–	–	13	–	–	601
	$	4 593	–	–	–	224 826	–	–	–	–	6 341	–	–	235 760
Lead	kg	–	–	x	77 374	–	–	x	–	–	73 991	125 924	39 140	318 515
	$	–	–	x	56 096	–	–	x	–	–	53 644	91 295	28 377	230 923
Lime	t	–	–	–	x	x	1 455	x	–	186	x	–	–	2 383
	$	–	–	–	x	x	103 205	11 285	–	16 388	x	–	–	182 834
Silver	kg	x	–	x	239	138	213	44	x	–	373	118	23	1 147
	$	x	–	x	36 055	20 769	32 108	6 595	x	–	56 312	17 800	3 526	173 219
Cobalt	kg	–	–	–	–	–	1 764	454	–	–	–	–	–	2 219
	$	–	–	–	–	–	109 541	27 345	–	–	–	–	–	136 886
Sulphur, elemental	t	–	–	–	–	–	–	–	x	5 760	x	–	–	6 350
	$	–	–	–	–	–	–	–	x	115 160	x	–	–	131 385
Clay products	$	x	–	x	x	x	75 895	x	x	x	9 284	–	–	117 326
Platinum group	g	–	–	–	–	–	x	x	–	–	–	–	–	10 505
	$	–	–	–	–	–	x	x	–	–	–	–	–	117 099
Peat	t	1	–	x	309	332	–	x	x	100	–	–	–	856
	$	53	–	x	32 465	40 558	–	x	x	17 250	–	–	–	108 199
Gypsum	t	x	–	5 223	–	–	857	x	–	–	476	–	–	6 892
	$	x	–	55 164	–	–	13 924	x	–	–	x	–	–	79 206
Total leading minerals	$	733 930	3 414	538 515	870 548	2 168 439	4 678 714	1 123 112	3 030 774	17 078 646	3 347 076	467 869	653 315	34 694 353
Total all minerals	$	735 302	3 414	539 913	885 822	2 630 441	4 780 453	1 136 029	3 052 656	17 078 646	3 447 686	467 871	653 315	35 411 548
Leading minerals as % of all minerals		99.8	100.0	99.7	98.3	82.4	97.9	98.9	99.3	100.0	97.1	100.0	100.0	98.0

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; p Preliminary; x Confidential.
Notes: Certain minerals are not included in the leading minerals due to confidentiality constraints. Confidential values are included in totals. Numbers may not add to totals due to rounding.

TABLE 8a. PRODUCTION OF LEADING MINERALS, BY PROVINCE AND TERRITORY IN CANADA, 1991

	Unit of Measure	Nfld.	P.E.I.	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskat-chewan	Alberta	British Columbia	Yukon	N.W.T.	Total Canada
	(000)													
Petroleum, crude	m^3	–	–	–	–	–	235	713	12 390	72 478	2 046	–	1 927	89 788
	$	–	–	–	–	–	35 678	90 343	1 186 476	8 675 431	266 118	–	202 318	10 456 364
Natural gas	000 m^3	–	–	–	–	–	428	–	6 042	85 477	12 934	–	362	105 244
	$	–	–	–	–	–	45 295	–	332 299	4 435 417	564 431	–	16 631	5 394 073
Gold	g	x	–	–	x	51 923	77 170	2 921	2 899	34	18 331	3 865	16 752	176 126
	$	x	–	–	x	692 762	1 029 603	38 969	38 685	454	244 573	51 573	223 504	2 349 872
Natural gas by-products	m^3	–	–	–	–	–	–	6	122	24 108	654	–	29	24 919
	$	–	–	–	–	–	–	541	10 826	2 103 801	59 849	–	3 077	2 178 094
Copper	kg	–	–	x	10 476	113 931	261 899	54 875	x	–	338 642	–	–	780 362
	$	–	–	x	28 356	308 370	708 862	148 525	x	–	916 578	–	–	2 112 152
Coal	t	–	–	4 138	498	–	–	–	8 981	32 554	24 962	–	–	71 133
	$	–	–	245 240	34 185	–	–	–	93 865	553 980	989 510	–	–	1 916 780
Nickel	kg	–	–	–	–	–	125 790	62 309	–	–	–	–	–	188 098
	$	–	–	–	–	–	1 219 277	588 342	–	–	–	–	–	1 807 619
Zinc	kg	–	–	x	209 790	117 404	213 599	88 486	x	–	125 980	149 487	173 154	1 083 008
	$	–	–	x	268 322	150 160	273 193	113 173	x	–	161 129	191 194	221 464	1 385 167
Iron ore	t	19 799	–	–	–	14 905	650	–	–	–	67	–	–	35 421
	$	714 885	–	–	–	x	x	–	–	–	1 514	–	–	1 228 188
Potash (K_2O)	t	–	–	–	x	–	–	–	x	–	–	–	–	7 087
	$	–	–	–	x	–	–	–	x	–	–	–	–	931 932
Cement	t	x	–	x	–	2 267	3 761	x	x	x	x	–	–	9 372
	$	x	–	x	–	135 840	348 646	x	x	x	x	–	–	810 769
Sand and gravel	t	2 535	1 123	5 526	7 400	32 804	65 317	8 000	9 871	38 401	42 023	1 441	1 824	216 264
	$	11 396	3 261	21 667	13 483	113 299	233 239	28 355	41 513	127 307	135 852	5 214	6 739	741 326
Uranium (U)	kg	–	–	–	–	–	1 251	–	6 911	–	–	–	–	8 162
	$	–	–	–	–	–	262 714	–	332 753	–	–	–	–	595 467
Stone	t	1 270	–	4 632	2 591	34 801	38 704	1 725	–	321	2 779	–	1 003	87 826
	$	7 691	–	24 810	15 851	208 805	238 446	11 023	–	3 556	24 685	–	4 788	539 654
Sulphur, elemental	t	–	–	–	–	–	2	–	x	5 675	x	–	–	6 180
	$	–	–	–	–	–	136	–	x	303 960	x	–	–	335 381
Asbestos	t	9	–	–	–	614	–	–	–	–	63	–	–	686
	$	3 259	–	–	–	226 338	–	–	–	–	41 433	–	–	271 030
Salt	t	–	–	x	x	x	7 182	–	566	1 245	–	–	–	11 871
	$	–	–	x	x	x	136 305	–	27 032	15 335	–	–	–	259 166
Lead	kg	–	–	x	51 957	–	x	2 286	–	–	63 385	93 912	35 388	248 102
	$	–	–	x	44 163	–	x	1 943	–	–	53 878	79 825	30 080	210 886
Lime	t	–	–	–	x	x	1 439	x	–	218	x	–	–	2 375
	$	–	–	–	x	x	107 790	9 382	–	20 407	x	–	–	193 541
Silver	kg	x	–	x	158	164	294	43	x	–	497	87	17	1 261
	$	x	–	x	23 563	24 406	43 723	6 391	x	–	74 010	12 890	2 524	187 676
Platinum group	g	–	–	–	–	–	x	x	–	–	–	–	–	11 123
	$	–	–	–	–	–	x	x	–	–	–	–	–	150 155
Clay products	$	x	–	x	x	x	74 737	x	–	x	14 072	–	–	119 838
Peat	t	3	–	x	263	350	–	x	x	102	–	–	–	833
	$	141	–	x	28 510	40 221	–	x	x	15 639	–	–	–	100 133
Sulphur, in smelter gas	t	–	–	1	55	129	480	. . .	–	–	85	. . .	–	749
	$	–	–	116	8 247	20 568	47 293	3	–	–	12 958	3	–	89 187
Cobalt	kg	–	–	–	–	–	1 761	410	–	–	–	–	–	2 171
	$	–	–	–	–	–	61 768	15 781	–	–	–	–	–	77 549
Total leading minerals	$	768 311	3 261	384 466	670 688	2 467 912	5 027 686	1 109 508	2 839 158	16 368 070	3 751 115	340 698	711 126	34 442 001
Total all minerals	$	772 269	3 261	460 615	671 475	2 930 011	5 101 464	1 127 188	2 862 986	16 372 931	3 851 171	340 703	711 126	35 205 199
Leading minerals as % of all minerals		99.5	100.0	83.5	99.9	84.2	98.6	98.4	99.2	100.0	97.4	100.0	100.0	97.8

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . . Amount too small to be expressed; x Confidential.
Notes: Certain minerals are not included in the leading minerals due to confidentiality constraints. Confidential values are included in totals. Numbers may not add to totals due to rounding.

TABLE 9. CANADA, PERCENTAGE CONTRIBUTION OF LEADING MINERALS TO TOTAL VALUE OF MINERAL PRODUCTION, 1986-92

	1986	1987	1988	1989	1990r	1991	1992p
Petroleum, crude	29.6	33.4	24.8	27.7	32.1	29.7	31.8
Natural gas	17.3	12.7	14.1	13.7	14.0	15.3	15.8
Natural gas by-products	5.6	5.2	4.3	4.1	5.8	6.2	6.5
Gold	5.2	6.1	6.3	5.9	5.9	6.7	5.9
Copper	4.4	5.3	6.5	6.1	6.0	6.0	5.8
Zinc	3.7	4.1	6.1	7.0	5.6	3.9	4.9
Nickel	3.0	3.5	7.5	7.7	5.0	5.1	4.7
Coal	5.3	4.5	4.9	4.9	4.5	5.4	4.7
Iron ore	4.1	3.8	3.6	3.5	3.1	3.5	3.2
Potash (K_2O)	1.8	2.0	3.2	2.6	2.4	2.6	2.7
Cement	2.5	2.7	2.6	2.4	2.4	2.3	2.1
Sand and gravel	2.1	2.1	2.3	2.2	2.0	2.1	1.8
Uranium (U)	3.2	3.3	2.8	2.3	2.2	1.7	1.6
Stone	1.5	1.6	1.7	1.7	1.6	1.5	1.4
Salt	0.7	0.7	0.7	0.6	0.6	0.7	0.7
Asbestos	0.7	0.7	0.7	0.7	0.7	0.8	0.7
Lead	0.7	1.1	1.0	0.7	0.7	0.6	0.7
Lime	0.5	0.5	0.5	0.5	0.5	0.6	0.5
Silver	0.8	1.2	1.0	0.7	0.6	0.5	0.5
Cobalt	0.1	0.1	0.1	0.1	0.1	0.2	0.4
Sulphur, elemental	2.6	1.4	1.2	1.1	0.9	1.0	0.4
Clay products	0.6	0.6	0.5	0.5	0.3	0.3	0.3
Platinum group	0.6	0.5	0.5	0.4	0.5	0.4	0.3
Peat	0.2	0.2	0.2	0.3	0.2	0.3	0.3
Gypsum	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Other minerals	2.9	2.4	2.6	2.4	2.3	2.2	2.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; r Revised.
Note: Numbers may not add to totals due to rounding.

TABLE 10. PRODUCTION OF CANADA'S TEN LEADING[1] MINERAL COMMODITIES, 1985-92

	Unit	1985	1986	1987	1988	1989	1990	1991	1992p
	(000)								
Petroleum	m^3	85 564	85 468	89 140	93 806	90 641	90 279	89 788	93 997
Natural gas	000 m^3	84 344	71 896	78 267	90 911	96 117	98 771	105 244	118 925
Natural gas by-products	m^3	19 682	19 127	21 560	22 556	23 055	23 863	24 919	26 551
Gold	g	87 562	102 899	115 818	134 813	159 494	167 373	176 126	157 554
Copper	kg	738 637	698 527	794 149	758 478	704 432	771 433	780 362	744 687
Zinc	kg	1 049 275	988 173	1 157 936	1 370 000	1 272 854	1 179 372	1 083 008	1 193 607
Nickel	kg	169 971	163 639	189 086	198 744	195 554	195 004	188 098	189 051
Coal	t	60 436	57 811	61 211	70 644	70 527	68 332	71 133	64 550
Iron ore	t	39 502	36 167	37 702	39 934	39 445	35 670	35 421	32 772
Potash (K_2O)	t	6 661	6 753	7 668	8 154	7 014	7 345	7 087	7 324

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary.
1 Based on contribution in 1992 to value of mineral production.

TABLE 11. CANADA'S WORLD ROLE AS A PRODUCER OF CERTAIN IMPORTANT MINERALS, 1991[p]

		World	Rank of Five Leading Countries 1	2	3	4	5
Uranium (U concentrates)[a]			**Canada**	Australia	United States	Niger	France
	t	25 330	**8 200[b]**	3 780	3 060	2 960	2 480
	% of Western World total		**32.4**	14.9	12.1	11.7	9.8
Zinc (mine production)			**Canada**	Australia	U.S.S.R.	China	Peru
	000 t	7 512	**1 157**	1 048	800	710	628
	% of world total		**15.4**	14.0	10.6	9.5	8.4
Potash (K_2O equivalent)			U.S.S.R.	**Canada**	Germany	United States	Israel
	000 t	26 126	8 562	**7 406**	3 902	1 692	1 270
	% of world total		32.8	**28.3**	14.9	6.5	4.9
Nickel (mine production)			U.S.S.R.	**Canada**	New Caledonia	Australia	Indonesia
	000 t	867	200	**192**	100	69	66
	% of world total		23.1	**22.1**	11.5	8.0	7.6
Asbestos			U.S.S.R	**Canada**	Brazil	China	Zimbabwe
	000 t	4 011	2 500[e]	**639[e]**	200[e]	200[e]	160[e]
	% of world total		62.3	**15.9**	5.0	5.0	4.0
Sulphur, elemental			United States	**Canada**	U.S.S.R.	Poland	Saudi Arabia
	000 t	37 084	9 503	**6 258**	5 334	3 917	2 045
	% of world total		25.6	**16.9**	14.4	10.6	5.5
Platinum group metals (mine production)			South Africa	U.S.S.R.	**Canada**	United States	Japan
	kg	292 426	147 000	121 500	**11 708**	7 780	2 041
	% of world total		50.3	41.5	**4.0**	2.7	0.7
Aluminum (primary metal)			United States	U.S.S.R.	**Canada**	Australia	Brazil
	000 t	17 574	4 121	2 100	**1 822**	1 235	1 140
	% of world total		23.4	11.9	**10.4**	7.0	6.5
Cobalt (shipments)			Zaire	U.S.S.R.	Zambia	**Canada**	Cuba
	t	26 806	8 790	5 000[e]	4 817	**2 171**	1 200[e]
	% of world total		32.8	18.7	18.0	**8.1**	4.5
Molybdenum (Mo content)			United States	China	Chile	**Canada**	U.S.S.R.
	t	112 553	53 364	16 000	14 540	**11 329**	10 000
	% of world total		47.4	14.2	12.9	**10.1**	8.9
Gypsum			United States	China	Iran	**Canada**	Japan
	000 t	96 551	13 880	8 074	7 983	**6 830**	6 350
	% of world total		14.4	8.4	8.3	**7.1**	6.6
Titanium concentrates (ilmenite)			Australia	South Africa	Norway	**Canada**	Malaysia
	000 t	5 436	1 582	975[d]	800	**600[e,b,c]**	336
	% of world total		29.1	17.9	14.7	**11.0**	6.2
Copper (mine production)			Chile	United States	U.S.S.R.	**Canada**	Zambia
	000 t	9 125	1 814	1 631	840	**811**	423
	% of world total		19.9	17.9	9.2	**8.9**	4.6
Silver (mine production)			Mexico	United States	Peru	**Canada**	U.S.S.R.
	t	14 123	2 196	1 848	1 769	**1 339**	1 270
	% of world total		15.5	13.1	12.5	**9.5**	9.0
Cadmium (refined production)			Japan	U.S.S.R.	Belgium	**Canada**	United States
	t	20 678	2 889	2 000	1 810	**1 787**	1 676
	% of world total		14.0	9.7	8.8	**8.6**	8.1
Lead (mine production)			Australia	United States	U.S.S.R.	China	**Canada**
	000 t	3 339	579	477	460	320	**277**
	% of world total		17.3	14.3	13.8	9.6	**8.3**
Gold (mine production)			South Africa	United States	U.S.S.R.	Australia	**Canada**
	t	2 017	601	290	240	236	**177**
	% of world total		29.8	14.4	11.9	11.7	**8.8**

[e] Estimated; [p] Preliminary.
[a] Total of Western World. [b] Includes uranium (tU) recovered by Elliot Lake producers from refinery/conversion facility wastes. [c] Titaniferous slag with 80% TiO_2 content.
[d] Titaniferous slag with 85% TiO_2 content.

TABLE 12. CANADA'S WORLD ROLE AS A PRODUCER OF CERTAIN IMPORTANT MINERALS, 1990

		World	Rank of Five Leading Countries 1	2	3	4	5
Uranium (U concentrates)[a]			**Canada**	Australia	United States	Namibia	France
	t	31 640	**8 780[b]**	3 530	3 420	3 210	2 830
	% of Western World total		**27.7**	11.2	10.8	10.1	8.9
Zinc (mine production)			**Canada**	Australia	U.S.S.R.	China	Peru
	000 t	7 359	**1 203**	931	870[e]	619	584
	% of world total		**16.4**	12.6	11.8	8.4	7.9
Gypsum			United States	**Canada**	Iran	China	Japan
	000 t	97 677	14 883	**8 202**	7 983	7 983	6 350
	% of world total		15.2	**8.4**	8.2	8.2	6.5
Potash (K_2O equivalent)			U.S.S.R.	**Canada**	Germany	United States	Israel
	000 t	27 429	9 088	**7 002**	4 850	1 654	1 311
	% of world total		33.1	**25.5**	17.7	6.0	4.8
Nickel (mine production)			U.S.S.R.	**Canada**	New Caledonia	Indonesia	Australia
	000 t	881	212	**196**	85	69	67
	% of world total		24.1	**22.2**	9.6	7.8	7.6
Asbestos			U.S.S.R	**Canada**	Brazil	Zimbabwe	China
	000 t	4 204	2 568[e]	**725**	200	188	165[e]
	% of world total		61.1	**17.2**	4.8	4.5	3.9
Sulphur, elemental			United States	**Canada**	U.S.S.R.	Poland	Mexico
	000 t	38 629	10 192	**5 923**	5 729	4 456	2 142
	% of world total		26.4	**15.3**	14.8	11.5	5.5
Platinum group metals (mine production)			South Africa	U.S.S.R.	**Canada**	United States	Japan
	kg	288 502	139 900	125 000	**11 209**	7 740	2 472
	% of world total		48.5	43.3	**3.9**	2.7	0.9
Aluminum (primary metal)			United States	U.S.S.R.	**Canada**	Australia	Brazil
	000 t	18 150	4 048	2 300[e]	**1 567**	1 233	931
	% of world total		22.3	12.7	**8.6**	6.8	5.1
Molybdenum (Mo content)			United States	China	Chile	**Canada**	U.S.S.R.
	t	122 232	61 611	15 700	13 830	**12 188**	11 000
	% of world total		50.4	12.8	11.3	**10.0**	9.0
Cobalt (shipments)			Zaire	Zambia	U.S.S.R.	**Canada**	Cuba
	t	27 945	10 033	4 844	2 400[e]	**2 184**	1 600[e]
	% of world total		35.9	17.3	8.6	**7.8**	5.7
Titanium concentrates (ilmenite)			Australia	South Africa	Norway	**Canada**	Malaysia
	000 t	6 026	1 866	904[d]	814	**760[e,b,c]**	530[r]
	% of world total		31.0	15.0	13.5	**12.6**	8.8
Copper (mine production)			Chile	United States	U.S.S.R.	**Canada**	Zambia
	000 t	9 040	1 588	1 587	900	**794**	496
	% of world total		17.6	17.6	10.0	**8.8**	5.5
Silver (mine production)			Mexico	United States	Peru	**Canada**	U.S.S.R.
	t	15 144	2 546	2 170	1 781	**1 502**	1 380
	% of world total		16.8	14.3	11.8	**9.9**	9.1
Lead (mine production)			Australia	United States	U.S.S.R.	China	**Canada**
	000 t	3 345	561	495	490[e]	315	**241**
	% of world total		16.8	14.8	14.6	9.4	**7.2**
Cadmium (refined production)			Japan	U.S.S.R.	Belgium	United States	**Canada**
	t	19 735	2 451	2 400	1 958	1 678	**1 470**
	% of world total		12.4	12.2	9.9	8.5	**7.4**
Gold (mine production)			South Africa	U.S.S.R.	United States	Australia	**Canada**
	t	2 147	603	302[e]	295	244	**169**
	% of world total		28.1	14.1	13.7	11.4	**7.9**

[e] Estimated; [r] Revised.
[a] Total of Western World. [b] Includes uranium (tU) recovered by Elliot Lake producers from refinery/conversion facility wastes. [c] Titaniferous slag with 80% TiO_2 content.
[d] Titaniferous slag with 85% TiO_2 content.

TABLE 13. CANADA, GROSS DOMESTIC PRODUCT OF INDUSTRIAL PRODUCTION, MINING AND MINERAL MANUFACTURING AT FACTOR COST AT 1986 PRICES, 1985-91

	1985	1986	1987	1988	1989	1990	1991p
				($ millions)			
Total industrial production	121 272.9	120 363.8	126 226.0	132 918.8	132 361.6	126 807.1	121 680.4
Total mining	18 825.2	17 502.3	18 631.7	20 422.3	19 886.7	19 833.0	20 011.9
METALS							
Gold mines	740.1	880.6	987.1	1 213.8	1 499.7	1 554.3	1 618.7
Other metal mines	2 382.5	2 346.5	2 734.0	2 708.7	2 412.8	2 332.3	2 287.3
Iron mines	585.8	452.7	505.1	568.5	609.9	512.7	497.1
FUELS							
Crude oil and natural gas	10 593.7	9 762.6	10 379.4	11 449.2	11 373.3	11 492.2	11 824.8
NONMETALS							
Asbestos	110.2	102.0	103.7	102.3	119.3	108.0	95.8
All nonmetals	448.3	485.4	583.4	609.0	539.8	531.3	547.0
Potash	280.5	309.9	369.9	439.8	372.6	366.9	397.4
Salt	132.9	135.6	125.8	138.9	143.2	151.1	160.2
Coal	825.2	755.2	849.8	1 012.7	1 005.4	995.0	1 050.3
Quarry and sand pits	541.2	643.7	687.7	721.4	726.5	682.8	635.2
SERVICES RELATED TO MINING	2 663.2	1 937.7	1 675.7	1 897.8	1 456.8	1 473.3	1 295.5
MINERAL MANUFACTURING							
Primary metals	6 351.6	6 127.7	6 773.1	7 130.8	6 982.5	6 436.5	6 521.9
Primary steel	2 816.3	2 625.8	2 827.1	2 957.8	2 974.4	2 644.8	2 582.2
Steel pipe and tube mills	342.1	277.7	328.6	485.2	460.6	438.9	520.1
Iron foundries	439.2	460.8	424.4	439.9	398.8	344.0	287.8
Nonferrous smelting and refining	1 989.0	1 954.7	2 301.2	2 316.8	2 211.8	2 135.9	2 313.6
Nonmetallic mineral products	2 845.4	2 971.3	3 256.9	3 308.0	3 259.2	3 081.0	2 595.4
Cement	387.0	384.0	431.2	449.8	451.3	425.2	359.7
Concrete products	422.7	448.4	476.8	523.8	532.3	482.6	354.7
Ready-mix concrete	448.4	507.1	568.7	519.8	561.5	506.2	404.0
Glass and glass products	689.3	647.8	694.5	667.6	630.6	604.8	547.4
Miscellaneous nonmetallic products	769.3	787.0	866.9	962.9	921.2	914.1	808.5
Petroleum and coal products	1 746.0	1 731.5	1 823.9	1 870.7	1 926.9	1 964.3	1 920.3

Source: Statistics Canada.
p Preliminary.

TABLE 14. CANADA, GROSS DOMESTIC PRODUCT BY INDUSTRY AT FACTOR COST AT 1986 PRICES, 1985-91

	1985	1986	1987	1988	1989	1990	1991p
				($ millions)			
Gross domestic product, all industries	438 450.1	451 845.3	471 519.4	492 587.8	503 661.1	502 690.9	497 162.6
Agriculture	9 404.2	11 056.7	9 965.7	9 451.7	10 149.2	11 306.3	11 331.3
Fishing and trapping	945.2	980.2	885.5	946.3	1 021.2	1 050.0	970.1
Forestry	2 635.3	2 690.8	3 008.2	3 044.2	3 060.5	2 762.6	2 483.1
Mines (including milling), quarries and oil wells	18 825.2	17 502.3	18 631.7	20 422.3	19 886.7	19 833.0	20 011.9
Manufacturing	86 150.2	86 797.1	90 967.2	95 599.8	95 790.2	90 907.1	84 889.0
Construction	26 953.0	28 081.7	29 686.5	30 815.0	32 146.2	32 329.1	30 915.0
Transportation and storage	19 763.4	20 253.4	21 659.9	22 756.3	22 033.5	21 769.5	21 251.1
Communications	12 634.8	13 247.9	14 140.2	15 223.2	16 887.6	18 211.1	18 948.2
Electric power, gas and water utilities	14 885.1	15 197.7	15 755.6	16 003.9	15 789.4	15 141.6	15 831.7
Trade, wholesale	21 765.8	23 312.0	25 131.6	26 971.7	27 870.7	27 170.2	27 470.9
Trade, retail	27 375.2	28 269.2	29 929.2	30 854.9	31 302.1	30 847.8	29 678.5
Finance, insurance and real estate	65 747.8	69 033.9	71 931.4	74 721.7	77 058.6	77 783.0	80 768.6
Community, business and personal services	48 776.9	52 119.0	55 102.8	59 240.1	62 064.2	63 196.3	61 050.4
Government services	30 954.5	31 365.5	31 418.1	31 906.0	32 591.2	33 250.7	33 673.6

Source: Statistics Canada.
p Preliminary.

TABLE 15. CANADA, EXPORTS OF MINERAL COMMODITIES BY COUNTRY AND BY COMMODITY AS DEFINED BY THE HARMONIZED SYSTEM (HS), 1992 (9 MONTHS)

HS Chapter[1]	Description	United States		EEC[2]		Japan		Mexico		Other		Total	
		($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)
25	Salts; sulphur; earths or stone, plastering materials, lime and cement	362 768	43.0	68 826	8.2	45 727	5.4	19 218	2.3	346 674	41.1	843 213	100
26	Ores, slag and ash	297 413	16.4	822 991	45.3	479 526	26.4	12 176	0.7	203 076	11.2	1 815 182	100
27	Mineral fuels, oils and products of their distillation; bituminous substances; mineral waxes[3]	10 651 802	87.0	229 869	1.9	863 905	7.1	25 775	0.2	466 757	3.8	12 238 108	100
28	Inorganic chemicals; compounds of precious metals, radioactive elements, etc.	1 018 215	81.6	82 131	6.6	75 151	6.0	302	–	71 458	5.7	1 247 257	100
31	Fertilizers	800 458	66.4	21 867	1.8	47 838	4.0	–	–	335 565	27.8	1 205 728	100
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	241 928	92.5	6 506	2.5	3 740	1.4	–	–	9 270	3.5	261 444	100
69	Ceramic products	29 821	80.1	1 837	4.9	225	0.6	6	–	5 338	14.3	37 227	100
70	Glass and glassware	258 615	83.1	38 201	12.3	3 010	1.0	42	–	11 155	3.6	311 023	100
71	Natural/cultured pearls, precious stones and metals, coins, etc.	1 230 192	55.5	115 596	5.2	42 586	1.9	71	–	829 105	37.4	2 217 550	100
72	Iron and steel	1 508 807	83.5	98 526	5.5	7 024	0.4	49 862	2.8	141 900	7.9	1 806 119	100
73	Articles of iron or steel	1 140 034	91.8	19 649	1.6	1 850	0.1	20 010	1.6	59 720	4.8	1 241 263	100
74	Copper and articles thereof	752 952	65.4	283 383	25.5	1 983	0.2	5	–	98 028	8.8	1 109 351	100
75	Nickel and articles thereof	422 542	34.1	373 069	30.1	71 166	5.8	4 682	0.4	366 112	29.6	1 237 571	100
76	Aluminum and articles thereof	1 967 174	74.5	294 244	11.1	179 304	6.8	274	–	198 509	7.5	2 639 505	100
78	Lead and articles thereof	66 451	72.8	8 247	9.0	1 576	1.7	–	–	14 966	16.4	91 240	100
79	Zinc and articles thereof	512 603	82.5	15 157	2.4	18 033	2.9	–	–	75 564	12.2	621 357	100
80	Tin and articles thereof	6 403	87.1	137	1.9	142	1.9	–	–	668	9.1	7 350	100
81	Other base metals; cermets; and articles thereof	64 742	40.2	35 335	21.9	11 372	7.1	1 074	0.7	48 643	30.2	161 166	100
	Total mineral exports	21 305 920	73.2	2 515 571	8.6	1 854 158	6.4	133 497	0.5	3 282 508	11.3	29 091 654	100
	Total domestic exports	86 289 538	76.6	8 106 544	7.2	5 513 169	4.9	547 108	0.5	12 162 923	10.8	112 619 282	100
	Percentage, mineral to domestic	24.7		31.0		33.6		24.4		27.0		25.8	

Source: Statistics Canada, Catalogue 65-003 (Quarterly).
1 Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System," as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. 2 EEC: European Economic Community. 3 Total value of coal exports included in Chapter 27 is $1577 million.
– Nil.

TABLE 16. CANADA, IMPORTS OF MINERAL COMMODITIES BY COUNTRY AND BY COMMODITY AS DEFINED BY THE HARMONIZED SYSTEM (HS), 1992 (9 MONTHS)

HS Chapter[1]	Description	United States		EEC[2]		Japan		Mexico		Other		Total	
		($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)
25	Salts; sulphur; earths or stone, plastering materials, lime and cement	238 493	79.3	7 208	2.4	722	0.2	6 314	2.1	47 945	15.9	300 682	100
26	Ores, slag and ash	336 857	54.7	53 665	8.7	–	–	–	–	225 557	36.6	616 079	100
27	Mineral fuels, oils and products of their distillation; bituminous substances; mineral waxes[3]	1 124 635	24.7	1 124 633	24.7	733	–	137 349	3.0	2 170 180	47.6	4 557 530	100
28	Inorganic chemicals; compounds of precious metals, radioactive elements, etc.	539 166	58.5	56 542	6.1	9 828	1.1	534	0.1	316 223	34.3	922 293	100
31	Fertilizers	156 391	88.0	14 046	7.9	650	0.4	17	–	6 610	3.7	177 714	100
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	209 046	74.3	48 390	17.2	3 699	1.3	1 986	0.7	18 117	6.4	281 238	100
69	Ceramic products	136 690	34.1	135 867	33.9	35 738	8.9	4 914	1.2	87 572	21.9	400 781	100
70	Glass and glassware	665 362	79.5	64 321	7.7	32 787	3.9	25 581	3.1	48 550	5.8	836 601	100
71	Natural/cultured pearls, precious stones and metals, coins, etc.	558 407	59.3	88 647	9.4	3 269	0.3	904	0.1	289 687	30.8	940 914	100
72	Iron and steel	834 961	62.6	226 271	17.0	95 383	7.1	527	–	177 335	13.3	1 334 477	100
73	Articles of iron or steel	1 525 539	76.4	153 605	7.7	93 513	4.7	15 431	0.8	208 413	10.4	1 996 501	100
74	Copper and articles thereof	316 399	83.4	27 232	7.2	2 301	0.6	793	0.2	32 817	8.6	379 542	100
75	Nickel and articles thereof	49 977	23.8	26 535	12.6	1 160	0.6	128	0.1	132 438	63.0	210 238	100
76	Aluminum and articles thereof	980 915	88.6	82 773	7.5	3 643	0.3	1 008	0.1	38 606	3.5	1 106 945	100
78	Lead and articles thereof	12 899	93.8	168	1.2	48	0.3	624	4.5	15	0.1	13 754	100
79	Zinc and articles thereof	16 915	85.3	372	1.9	102	0.5	–	–	2 441	12.3	19 830	100
80	Tin and articles thereof	8 157	28.0	2 862	9.8	8	–	21	0.1	18 050	62.0	29 098	100
81	Other base metals; cermets; and articles thereof	72 390	52.7	11 490	8.4	1 381	1.0	–	–	52 221	38.0	137 482	100
	Total mineral imports	7 783 199	54.6	2 124 627	14.9	284 965	2.0	196 131	1.4	3 872 777	27.2	14 261 699	100
	Total domestic imports	71 083 747	64.9	10 869 854	9.9	8 207 844	7.5	2 049 925	1.9	17 266 177	15.8	109 477 547	100
	Percentage, mineral to domestic	10.9		19.5		3.5		9.6		22.4		13.0	

Source: Statistics Canada, Catalogue 65-006 (Quarterly).
[1] Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System," as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] EEC: European Economic Community. [3] Total value of coal imports included in Chapter 27 is $466.61 million.

TABLE 17. CANADA, EXPORTS OF MINERAL COMMODITIES BY COUNTRY AND BY COMMODITY AS DEFINED BY THE HARMONIZED SYSTEM (HS), 1991 REVISED

HS Chapter[1]	Description	United States		EEC[2]		Japan		Mexico		Other		Total	
		($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)
25	Salts; sulphur; earths or stone, plastering materials, lime and cement	503 699	36.0	148 885	10.7	67 063	4.8	35 861	2.6	642 204	45.9	1 397 712	100
26	Ores, slag and ash	405 063	16.4	1 055 495	42.8	742 887	30.1	1 155	–	262 542	10.6	2 467 142	100
27	Mineral fuels, oils and products of their distillation; bituminous substances; mineral waxes[3]	13 336 836	84.2	433 253	2.7	1 312 058	8.3	18 385	0.1	738 098	4.7	15 838 630	100
28	Inorganic chemicals; compounds of precious metals, radioactive elements, etc.	1 252 573	83.0	125 253	8.3	25 188	1.7	308	–	106 377	7.0	1 509 699	100
31	Fertilizers	938 686	60.1	22 929	1.5	65 715	4.2	2 463	0.2	531 534	34.0	1 561 327	100
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	310 514	92.3	14 334	4.3	2 281	0.7	206	0.1	9 255	2.7	336 590	100
69	Ceramic products	35 110	79.8	1 207	2.7	390	0.9	45	0.1	7 270	16.5	44 022	100
70	Glass and glassware	291 313	81.8	40 828	11.5	5 088	1.4	98	–	18 955	5.3	356 282	100
71	Natural/cultured pearls, precious stones and metals, coins, etc.	1 627 985	62.4	87 971	3.4	53 222	2.0	711	–	840 075	32.2	2 609 964	100
72	Iron and steel	1 448 633	66.8	75 647	3.5	21 887	1.0	44 404	2.0	576 859	26.6	2 167 230	100
73	Articles of iron or steel	1 441 053	87.6	29 438	1.8	2 760	0.2	1 890	0.1	170 493	10.4	1 645 634	100
74	Copper and articles thereof	799 839	55.9	463 784	32.4	12 496	0.9	142	–	155 389	10.9	1 431 650	100
75	Nickel and articles thereof	692 257	48.8	258 053	18.2	25 554	1.8	835	0.1	440 510	31.1	1 417 209	100
76	Aluminum and articles thereof	2 383 593	71.5	349 061	10.5	297 958	8.9	480	–	303 007	9.1	3 334 099	100
78	Lead and articles thereof	63 143	72.8	9 609	11.1	4 942	5.7	–	–	9 022	10.4	86 716	100
79	Zinc and articles thereof	568 023	74.8	21 397	2.8	29 586	3.9	–	–	140 101	18.5	759 107	100
80	Tin and articles thereof	6 938	83.5	457	5.5	290	3.5	–	–	625	7.5	8 310	100
81	Other base metals; cermets; and articles thereof	131 042	61.3	28 305	13.3	3 735	1.7	245	0.1	50 288	23.5	213 615	100
	Total mineral exports	26 236 300	70.6	3 165 906	8.5	2 673 100	7.2	107 228	0.3	5 002 404	13.5	37 184 938	100
	Total domestic exports	103 461 959	74.7	11 146 132	8.1	7 119 396	5.1	560 726	0.4	16 148 965	11.7	138 437 178	100
	Percentage, mineral to domestic	25.4		28.4		37.5		19.1		31.0		26.9	

Source: Statistics Canada, Catalogue #65-003 (Quarterly).
– Nil.
[1] HS Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System," as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] EEC: European Economic Community. [3] Value of coal exports included in Chapter 27 is $2236 million.

TABLE 18. CANADA, IMPORTS OF MINERAL COMMODITIES BY COUNTRY AND BY COMMODITY AS DEFINED BY THE HARMONIZED SYSTEM (HS), 1991 REVISED

HS Chapter[1]	Description	United States		EEC[2]		Japan		Mexico		Other		Total	
		($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)
25	Salts; sulphur; earths or stone, plastering material, lime and cement	301 806	77.7	10 655	2.7	1 226	0.3	15 570	4.0	59 387	15.3	388 644	100
26	Ores, slag and ash	473 738	64.6	79 121	10.8	45	–	703	0.1	179 977	24.5	733 584	100
27	Mineral fuels, oils and products of their distillation; bituminous substances; mineral waxes[3]	1 444 597	21.9	1 707 375	25.9	600	–	97 606	1.5	3 338 439	50.7	6 588 617	100
28	Inorganic chemicals; compounds of precious metals, radioactive elements, etc.	788 454	60.6	88 907	6.8	32 483	2.5	735	0.1	389 485	30.0	1 300 064	100
31	Fertilizers	192 450	88.0	22 466	10.3	532	0.2	40	–	3 214	1.5	218 702	100
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	237 334	68.9	77 732	22.6	4 707	1.4	2 463	0.7	21 998	6.4	344 234	100
69	Ceramic products	177 450	34.2	195 433	37.6	45 243	8.7	5 267	1.0	95 706	18.4	519 099	100
70	Glass and glassware	786 864	76.9	86 175	8.4	45 283	4.4	33 128	3.2	71 505	7.0	1 022 955	100
71	Natural/cultured pearls, precious stones and metals, coins, etc.	703 796	61.0	135 205	11.7	4 247	0.4	1 327	0.1	308 985	26.8	1 153 560	100
72	Iron and steel	1 117 878	62.2	287 423	16.0	116 509	6.5	4 484	0.2	270 132	15.0	1 796 426	100
73	Articles of iron or steel	1 759 012	69.8	339 179	13.5	168 030	6.7	20 774	0.8	233 298	9.3	2 520 293	100
74	Copper and articles thereof	373 701	83.9	30 925	6.9	5 396	1.2	486	0.1	34 980	7.9	445 488	100
75	Nickel and articles thereof	66 757	25.1	42 611	16.0	345	0.1	82	–	156 534	58.8	266 329	100
76	Aluminum and articles thereof	1 159 547	87.0	115 015	8.6	4 585	0.3	1 568	0.1	52 494	3.9	1 333 209	100
78	Lead and articles thereof	18 846	93.1	171	0.8	13	0.1	1 201	5.9	21	0.1	20 252	100
79	Zinc and articles thereof	21 222	87.2	309	1.3	138	0.6	–	–	2 657	10.9	24 326	100
80	Tin and articles thereof	8 546	25.6	1 742	5.2	2	–	17	0.1	23 043	69.1	33 350	100
81	Other base metals; cermets; and articles thereof	110 965	59.0	27 225	14.5	1 927	1.0	–	–	47 954	25.5	188 071	100
	Total mineral imports	9 742 963	51.6	3 247 669	17.2	431 311	2.3	185 451	1.0	5 289 809	28.0	18 897 203	100
	Total domestic imports	86 288 642	63.8	14 705 378	10.9	10 248 972	7.6	2 573 972	1.9	21 466 983	15.9	135 283 947	100
	Percentage, mineral to domestic	11.3		22.1		4.2		7.2		24.6		14.0	

Source: Statistics Canada, Catalogue No. 65-006 (Quarterly).
– Nil.
[1] HS Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System," as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] EEC: European Economic Community. [3] Total value of coal imports included in Chapter 27 is $538 million.

TABLE 19. CANADA, APPARENT CONSUMPTION[1] OF SOME MINERALS AND RELATION TO PRODUCTION,[2] 1989-91

	1989			1990			1991p		
	Apparent Consumption	Production	Consumption as % of Production	Apparent Consumption	Production	Consumption as % of Production	Apparent Consumption	Production	Consumption as % of Production
	(tonnes)			(tonnes)			(tonnes)		
Quartz silica	3 117 854	2 491 000	125.2	2 921 507r	2 081 170	140.4r	2 115 864	1 495 146	141.5
Salt	11 381 522	11 158 411	102.0	11 388 890	11 191 385	101.8	10 290 717	11 870 859	86.7
Lime	2 512 602	2 551 934	98.5	2 266 327	2 340 737	96.8	2 304 345	2 375 260	97.0
Cement[3]	10 724 725	12 590 637	85.2	9 560 239r	11 745 152	81.4r	7 194 192	9 372 219	76.8
Gypsum	3 113 906	8 179 588	38.1	2 538 472	7 977 685	31.8	2 036 891	6 727 221	30.3
Iron ore	14 590 583	39 445 047	37.0	12 742 241r	35 670 008	35.7	10 708 938	35 421 247	30.2
Potash (K_2O)	341 970	7 014 074	4.9	354 596r	7 344 620	4.8r	663 808	7 087 027	9.4
Asbestos	5 496r	714 036	0.8r	37 021r	685 627	5.4r	822	686 008	0.1

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; r Revised.
1 "Apparent consumption" is production, plus imports, less exports. 2 "Production" refers to producers' shipments. 3 Apparent consumption contains clinker cement in the trade data.

TABLE 20. CANADA, REPORTED CONSUMPTION OF MINERALS AND RELATION TO PRODUCTION, 1989-91

		1989			1990			1991p		
	Unit of Measure	Consumption	Production	Consumption as % of Production	Consumption	Production	Consumption as % of Production	Consumption	Production	Consumption as % of Production
METALS										
Aluminum[1]	t	508 810r	1 554 753	32.7r	465 915r	1 567 395	29.7r	466 227	1 821 642	25.6
Antimony	kg	442 942	2 817 810	15.7	294 321	564 527	52.1	406 221	428 559	94.8
Bismuth	kg	16 158	156 727	10.3	12 032	74 300	16.2	32 036	59 526	53.8
Cadmium	kg	28 826	1 710 527	1.7	35 194	1 333 664	2.6	27 667	1 549 087	1.8
Chromium (chromite)	t	21 066	–	. .	19 921	–	. .	14 751	–	. .
Cobalt	kg	147 299	2 344 389	6.3	194 205	2 183 620	8.9	165 908	2 171 483	7.6
Copper[2]	t	218 571	704 432	31.0	184 497r	771 433	23.9r	185 055	780 362	23.7
Lead[3]	t	87 715r	268 887	32.6r	71 468r	233 372	30.6r	68 252	248 102	27.5
Magnesium	t	15 407	x	x	15 125	x	x	15 248	x	x
Manganese ore	t	203 574	–	. .	253 002r	–	. .	109 028	–	. .
Mercury	kg	31 914	–	. .	33 907	–	. .	9 299	–	. .
Molybdenum (Mo content)	t	1 383	13 543	10.2	1 179	12 188	9.7	1 644	11 437	14.4
Nickel	t	10 423	195 554	5.3	8 410r	195 004	4.3r	11 577	188 098	6.2
Selenium	kg	14 806	212 794	7.0	13 798	369 193	3.7	18 479	226 636	8.2
Silver	kg	531 046	1 312 433	40.5	579 407	1 381 257	41.9	399 295	1 261 359	31.7
Tellurium	kg	x	7 562	x	x	12 212	x	x	16 108	x
Tin	t	3 567	x	x	3 600	3 844	93.7	3 146	4 392	71.6
Tungsten (W content)	kg	345 018	–	. .	326 216r	–	. .	254 593	–	. .
Zinc[3]	t	145 282r	1 272 854	11.4r	123 387r	1 179 372	10.5r	102 220	1 083 008	9.4
NONMETALS										
Barite	t	16 495	38 511	42.8	17 164	43 906	39.1	11 654	46 614	25.0
Feldspar	t	2 049	–	. .	2 177	–	. .	2 346	–	. .
Fluorspar	t	162 528	x	x	140 569	x	x	108 776	–	. .
Mica	kg	6 395r	x	x	4 066r	x	x	3 552	x	x
Nepheline syenite	t	88 660	551 324	16.1	72 258	532 911	13.6	65 973	485 520	13.6
Phosphate rock	t	1 884 742	–	. .	1 392 043	–	. .	1 181 971	–	. .
Potash (K_2O)	t	214 023r	7 014 074	3.1r	262 934r	7 344 620	3.6r	264 280	7 087 027	3.7
Sodium sulphate	t	223 135	327 444	68.1	184 045	346 607	53.1	144 287	334 959	43.1
Sulphur	t	1 082 380	6 558 584	16.5	1 017 273r	6 611 933	15.4r	946 691	6 929 014	13.7
Talc, etc.	t	72 447	144 828	50.0	70 004	130 861	53.5	63 529	114 898	55.3
FUELS										
Coal	000 t	53 881	70 527	76.4	49 039	68 332	71.8	50 282	71 133	70.7
Crude oil[4]	000 m^3	87 789	90 641	96.9	90 207	90 279	99.9	84 359	89 788	94.0
Natural gas[5]	million m^3	52 336	96 117	54.5	50 565r	98 771	51.2r	49 983	105 244	47.5

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available; p Preliminary; r Revised; x Confidential.
1 Consumption of primary aluminum ingot and alloys, secondary ingot and scrap, reported by consumers. 2 Consumption defined as domestic shipments of refined copper plus imports of refined copper. 3 Consumption of primary and secondary refined metal. 4 Consumption defined as refinery receipts. 5 Consumption defined as domestic sales.
Notes: Unless otherwise stated, consumption refers to reported consumption of refined metals or nonmetallic minerals by consumers. Production of metals, in most cases, refers to production in all forms, and includes the recoverable 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.

TABLE 21. CANADA, DOMESTIC CONSUMPTION OF PRINCIPAL REFINED METALS IN RELATION TO REFINERY PRODUCTION,[1] 1985-91

	Unit of Measure	1985	1986	1987	1988	1989	1990	1991p
ALUMINUM								
Domestic consumption[2]	t	346 033	388 879	413 237	493 986	508 810r	465 915r	466 227
Production	t	1 282 316	1 355 161	1 540 439	1 534 499	1 554 753	1 567 395	1 821 642
Consumption of production	%	27.0	28.7	26.8	32.2	32.7r	29.7r	25.6
COPPER								
Domestic consumption[3]	t	222 466	225 586	231 288	236 280	218 571	184 497r	185 055
Production	t	499 626	493 445	491 124	528 723	515 216	515 835	538 339
Consumption of production	%	44.5	45.7	47.1	44.7	42.4	35.8r	34.4
LEAD								
Domestic consumption[4]	t	104 447	94 680	97 281	88 041	87 715r	71 468r	68 252
Production[5]	t	240 011	257 680	230 661	268 076	242 845	183 645	212 366
Consumption of production	%	43.5	36.7	42.2	32.8	36.1r	38.9r	32.1
ZINC								
Domestic consumption[4]	t	123 256	126 115	131 659	150 616	145 282r	123 387r	102 220
Production	t	692 406	570 981	609 909	703 206	669 677	591 786	660 552
Consumption of production	%	17.8	22.1	21.6	21.4	21.7r	20.8r	15.5

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; r Revised.
1 Production of refined metal from all sources, including metal derived from secondary materials at primary refineries. 2 Consumption of primary aluminum ingot and alloys, secondary ingot and scrap, reported by consumers. 3 Consumption defined as domestic shipments of refined copper plus imports of refined copper. 4 Consumption of primary and secondary refined metal, reported by consumers. 5 Production of primary and secondary refined lead.

TABLE 22. AVERAGE ANNUAL PRICES[1] OF SELECTED MINERALS, 1986-92

	Unit of Measure	1986	1987	1988	1989	1990	1991	1992
Aluminum, London Metal Exchange	¢/lb	52.179	71.004	115.394	88.242	74.361	59.066	56.893
Antimony, New York dealer	$/lb	1.219	1.116	1.039	0.943	0.818	0.828	0.791
Asbestos, No. 4T cement fibre	C$/t	1 083.000	1 083.000	1 080.000	1 080.000	1 080.000	1 080.000	1 080.000
Bismuth, New York dealer	$/lb	3.017	3.629	5.726	5.657	3.474	2.969	2.506
Cadmium, New York dealer[2]	$/lb	1.248	1.768	7.031	6.277	3.378	1.974	0.907
Calcium, metal crowns (Producer Price List)	$/lb	3.920	3.850	3.850	3.850	3.850	3.850	3.850
Chrome, U.S. metal, 9% carbon	$/lb	3.021	2.700	2.700	3.621	4.241	4.437	4.500
Cobalt, metal, shot/cathode/250 kg	$/lb	11.242	7.000	7.532	8.400	8.400	11.000	24.300
Columbium, pyrochlore	$/lb	2.600	3.250	2.600	2.600	2.800	2.800	3.500
Copper, electrolytic cathode, COMEX	¢/lb	61.649	77.837	119.183	129.454	124.085	108.211	102.721
Gold, London[3]	C$/troy oz	510.628	592.011	538.024	451.691	383.466	362.183	343.731
Iridium, New York dealer[4]	$/troy oz	600.000	513.750	301.813r	302.667r	307.313	281.354	155.167
Iron ore, taconite pellets	¢/ltu	80.500	77.548	72.441	72.450	72.450	72.450	72.450
Lead, producer	C¢/lb	30.885	47.985	46.013	47.171	53.181	38.556	41.469
Magnesium, U.S. primary ingot (Producer Price List)	$/lb	1.530	1.530	1.563	1.630	1.613	1.430	1.438
Manganese, U.S. metal, regular	¢/lb	79.450	80.687	86.417	91.000	92.896	104.000	104.000
Mercury, New York dealer	$/flask (76 lb)	232.785	295.503	335.517	287.722	249.218	122.424	167.603
Molybdenum, dealer, oxide	$/lb	2.871	2.899	3.449	3.341	2.807	2.349	2.197
Nickel, New York dealer, cathode	$/lb	1.855	2.278	6.122	5.982	4.074	3.796	3.177
Osmium, New York dealer	$/troy oz	698.854	632.458	588.750	547.917	413.438	400.000	400.000
Palladium, London PM fix	$/troy oz	117.002r	131.399r	124.256r	144.578r	114.915	88.290	88.228
Platinum, London PM fix	$/troy oz	464.989r	555.956r	530.777r	509.636r	471.583	376.083	359.799
Potash, coarse, major producer, 60% contained, K_2O[5]	$/st	46.750	68.000	86.000	88.000	88.000	87.500	87.000
Rhodium, New York dealer[6]	$/troy oz	1 194.583	1 240.000	1 275.000	1 275.000	3 565.185	3 739.126	2 365.102
Ruthenium, New York dealer	$/troy oz	73.423	69.796	62.204	62.258	60.917	55.233	28.538
Selenium, New York dealer	$/lb	5.596	6.479	10.085	7.451	5.676	5.241	4.947
Silver, Handy & Harman, Toronto	C$/troy oz	5.470r	7.009r	6.535r	5.499	4.820	4.039	3.936
Sulphur, elemental, North American deliveries	C$/t	107.959	88.234	71.050	72.060	62.030	56.814	22.050
Tantalum, tantalite ore, spot	$/lb	18.008	20.542	37.700	35.302	30.077	28.538	27.365
Tin, New York dealer	$/lb	2.941	3.156	3.309	3.973	2.877	2.588	2.822
Tungsten, U.S. spot ore	$/ltu	42.554	41.687r	50.346r	45.525	34.721	53.417	49.325
Uranium, U_3O_8	US$/lb	25.000r	23.000r	25.000r	24.000	24.000	21.000	19.000
Zinc, special high grade	C¢/lb	55.129	57.794	74.988	97.538	68.850	50.647	56.235

Sources: Energy, Mines and Resources Canada; Alberta Energy Resource Industries Monthly Statistics (Sulphur); "Engineering and Mining Journal" (Asbestos); "Industrial Minerals" (Potash); "Metals Week"; "Northern Miner."

r Revised.

1 Prices, except where noted, are in U.S. currency. 2 1986 U.S. producer price; 1987 to 1989 New York Dealer price. 3 Average afternoon fixings of London bullion dealers, converted to Canadian dollars. 4 The Impala producer price is given for the years 1986-89. 5 Annual average not available, indicative price given.
6 The Impala producer price is given for the years 1986-89.

TABLE 23. CANADIAN AVERAGE ANNUAL PRICES OF SELECTED MINERALS, 1986-92

	Unit of Measure	1986	1987	1988	1989	1990	1991	1992
Aluminum, London Metal Exchange	$/kg	1.598	2.076	3.131	2.304	1.913	1.492	1.516
Antimony, New York dealer	$/kg	3.734	3.262	2.819	2.462	2.104	2.092	2.107
Asbestos, No. 4T cement fibre	$/t	1 083.000	1 083.000	1 080.000	1 080.000	1 080.000	1 080.000	1 080.000
Bismuth, New York dealer	$/kg	9.241	10.609	15.538	14.768	8.936	7.500	6.676
Cadmium, New York dealer[1]	$/kg	3.823	5.168	19.079	16.387	8.689	4.986	2.416
Calcium, metal crowns (Producer Price List)	$/kg	12.007	11.255	10.447	10.051	9.904	9.725	10.256
Chrome, U.S. metal, 9% carbon	$/kg	9.254	7.893	7.327	9.453	10.909	11.208	11.987
Cobalt, metal, shot/cathode/250 kg	$/kg	34.436	20.463	20.439	21.930	21.608	27.787	64.731
Columbium, pyrochlore	$/kg	7.964	9.501	7.055	6.788	7.203	7.073	9.323
Copper, electrolytic cathode, COMEX	$/kg	1.888	2.275	3.234	3.380	3.192	2.733	2.736
Gold, London[2]	$/g	16.417	19.034	17.298	14.522	12.329	11.644	11.051
Iridium, New York dealer[3]	$/g	26.802	21.902	11.944[r]	11.523[r]	11.528	10.365	6.028
Iron ore, taconite pellets	¢/mtu	110.082	101.204	87.757	84.440	83.200	81.702	86.159
Lead, producer	¢/kg	68.090	105.789	101.441	103.994	117.244	85.001	91.423
Magnesium, U.S. primary ingot (Producer Price List)	$/kg	4.687	4.473	4.241	4.255	4.149	3.612	3.831
Manganese, U.S. metal, regular	$/kg	2.434	2.359	2.345	2.376	2.390	2.627	2.770
Mercury, New York dealer	$/kg	9.382	11.366	11.980	9.884	8.435	4.069	5.875
Molybdenum, dealer, oxide	$/kg	8.794	8.475	9.359	8.722	7.221	5.934	5.852
Nickel, New York dealer, cathode	$/kg	5.682	6.659	16.613	15.617	10.480	9.589	8.463
Osmium, New York dealer	$/g	31.218	26.963	23.299	20.861	15.510	14.735	15.539
Palladium, London PM fix	$/g	5.227[r]	5.602[r]	4.917[r]	5.505[r]	4.311	3.252	3.427
Platinum, London PM fix	$/g	20.771[r]	23.701[r]	21.005[r]	19.403[r]	17.691	13.854	13.977
Potash, coarse, major producer, 60% contained, K_2O[4]	$/t	71.601	99.392	116.685	114.871	113.184	110.515	115.877
Rhodium, New York dealer[5]	$/g	53.363	52.863	50.456	48.543	133.743	137.743	91.879
Ruthenium, New York dealer	$/g	3.280	2.976	2.462	2.370	2.285	2.035	1.109
Selenium, New York dealer	$/kg	17.142	18.940	27.367	19.452	14.601	13.239	13.178
Silver, Handy & Harman, Toronto	$/kg	244.349	298.804	258.611	209.363	180.815	148.790	152.905
Sulphur, elemental, North American deliveries	$/t	107.959	88.234	71.050	72.060	62.030	56.814	22.050
Tantalum, tantalite ore, spot	$/kg	55.161	60.050	102.302	92.163	77.369	72.089	72.896
Tin, New York dealer	$/kg	9.009	9.226	8.979	10.372	7.401	6.537	7.517
Tungsten, U.S. spot ore	$/mtu	59.125	54.403[r]	60.990[r]	53.059[r]	39.873	60.239	58.658
Uranium, U	$/kg	89.000	79.000	79.000	74.000	71.000	61.000	59.000
Zinc, special high grade	$/kg	1.215	1.274	1.653	2.150	1.518	1.117	1.240

Sources: Energy, Mines and Resources Canada; Alberta Energy Resource Industries Monthly Statistics (Sulphur); "Engineering and Mining Journal" (Asbestos); "Industrial Minerals" (Potash); "Metals Week"; "Northern Miner."

[r] Revised.

[1] 1986 U.S. producer price; 1987 to 1989 New York dealer price. [2] Average afternoon fixings of London bullion dealers, converted to Canadian dollars. [3] The Impala producer price is given for the years 1986-89. [4] Annual average not available, indicative price given. [5] The Impala producer price is given for the years 1986-89.

TABLE 24. CANADA, MINERAL PRODUCTS INDUSTRIES, SELLING PRICE INDEXES, 1985-91

Base (1986=100)	1985	1986	1987	1988	1989	1990	1991p
IRON AND STEEL PRODUCTS INDUSTRIES							
Ferroalloy and steel foundry industries	98.7	100.0	100.7	106.3	116.1	108.6	108.2
Iron foundries	97.4	100.0	100.8	103.2	106.3	109.8	110.9
Primary steel industries	99.0	100.0	101.6	107.5	110.0	108.1	105.6
Steel pipe and tube industry	99.7	100.0	100.5	104.7	105.7	102.3	101.3
NONFERROUS PRIMARY METAL PRODUCTS INDUSTRIES							
Aluminum rolling, casting and extruding industry	97.2	100.0	104.4	123.2	117.2	100.5	91.6
Copper rolling, casting and extruding industry	97.0	100.0	111.5	146.5	161.1	154.4	138.9
Jewellery and precious metals industries	92.5	100.0	103.8	98.8	91.0	90.8	89.6
Other rolling, casting and extruding industry	98.6	100.0	106.3	122.4	124.3	113.7	101.7
Nonferrous metal smelting and refining industries	96.3	100.0	111.6	148.2	141.4	117.0	99.0
NONMETALLIC MINERAL PRODUCTS INDUSTRIES							
Agricultural chemicals industries	102.5	100.0	94.4	98.3	98.8	95.1	97.6
Hydraulic cement industry	97.6	100.0	100.8	102.1	104.8	106.8	110.3
Clay products industry (from domestic clay)	93.7	100.0	107.7	110.8	117.3	122.7	122.0
Clay products industry (from imported clay)	94.9	100.0	105.2	112.3	118.0	123.4	124.6
Concrete products industries	94.7	100.0	104.8	113.0	116.2	118.3	119.9
Glass and glass products industries	96.1	100.0	104.5	110.2	111.1	110.7	109.8
Nonmetallic mineral insulating materials industry	99.2	100.0	104.5	109.6	114.1	114.5	114.2
Refined petroleum and coal products industries	124.5	100.0	95.0	88.2	89.5	100.9	97.7
FABRICATED METAL PRODUCTS INDUSTRIES							
Agricultural implement industry	97.7	100.0	101.8	104.3	106.7	109.0	109.9
Miscellaneous fabricated structural metal products	97.7	100.0	102.1	108.1	111.8	112.8	111.4
Hardware, tool and cutlery industries	96.6	100.0	103.9	109.2	113.7	117.4	120.0
Heating equipment industry	98.2	100.0	102.3	106.3	110.6	113.1	115.6
Other metal fabricating industries	96.4	100.0	102.2	107.5	112.8	115.4	117.8
Power boiler and heat exchanger industry	92.3	100.0	107.8	112.7	120.7	125.3	130.1
Stamped, pressed and coated metal products industries	96.1	100.0	102.3	105.1	105.6	104.7	103.9
Wire and wire products industries	99.2	100.0	101.4	106.9	111.5	112.7	112.7

Source: Statistics Canada, Catalogue No. 62-011.
p Preliminary.

TABLE 25. CANADA, SELLING PRICE INDEXES OF MINERAL RAW MATERIALS, 1985-91

Base (1986=100)	1985	1986	1987	1988	1989	1990	1991p
METALLIC MINERALS							
Copper concentrates	96.7	100.0	118.7	158.7	165.3	153.0	131.5
Iron ore	98.7	100.0	96.4	91.0	82.8	82.8	81.7
Lead concentrates	83.7	100.0	156.9	151.9	154.1	170.4	123.9
Nickel concentrates	114.0	100.0	111.1	263.3	251.6	166.0	149.9
Other base metals	98.0	100.0	107.0	130.6	119.4	96.0	80.3
Precious metals	89.2	100.0	114.5	103.9	87.8	85.4	78.0
Gold and alloys in primary form	88.8	100.0	114.2	103.9	87.8	85.9	78.8
Platinum	62.1	100.0	116.5	101.8	95.5	86.9	68.4
Silver	110.1	100.0	121.9	106.2	86.4	74.7	61.7
Radio-active concentrates	100.9	100.0	97.9	86.8	60.0	57.8	49.8
Zinc concentrates	103.3	100.0	106.2	138.8	184.8	165.7	121.9
NONMETALLIC MINERALS							
Asbestos fibres	100.3	100.0	100.1	100.9	107.2	108.9	111.0
Other crude minerals	98.7	100.0	100.4	106.0	105.7	104.6	104.7
Potash (muriate)	101.6	100.0	107.7	145.3	140.8	133.4	137.9
Quartz and silica sand	97.0	100.0	100.5	107.6	106.8	109.8	108.3
Sand and gravel	97.6	100.0	104.6	114.2	125.2	126.8	124.3
Stone	96.3	100.0	102.9	107.9	109.6	114.6	116.4
Building	97.4	100.0	103.5	106.5	111.4	117.2	119.5
Crushed	94.9	100.0	104.2	109.1	110.5	116.4	120.4
Other	97.4	100.0	103.5	106.5	111.4	117.2	119.5
Sulphur	93.4	100.0	81.4	65.8	65.9	57.6	53.0
MINERAL FUELS							
Coal (thermal)	100.2	100.0	100.7	89.7	90.0	90.7	94.6
Crude mineral oil	173.4	100.0	110.6	86.5	99.0	120.0	108.3
Natural gas	101.9	100.0	96.7	89.1	85.0	85.8	86.8

Source: Statistics Canada, Catalogue No. 62-011.
p Preliminary.

TABLE 26. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY,[1] 1990

	Mining Activity								Total Activity[2]		
		Production and Related Workers			Costs						
	Establish-ments	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)
METALS											
Nickel-copper-zinc	28	13 705	30 821	653 915	236 549	1 991 490	5 836 150	3 608 111	19 104	945 838	3 638 147
Gold	66	9 591	20 943	492 259	135 252	559 464	2 282 757	1 588 041	11 807	604 836	1 584 276
Uranium	5	3 066	6 370	161 643	54 056	125 160	735 694	556 478	3 702	198 024	556 969
Silver-lead-zinc	16	2 304	5 246	103 173	73 145	610 426	1 476 505	792 934	3 727	174 141	798 190
Iron	7	4 384	9 400	226 563	167 528	410 416	1 214 158	636 214	5 820	306 016	606 336
Miscellaneous metal mines[3]	5	845	1 838	36 498	15 284	59 421	168 803	94 098	1 088	48 681	94 554
Total	127	33 895	74 617	1 674 050	681 814	3 756 376	11 714 067	7 275 876	45 248	2 277 536	7 278 472
INDUSTRIALS											
Potash	11	2 810	6 249	111 612	101 372	137 292	968 512	729 848	3 822	162 523	732 506
Stone	123	2 270	5 165	80 360	37 522	118 233	476 858	321 104	2 951	108 954	326 558
Sand and gravel	132	1 696	3 972	58 040	28 182	86 885	365 266	250 199	2 425	85 128	259 954
Miscellaneous nonmetals[4]	34	1 804	3 956	63 789	29 642	61 567	332 826	241 616	2 468	92 392	240 712
Asbestos	4	2 080	4 752	77 772	35 802	53 618	293 731	204 311	2 699	107 764	204 902
Peat	48	1 386	3 063	28 299	5 606	27 713	118 414	85 095	1 740	39 437	85 231
Gypsum	10	656	1 515	18 853	7 105	20 292	88 575	61 178	786	23 948	61 029
Total	362	12 702	28 673	438 725	245 232	505 601	2 644 181	1 893 349	16 891	620 145	1 910 891
FUELS											
Oil, crude and natural gas	714	8 699	17 654	430 018	359 799	1 395 421	18 681 735	16 926 515	31 926	1 742 725	17 117 866
Coal	29	9 410	18 197	447 543	137 092	393 904	1 828 044	1 297 048	11 504	550 214	1 318 855
Total	743	18 109	35 851	877 561	496 891	1 789 325	20 509 779	18 223 563	43 430	2 292 939	18 436 721
Total mineral industry	1 232	64 706	139 141	2 990 336	1 423 937	6 051 302	34 868 027	27 392 788	105 569	5 190 620	27 626 084

Sources: Energy, Mines and Resources Canada; Statistics Canada.
1 Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. 2 Total activity includes sales and head offices.
3 Includes molybdenum. 4 Includes salt.
Note: Numbers may not add to totals due to rounding.

TABLE 26a. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY,[1] 1989

	Mining Activity								Total Activity[2]		
		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)
METALS											
Nickel-copper-zinc	27	14 374	31 561	644 216	228 734	1 914 018	6 617 321	4 474 570	19 837	920 213	4 515 629
Gold	70	10 130	22 117	469 884	120 501	530 195	2 079 569	1 428 873	12 631	588 283	1 425 910
Uranium	5	4 123	8 570	197 028	51 756	155 290	916 419	709 372	4 839	238 520	706 903
Silver-lead-zinc	15	3 105	7 127	138 782	59 653	709 046	1 749 389	980 690	4 487	208 358	989 947
Iron	7	4 786	10 421	220 108	177 860	416 147	1 351 098	757 091	6 303	298 824	741 271
Miscellaneous metal mines[3]	6	933	2 035	37 635	14 125	56 319	188 295	117 850	1 308	53 693	123 027
Total	130	37 451	81 830	1 707 653	652 629	3 781 017	12 902 092	8 468 446	49 405	2 307 891	8 502 686
INDUSTRIALS											
Potash	11	2 887	6 361	108 302	98 387	142 716	1 074 242	833 139	3 893	155 976	841 515
Stone	125	2 410	5 652	82 514	36 563	134 571	513 922	342 788	3 145	111 334	351 350
Sand and gravel	139	1 836	4 256	60 228	29 039	94 583	403 824	280 202	2 736	95 190	300 712
Miscellaneous nonmetals[4]	33	1 697	3 775	60 012	28 485	62 756	364 285	273 044	2 343	85 618	272 714
Asbestos	4	2 128	5 021	82 386	34 673	63 208	303 737	205 856	2 800	113 296	208 599
Peat	56	1 355	3 018	27 992	5 721	30 177	120 324	84 427	1 713	38 635	86 872
Gypsum	10	663	1 452	19 316	7 852	20 381	90 768	62 535	965	32 258	66 026
Total	378	12 976	29 534	440 750	240 720	548 391	2 871 102	2 081 991	17 595	632 308	2 127 787
FUELS											
Oil, crude and natural gas	725	9 111r	18 609r	422 756r	336 559	1 352 711	16 109 679	14 415 409	32 696r	1 772 335r	14 610 015
Coal	29	9 166r	18 582r	414 402r	119 660r	389 413r	1 672 583r	1 163 510r	11 279r	520 452r	1 199 706r
Total	754	18 277r	37 191r	837 158r	456 219r	1 742 124r	17 782 262r	15 578 919r	43 975r	2 292 787r	15 809 721r
Total mineral industry	1 262	68 704r	148 555r	2 985 561r	1 349 568r	6 071 532r	33 555 456r	26 129 356r	110 975r	5 232 986r	26 440 194r

Sources: Energy, Mines and Resources Canada; Statistics Canada.
r Revised.
1 Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. 2 Total activity includes sales and head offices.
3 Includes molybdenum. 4 Includes salt.
Note: Numbers may not add to totals due to rounding.

TABLE 27. CANADA, PRINCIPAL STATISTICS OF THE MINERAL MANUFACTURING INDUSTRIES, 1989

	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 Shipments	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
PRIMARY METAL INDUSTRIES											
Primary steel	64	36 625	78 067	1 491 705	524 198	5 373 223	9 680 139	4 017 368	46 738	1 990 217	4 000 198
Smelting and refining	35	21 606	45 387	939 692	527 155	2 842 624	6 716 374	3 363 962	30 651	1 399 013	3 420 324
Wire and wire products industries[2]	325	11 927	25 119	325 754	38 745	1 051 054	1 865 837	787 747	15 077	441 958	828 479
Aluminum rolling, casting and extruding	76	4 928	10 930	170 640	32 179	1 718 537	2 305 069	537 770	6 285	230 649	532 692
Iron foundries	105	6 397	13 366	195 901	46 077	339 634	850 241	459 434	7 538	244 107	469 057
Metal rolling, casting and extruding n.e.s.	138	5 543	11 256	156 561	30 168	770 942	1 229 926	423 055	6 645	204 325	431 494
Steel pipe and tube	60	4 338	8 992	152 716	18 869	980 670	1 514 856	516 797	5 438	210 605	520 077
Copper and alloy rolling, casting and extruding	45	2 673	5 561	72 989	15 835	417 693	587 906	131 294	3 119	99 714	127 585
Total	848	94 037	198 678	3 505 958	1 233 226	13 494 377	24 750 348	10 237 427	121 491	4 820 588	10 329 906
NONMETALLIC MINERAL PRODUCTS INDUSTRIES											
Ready-mix concrete	654	10 720	23 395	328 801	65 385	1 202 262	2 052 130	785 174	12 377	392 292	795 858
Cement	22	2 122	4 617	89 789	153 630	189 852	955 916	610 300	3 350	145 743	627 698
Primary glass and glass containers	30	4 845	10 416	150 891	49 114	175 869	641 429	411 466	5 995	200 751	410 061
Glass products	166	5 604	11 591	157 442	18 071	319 485	716 665	381 815	6 669	197 039	414 089
Gypsum products	30	1 595	3 583	54 600	30 206	203 142	441 666	208 957	2 320	82 575	213 503
Mineral insulating products	49	2 396	5 326	78 284	37 444	184 657	466 254	243 429	3 620	133 545	368 047
Other concrete products	270	5 483	11 584	132 286	20 342	289 182	643 420	338 580	6 118	162 683	352 452
Structural concrete products	79	2 907	6 344	92 783	6 378	147 463	406 977	255 763	3 596	118 605	262 482
Clay products (domestic)	31	1 109	2 459	35 578	24 191	26 354	193 741	149 935	1 571	53 256	151 839
Other nonmetallic mineral products	175	2 972	6 369	76 311	11 605	122 538	325 159	191 681	3 377	93 418	194 579
Concrete pipe	45	1 425	3 057	43 511	5 729	97 396	248 308	146 806	1 791	59 902	148 318
Clay products (imported)	48	1 254	2 512	31 352	6 492	39 133	134 572	88 166	1 473	38 664	89 397
Refractory products	32	1 076	2 185	29 769	7 058	87 729	220 956	122 483	1 746	56 633	138 804
Abrasives	35	1 547	3 328	42 838	42 489	123 084	299 709	136 550	2 039	61 776	154 725
Lime	13	661	1 450	24 150	40 903	33 254	185 011	110 927	871	34 304	110 270
Asbestos products industry	9	303	646	6 549	827	12 492	26 061	11 033	404	9 801	11 759
Total	1 688	46 019	98 861	1 374 934	519 864	3 253 892	7 957 974	4 193 065	57 317	1 841 087	4 443 881

TABLE 27 (cont'd)

	Mineral Manufacturing Activity								Total Activity[1]		
		Production and Related Workers			Costs						
	Establish-ments	Employees	Person-Hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Shipments	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
FABRICATED METAL PRODUCTS INDUSTRIES											
Stamped and pressed metal products industries	1 027	31 391	66 270	805 115	84 401	3 071 888	5 198 307	2 035 781	36 707	1 003 554	2 089 144
Fabricated structural metal products industries	498	18 690	38 689	555 424	34 572	1 461 570	2 857 495	1 389 528	23 006	722 430	1 414 373
Hardware, tool and cutlery industry	895	22 964	48 065	608 299	30 958	743 912	1 936 707	1 162 871	25 626	707 493	1 200 754
Other metal fabricating industries	599	16 405	33 836	425 592	41 778	1 186 104	2 247 150	1 028 638	20 099	566 992	1 066 412
Ornamental and architectural metal products industries	834	19 111	39 986	443 132	27 891	1 233 492	2 257 224	990 386	22 591	574 073	1 011 314
Machine shop industry	1 544	23 774	49 298	601 487	31 436	622 807	1 532 432	881 732	24 639	636 035	886 078
Power boiler and heat exchanger industry	49	3 480	7 036	113 454	6 230	275 211	622 031	356 996	5 407	189 002	362 656
Heating equipment industry	155	5 650	11 640	129 760	6 475	321 697	637 090	313 906	7 076	176 390	320 174
Total	5 601	141 465	294 820	3 682 263	263 741	8 916 681	17 288 436	8 159 838	165 151	4 575 969	8 350 905
PETROLEUM AND COAL PRODUCTS INDUSTRIES											
Petroleum refining products	36	6 264	12 969	328 639	308 092	12 742 900	14 401 768	1 539 127	15 057	772 521	1 521 242
Other petroleum and coal products	88	856	1 796	24 728	11 099	170 453	269 589	91 056	1 135	35 439	101 802
Lubricating oils and greases	39	649	1 373/	21 849	5 556	207 637	287 308	71 719	1 029	36 717	85 617
Total	163	7 769	16 138	375 216	324 747	13 120 990	14 958 665	1 701 902	17 221	844 677	1 708 661
Total mineral manufacturing industries	8 300	289 290	608 497	8 938 371	2 341 578	38 785 940	64 955 423	24 292 232	361 180	12 082 321	24 833 353

Source: Statistics Canada, Catalogue No. 31-203.
n.e.s. Not elsewhere specified.
1 Total activity includes sales and head offices. **2** Wire and wire products have been included in the primary metal industries group.
Note: Numbers may not add to totals due to rounding.

TABLE 28. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY[1] BY REGION, 1990

	Mines, Quarries and Oil Wells Activity								Total Activity[2]		
		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)
Atlantic provinces[3]	84	8 351	16 532	309 664	150 992	661 745	1 793 866	981 125	10 738	416 926	960 302
Quebec[3]	183	10 777	23 497	462 174	214 085	780 391	2 437 732	1 443 258	14 751	651 791	1 463 206
Ontario	152	16 297	36 215	763 508	232 569	1 432 595	5 443 462	3 778 297	21 907	1 060 611	3 801 042
Prairie provinces	597	16 849	34 897	785 998	551 720	1 948 718	20 397 764	17 897 328	42 491	2 225 155	18 072 230
British Columbia[4]	180	10 095	22 435	526 293	216 949	954 158	3 478 401	2 307 295	12 577	654 998	2 335 877
Yukon and Northwest Territories[5]	36	2 337	5 568	142 698	57 624	273 694	1 316 805	985 487	3 105	181 141	993 426
Total	1 232	64 706	139 141	2 990 336	1 423 937	6 051 302	34 868 027	27 392 788	105 569	5 190 620	27 626 084

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) 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.
Note: Numbers may not add to totals due to rounding.

TABLE 28a. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY[1] BY REGION, 1989

	Mines, Quarries and Oil Wells Activity								Total Activity[2]		
		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)
Atlantic provinces[3]	87	8 775r	18 816r	313 919r	138 804	665 979	1 777 953r	973 166r	11 116	412 951	975 835r
Quebec[3]	191	11 055	24 356	455 928	200 889	741 327	2 255 701	1 313 484	15 196	643 051	1 353 497
Ontario	158	18 773r	41 401r	832 148r	250 902	1 466 418	6 096 815	4 374 495	25 030r	1 140 515r	4 411 358
Prairie provinces	613	17 319r	35 814r	749 291r	512 479	1 923 100r	18 579 464r	16 143 882r	43 460r	2 224 838r	16 312 132r
British Columbia[4]	178	10 560r	22 717r	506 588r	198 320r	972 434r	3 462 081r	2 291 328r	13 071r	639 850r	2 322 994r
Yukon and Northwest Territories[5]	35	2 222	5 451	127 687	48 173	302 270	1 383 443	1 032 999	3 102	171 782	1 064 380
Total	1 262	68 704r	148 555r	2 985 561r	1 349 568r	6 071 532r	33 555 456r	26 129 356r	110 975r	5 232 986r	26 440 194r

Sources: Energy, Mines and Resources Canada; Statistics Canada.
r Revised.
[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) 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.
Note: Numbers may not add to totals due to rounding.

TABLE 29. CANADA, PRINCIPAL STATISTICS OF THE MINERAL MANUFACTURING INDUSTRIES BY REGION, 1989

	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 Shipments	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
PRIMARY METALS INDUSTRY											
Atlantic provinces	10	x	x	x	x	x	x	x	x	x	x
Quebec	136	20 130	42 142	795 098	491 563	3 636 330	7 375 258	3 285 174	28 379	1 195 164	3 271 040
Ontario	244	49 402	105 765	1 916 499	539 385	7 122 092	12 376 548	4 891 596	62 043	2 555 083	4 890 930
Prairie provinces	72	x	x	x	x	x	x	x	x	x	x
British Columbia	61	5 585	10 966	220 790	22 198	440 070	1 112 999	645 339	7 226	296 734	716 830
Yukon and Northwest Territories	–	–	–	–	–	–	–	–	–	–	–
Total Canada	523	82 110	173 558	3 180 204	1 194 481	12 443 323	22 884 511	9 449 680	106 414	4 378 630	9 501 427
NONMETALLIC MINERAL PRODUCTS INDUSTRY											
Atlantic provinces	128	2 169	4 527	53 843	20 492	121 760	301 947	162 390	2 595	69 680	162 605
Quebec	404	11 070	23 627	311 687	121 353	692 032	1 761 818	933 561	12 685	415 283	971 927
Ontario	628	23 865	51 745	731 914	283 593	1 744 323	4 252 530	2 246 482	29 645	982 916	2 441 712
Prairie provinces	343	5 376	11 648	158 324	53 752	391 407	937 625	489 374	6 888	214 497	501 023
British Columbia	185	3 539	7 315	119 166	40 674	304 370	704 054	361 238	4 504	158 711	366 614
Yukon and Northwest Territories	–	–	–	–	–	–	–	–	–	–	–
Total Canada	1 688	46 019	98 861	1 374 934	519 864	3 253 892	7 957 974	4 193 065	57 317	1 841 087	4 443 881
FABRICATED METAL PRODUCTS INDUSTRY[2]											
Atlantic provinces	204	3 426	7 181	85 944	5 537	196 126	366 793	168 572	4 201	112 172	182 012
Quebec	1 331	32 154	66 054	807 383	63 906	2 004 419	4 066 281	2 038 493	39 026	1 044 765	2 070 594
Ontario	3 062	93 244	195 621	2 448 749	187 188	6 124 769	11 557 804	5 252 383	107 811	3 020 443	5 390 923
Prairie provinces	746	14 863	31 046	378 771	26 978	941 793	1 796 493	835 037	17 619	475 376	848 902
British Columbia	583	9 705	20 038	287 170	18 877	700 628	1 366 902	653 100	11 571	365 171	686 953
Yukon and Northwest Territories	–	–	–	–	–	–	–	–	–	–	–
Total Canada	5 926	153 392	319 939	4 008 017	302 486	9 967 735	19 154 273	8 947 585	180 228	5 017 927	9 179 384
PETROLEUM AND COAL PRODUCTS INDUSTRY											
Atlantic provinces	11	x	x	x	x	x	x	x	x	x	x
Quebec	29	1 238	2 568	60 593	63 729	2 433 196	2 708 069	253 035	1 632	78 475	261 627
Ontario	57	3 654	7 554	180 642	151 188	4 932 371	5 635 043	597 333	8 789	455 715	598 924
Prairie provinces	49	x	x	x	x	x	x	x	x	x	x
British Columbia	16	638	1 200	31 915	18 626	1 219 939	1 455 859	239 437	917	49 052	242 440
Yukon and Northwest Territories	–	x	x	x	x	x	x	x	x	x	x
Total Canada	163	7 769	16 138	375 216	324 747	13 120 990	14 958 665	1 701 902	17 221	844 677	1 708 661
TOTAL MINERAL MANUFACTURING INDUSTRIES											
Atlantic provinces	353	x	x	x	x	x	x	x	x	x	x
Quebec	1 900	64 592	134 390	1 974 761	740 551	8 765 977	15 911 426	6 510 283	82 722	2 733 687	6 575 188
Ontario	3 991	170 165	360 684	5 277 804	1 161 354	19 923 555	33 821 925	12 987 794	208 288	7 014 157	13 322 489
Prairie provinces	1 210	x	x	x	x	x	x	x	x	x	x
British Columbia	845	19 467	39 519	659 041	100 375	2 665 007	4 639 814	1 899 114	24 218	869 668	2 012 837
Yukon and Northwest Territories	–	x	x	x	x	x	x	x	x	x	x
Total Canada	8 300	289 290	608 497	8 938 371	2 341 578	38 785 940	64 955 423	24 292 232	361 180	12 082 321	24 833 353

Source: Statistics Canada, Catalogue No. 31-203.
– Nil; x Confidential.
[1] Total activity includes sales and head offices. [2] For reasons of confidentiality, SIC 305 (wire and wire products), normally included in Primary Metals, is included in Fabricated Metal Products.

TABLE 30. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY,[1] 1983-90

	Mines, Quarries and Oil Wells Activity								Total Activity[2]		
		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)
1983	1 407	66 629	131 406	1 963 773	1 022 417	3 756 625	32 771 401	27 992 357	113 831	3 687 911	28 012 167
1984	1 381	69 650	140 567	2 295 256	1 204 008	4 290 972	37 976 019	32 481 039	115 790	4 106 049	32 545 525
1985	1 385	66 945r	140 092r	2 347 084r	1 264 619	4 442 358	38 127 807	32 420 830	116 383r	4 421 553r	32 495 098
1986	1 507	64 360r	135 055r	2 378 524r	1 240 371	4 649 767	27 785 615	21 895 474	109 433r	4 445 569r	22 224 015
1987	1 276	64 370r	138 236r	2 444 934r	1 233 806	4 870 150	30 652 347	24 548 391	107 676r	4 449 357r	24 803 839
1988	1 340	67 360r	144 551r	2 749 351r	1 296 757	5 685 034	31 777 388	24 795 628	110 757r	4 876 209r	25 100 343
1989	1 262	68 704r	148 555r	2 985 561r	1 349 568r	6 071 532r	33 555 456r	26 129 356r	110 975r	5 232 986r	26 440 194r
1990	1 232	64 706	139 141	2 990 336	1 423 937	6 051 302	34 868 027	27 392 788	105 569	5 190 620	27 626 084

Sources: Energy, Mines and Resources Canada; Statistics Canada.
r Revised.
1 Cement manufacturing, lime manufacturing, 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,[1] 1982-89

	Mineral Manufacturing Activity								Total Activity[2]		
		Production and Related Workers			Costs						
	Establishments	Employees	Person-Hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Shipments	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
1982	5 687	229 518	475 378	5 333 201	1 728 740	34 241 605	50 045 037	14 497 245	321 785	8 126 238	14 823 990
1983	7 370	216 944	447 947	5 420 307	1 905 777	34 720 416	52 773 875	15 861 491	301 112	8 143 674	16 196 749
1984	7 511	223 816	470 367	5 948 626	2 125 032	37 738 117	57 207 764	17 980 271	304 309	8 719 151	18 265 131
1985	7 625	238 544	506 377	6 507 081	2 229 270	39 497 925	61 241 939	19 305 730	313 850	9 271 447	19 646 938
1986	7 841	248 039	524 184	6 829 899	2 096 145	31 806 478	54 521 641	19 788 464	319 950	9 563 918	20 124 687
1987	7 598	. .	. .	. .	2 155 505	38 820 112	63 607 352	. .	333 009	10 170 081	22 760 931
1988	8 309	277 965	586 697	8 187 400	2 268 400	35 436 700	62 739 600	22 871 500	350 917	11 191 000	25 725 700
1989	8 300	289 290	608 497	8 938 371	2 341 578	38 785 940	64 955 423	24 292 232	361 180	12 082 321	24 833 353

Source: Statistics Canada.
. . Not available.
1 Includes the following industries: Primary Metals, Nonmetallic Mineral Products, Fabricated Metal Poducts, and Petroleum and Coal Products. 2 Total activity includes sales and head offices.

TABLE 32. CANADA, CONSUMPTION OF FUEL AND ELECTRICITY IN THE MINERAL INDUSTRY,[1] 1990

	Unit	Metals	Industrials[2]	Total
Coal	000 t	191	–	191
	$000	13 919	–	13 919
Gasoline	000 litres	24 219	20 454	44 673
	$000	10 369	9 521	19 890
Fuel oil, kerosene, diesel oil	000 litres	432 108	255 927	688 035
	$000	182 261	72 962	255 223
Liquefied petroleum gas	000 litres	118 602	14 465	133 067
	$000	23 389	3 247	26 636
Natural gas	000 m^3	172 526	652 165	824 691
	$000	18 768	43 669	62 437
Other fuels[3]	$000	22 105	1 681	23 786
Total value of fuels	$000	270 811	131 080	401 891
Electricity purchased	million kWh	13 097	2 842	15 939
	$000	411 002	114 151	525 153
Total value of fuels and electricity purchased in the nonfuel mineral industry	$000	681 813	245 231	927 044
Total value of fuels and electricity purchased in the fuel industry	$000	. .	. .	496 891
Total value of fuels and electricity purchased in the mineral industry, all reporting companies	$000	. .	. .	1 423 935

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available.
1 Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. 2 Includes structural materials. 3 Includes wood, manufactured gas, steam purchased, and other miscellaneous fuels.
Note: Numbers may not add to totals due to rounding.

TABLE 33. CANADA, COST OF FUEL AND ELECTRICITY USED IN THE MINERAL INDUSTRY,[1] 1983-90

	Unit	1983	1984	1985	1986	1987	1988	1989	1990
METALS									
Fuel	$000	270 098	331 231	337 445	276 894	249 932	251 343	254 442	270 811
Electricity purchased	million kWh	9 659	11 672	11 504	12 066	12 128	13 264	13 396	13 097
	$000	238 458	272 932	281 373	320 828	345 068	368 369	398 188	411 002
Total cost of fuel and electricity	$000	508 556	604 163	618 818	597 722	595 000	619 712	652 630	681 813
INDUSTRIALS[2]									
Fuel	$000	157 872	169 486	165 665	153 442	137 873	139 126	127 612	131 080
Electricity purchased	million kWh	1 928	2 120	2 122	2 107	2 237	2 510	2 548	2 842
	$000	64 052	76 884	82 114	86 571	96 876	107 496	113 108	114 151
Total cost of fuel and electricity	$000	221 924	246 370	247 779	240 013	234 749	246 622	240 720	245 231
TOTAL NONFUEL MINERAL INDUSTRY									
Fuel	$000	427 970	500 717	503 110	430 336	387 805	390 469	382 054	401 891
Electricity purchased	million kWh	11 587	13 792	13 626	14 173	14 365	15 774	15 944	15 939
	$000	302 510	349 816	363 487	407 399	441 944	475 865	511 296	525 153
Total cost of fuel and electricity	$000	730 480	850 533	866 597	837 735	829 749	866 334	893 350	927 044
FUELS[3]									
Fuel	$000	68 800	89 237	101 049	73 426	67 103	68 654	. .	. .
Electricity purchased	million kWh	4 958	5 840	6 569	7 183	7 822	8 726	. .	. .
	$000	223 136	264 233	296 973	329 208	336 952	371 632	. .	. .
Total cost of fuel and electricity	$000	291 936	353 470	398 022	402 634	404 055	440 286	456 219r	496 891
TOTAL MINERAL INDUSTRY									
Fuel	$000	496 770	589 954	604 159	503 762	454 908	459 123	. .	. .
Electricity purchased	million kWh	16 545	19 632	20 195	21 356	22 187	24 501	. .	. .
	$000	525 646	614 049	660 460	736 607	778 896	847 497	. .	. .
Total cost of fuel and electricity	$000	1 022 416	1 204 003	1 264 619	1 240 369	1 233 804	1 306 620	1 349 569	1 423 935

Sources: Energy, Mines and Resources Canada; Statistics Canada.
. . Not available; r Revised.
1 Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. 2 Includes structural materials.
3 Breakdown not available for the fuel industries in 1989 and 1990.

TABLE 34. CANADA, EMPLOYMENT IN THE MINERAL INDUSTRY, STAGE I - MINERAL EXTRACTION AND CONCENTRATING (TOTAL ACTIVITY),[1] 1961-92

	Metal Mines	Nonmetal Mines	Structural Materials	Nonfuel Mining	Coal	Crude Oil and Natural Gas	Total Nonfuel and Fuel
SIC no.	061	062	081, 082	061, 062 081, 082	063	071	
				(number)			
1961	58 591	11 003	5 235	74 829	10 302	11 184	96 315
1962	58 243	11 408	5 514	75 165	9 897	11 232	96 294
1963	57 119	11 661	5 686	74 466	9 828	11 237	95 531
1964	57 648	11 727	6 044	75 419	9 796	11 242	96 457
1965	60 942	12 116	6 248	79 306	9 697	11 817	100 820
1966	61 670	12 422	6 312	80 404	9 281	12 378	102 063
1967	61 728	13 077	5 779	80 584	8 981	13 113	102 678
1968	63 369	13 673	5 836	82 878	8 427	13 611	104 916
1969	60 550	14 322	5 692	80 564	7 371	14 153	102 088
1970	66 590	15 150	5 510	87 250	7 874	14 970	110 094
1971	66 012	15 105	5 328	86 445	8 069	15 896	110 410
1972	61 994	14 866	5 154	82 014	8 704	16 604	107 322
1973	66 134	15 391	5 276	86 801	7 856	16 786	111 443
1974	70 038	16 198	6 197	92 433	8 142	18 155	118 730
1975	69 161	13 703	6 382	89 246	8 416	18 053	115 715
1976	68 269	15 649	5 685	89 603	8 995	19 096	117 694
1977	67 242	16 608	5 190	89 040	9 781	20 240	119 061
1978	56 447	16 035	4 847	77 329	10 574	22 045	109 948
1979	58 960	16 770	4 692	80 422	10 269	24 554	115 245
1980	66 118	16 979	4 461	87 558	11 416	27 448	126 422
1981	68 712	16 391	4 183	89 286	11 182	28 783	129 251
1982	61 503	13 680	3 491	78 674	13 113	31 699	123 486
1983	52 194	13 170	3 403	68 767	11 646	33 418	113 831
1984	52 683	13 698	3 560	69 941	11 905	33 944	115 790
1985	48 672	12 974	3 941	65 587	12 076	38 720	116 383
1986	46 487	12 376	4 887	63 750	10 747	34 936	109 433
1987	45 496	12 181	5 738	63 415	10 406	33 855	107 676
1988	48 277	11 679	5 917	65 873	11 122	33 762	110 757
1989	49 405	11 714	5 881	67 000	11 279	32 696	110 975
1990	45 248	11 515	5 376	62 139	11 504	31 926	105 569
1991p	42 014	10 744	5 015	57 773	11 498e	31 450	100 721
1992f	39 305	10 455	4 690	54 451	9 585	28 586	92 621

Sources: Energy, Mines and Resources Canada; Statistics Canada.
SIC: 1980 Standard Industrial Classification.
e Estimated; f Forecast; p Preliminary.
1 Total activity includes sales and head offices.

TABLE 35. CANADA, EMPLOYMENT IN THE NONFUEL MINERAL INDUSTRY, STAGE I – MINERAL EXTRACTION AND CONCENTRATING (TOTAL ACTIVITY),[1] 1961-92

	Gold	Uranium	Iron	Nickel, Copper, Zinc	Silver, Lead, Zinc	Other Nonferrous	Asbestos	Peat	Gypsum	Potash	Other Nonmetal	Stone Quarries	Sand and Gravel	Total Nonfuel Mining
SIC no.	0611	0616	0617	0612, 0613	0614	0615, 0619	0621	0622	0623	0624	0625, 0629	081	082	
							(number)							
1961	15 994	(2)	8 446	23 351	4 524	6 276	6 773	1 207	549	(3)	2 424	3 173	2 062	74 829
1962	15 425	(2)	9 181	23 383	4 669	5 585	6 936	1 220	594	(3)	2 658	3 221	2 293	75 165
1963	14 639	(2)	9 608	22 703	5 163	5 006	6 828	1 303	677	(3)	2 853	3 477	2 209	74 466
1964	14 012	(2)	9 544	23 848	5 898	4 346	6 544	1 290	710	(3)	3 183	3 718	2 326	75 419
1965	13 155	(2)	11 739	25 892	6 121	4 035	6 536	1 201	646	1 050	2 683	3 511	2 737	79 306
1966	11 656	(2)	11 464	27 651	6 356	4 543	6 736	1 254	585	1 195	2 652	3 701	2 611	80 404
1967	10 355	(2)	10 899	29 288	6 030	5 156	6 931	1 261	505	1 724	2 656	3 381	2 398	80 584
1968	9 001	(2)	11 342	30 557	6 320	6 149	7 213	1 306	489	2 086	2 579	3 340	2 496	82 878
1969	8 221	(2)	10 490	28 679	6 467	6 693	7 242	1 156	657	2 713	2 554	3 252	2 440	80 564
1970	7 185	(2)	11 336	36 253	7 103	4 713	7 664	1 195	671	2 837	2 783	3 023	2 487	87 250
1971	6 148	(2)	11 524	37 713	6 506	4 121	8 101	1 269	603	2 519	2 613	2 832	2 496	86 445
1972	5 579	(2)	10 842	36 012	6 057	3 504	7 843	1 114	670	2 440	2 799	2 803	2 351	82 014
1973	5 603	(2)	13 395	37 602	6 112	3 422	8 027	1 236	676	2 684	2 768	3 097	2 179	86 801
1974	5 665	(2)	15 019	38 876	6 722	3 756	8 131	1 288	671	3 224	2 884	3 458	2 739	92 433
1975	5 798	(2)	16 155	35 538	7 362	4 308	6 042	1 303	576	3 351	2 431	3 544	2 838	89 246
1976	5 051	3 430	16 765	34 049	7 351	1 623	7 900	1 168	591	3 270	2 720	3 217	2 468	89 603
1977	4 643	4 140	15 550	33 703	7 512	1 694	8 302	1 244	652	3 628	2 782	3 004	2 186	89 040
1978	4 943	4 965	12 103	25 610	7 073	1 753	7 752	1 295	683	3 708	2 597	2 876	1 971	77 329
1979	5 013	5 858	14 563	25 116	7 081	1 329	8 067	1 372	738	3 905	2 688	2 860	1 832	80 422
1980	5 839	6 304	13 753	31 063	7 349	1 810	8 055	1 308	715	4 160	2 741	2 660	1 801	87 558
1981	6 809	6 869	12 397	33 246	7 740	1 651	6 829	1 441	711	4 661	2 749	2 418	1 765	89 286
1982	7 350	6 035	10 676	28 851	6 837	1 754	4 973	1 323	614	4 076	2 694	2 028	1 463	78 674
1983	7 956	5 390	8 236	24 953	5 073	586	4 617	1 301	682	3 696	2 874	1 980	1 423	68 767
1984	8 450	6 249	7 843	24 000	5 165	976	4 177	1 369	770	4 508	2 874	2 256	1 304	69 941
1985	7 862	5 989	7 077	22 073	4 724	947	3 569	1 363	753	4 488	2 801	2 340	1 601	65 587
1986	8 562	5 608	6 379	20 616	4 162	1 160	2 766	1 468	990	4 315	2 837	2 627	2 260	63 750
1987	9 757	5 289	6 039	18 979	4 372	1 060	2 858	1 510	929	4 094	2 790	2 911	2 827	63 415
1988	12 594	5 103	6 095	18 881	4 443	1 161	2 720	1 581	956	3 970	2 452	2 981	2 936	65 873
1989	12 631	4 839	6 303	19 837	4 487	1 308	2 800	1 713	965	3 893	2 343	3 145	2 736	67 000
1990	11 807	3 702	5 820	19 581	3 921	1 090	2 699	1 740	786	3 822	2 471	2 951	2 425	62 815
1991p	10 552	2 391	5 683	18 607	3 459	1 322	2 423	1 469	632	3 825	2 395	2 707	2 308	57 773
1992f	9 951	1 939	5 359	17 547	3 262	1 247	2 358	1 429	615	3 722	2 331	2 683	2 008	54 451

Sources: Energy, Mines and Resources Canada; Statistics Canada.
f Forecast; p Preliminary.
1 Total activity includes sales and head offices. (2) Included in "Other Nonferrous." (3) Included in "Other Nonmetal."

TABLE 36. CANADA, EMPLOYMENT IN THE MINERAL INDUSTRY, STAGE II - SMELTING AND REFINING (TOTAL ACTIVITY),[1] 1961-92

	Smelting/ Refining	Iron and Steel Mills	Total Primary Metals	Petroleum Refineries	Total Smelting and Refining
SIC no.	295	291	291, 295	3611	
			(number)		
1961	29 938	34 749	64 687	10 660	75 347
1962	29 693	36 593	66 286	10 184	76 470
1963	28 516	38 196	66 712	9 734	76 446
1964	30 153	41 505	71 658	9 547	81 205
1965	31 835	44 274	76 109	8 976	85 085
1966	34 237	45 999	80 236	8 996	89 232
1967	34 764	44 203	78 967	9 147	88 114
1968	34 710	44 634	79 344	9 091	88 435
1969	33 376	42 954	76 330	8 765	85 095
1970	37 298	49 169	86 467	14 725	101 192
1971	36 445	49 601	86 046	14 506	100 552
1972	33 829	49 758	83 587	14 376	97 963
1973	32 396	53 008	85 404	14 843	100 247
1974	35 249	54 253	89 502	15 967	105 469
1975	35 577	54 003	89 580	15 624	105 204
1976	34 246	51 978	86 224	15 105	101 329
1977	35 647	52 709	88 356	16 464	104 820
1978	32 652	56 669	89 321	18 958	108 279
1979	32 869	59 167	92 036	18 037	110 073
1980	36 137	61 238	97 375	18 743	116 118
1981	38 011	56 543	94 554	21 325	115 879
1982	33 215	52 330	85 545	20 155	105 700
1983	31 788	47 693	79 481	17 557	97 038
1984	31 752	48 899	80 651	15 847	96 498
1985	30 567	47 685	78 252	15 326	93 578
1986	29 058	46 461	75 519	13 287	88 806
1987	29 397	46 493	75 890	13 252	89 142
1988	30 099	48 259	78 358	13 358	91 716
1989	30 651	46 738	77 389	13 881	91 270
1990[e]	29 974	39 722	69 696	12 741	82 437
1991[p]	27 040[a]	36 624	63 664[a]	11 654	75 317
1992[f]	23 634[a]	34 265	57 898[a]	11 627	69 525

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[e] Estimated; [f] Forecast; [p] Preliminary.
[a] Change is partially due to the reclassification of a unit from SIC 295 to SIC 296 effective May 1991.
[1] Total activity includes sales and head offices.

TABLE 37. CANADA, EMPLOYMENT IN THE MINERAL INDUSTRY, STAGE III - SEMI-FABRICATION (TOTAL ACTIVITY),[1] 1961-92

	Total Nonfuel Semi-Fabrication	Miscellaneous Petroleum and Coal Products	Lubricating Oil and Greases	Total Semi-Fabrication
SIC no.[2]		369	3612	
		(number)		
1961	77 063	581	331	77 975
1962	80 606	608	352	81 566
1963	82 420	635	354	83 409
1964	87 843	726	373	88 942
1965	93 912	531	408	94 851
1966	98 602	585	424	99 611
1967	96 033	546	407	96 986
1968	96 375	518	397	97 290
1969	99 438	532	438	100 408
1970	96 144	499	423	97 066
1971	95 831	561	450	96 842
1972	101 109	555	478	102 142
1973	105 884	757	487	107 128
1974	109 818	954	514	111 286
1975	104 296	984	656	105 936
1976	103 411	982	602	104 995
1977	101 257	716	669	102 642
1978	107 234	683	712	108 629
1979	111 231	461	695	112 387
1980	105 902	532	798	107 232
1981	103 192	584	729	104 505
1982	90 194	571	792	91 557
1983	86 814	503	857	88 174
1984	91 405	521	896	92 822
1985	94 515	513	900	95 928
1986	96 744	778	1 001	98 523
1987	99 963	894	1 002	101 859
1988	103 307	1 161	1 091	105 559
1989	101 419	1 135	1 029	103 583
1990[e]	94 078	939	944	95 961
1991[p]	83 263	823	863	84 949
1992[f]	82 160	815	861	83 837

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[e] Estimated; [f] Forecast; [p] Preliminary.
[1] Includes sales and head offices. [2] 1970 SIC for years 1961-82.

TABLE 38. CANADA, EMPLOYMENT IN THE MINERAL INDUSTRY, STAGE III - NONFUEL SEMI-FABRICATION (TOTAL ACTIVITY),1 1961-92

	Steel Pipe and Tube	Iron Foundries	Aluminum Rolling, Casting, Extruding	Copper Rolling, Casting, Extruding	Other Rolling, Casting, Extruding	Wire and Wire Products	Clay and Clay Products	Cement	Concrete Products	Ready-Mix Concrete	Glass and Glass Products2	Abrasives	Lime	Other Non-metallic Products	Total Nonfuel Semi-Fabrication
SIC no.	292	294	296	297	299	305	351	352	354	355	356	357	358	359	
								(number)							
1961	3 407	8 178	5 095	3 482	2 731	12 227	5 327	3 590	8 503	4 232	9 802	2 481	847	7 161	77 063
1962	3 676	8 546	5 118	3 492	2 770	13 045	5 468	3 679	9 156	4 886	10 042	2 577	949	7 202	80 606
1963	3 840	8 216	5 164	3 651	3 038	13 743	5 376	3 566	9 317	5 411	10 346	2 464	886	7 402	82 420
1964	4 437	9 620	4 834	3 849	3 382	14 850	5 582	3 592	10 225	6 171	10 362	2 580	815	7 544	87 843
1965	4 799	11 714	4 654	3 620	3 736	16 099	5 675	3 837	10 988	6 559	10 873	2 821	800	7 737	93 912
1966	4 795	13 027	4 943	4 199	4 103	16 391	5 876	4 053	11 090	7 349	11 248	3 044	785	7 699	98 602
1967	5 012	11 970	5 468	4 027	4 287	16 060	5 559	3 972	10 321	7 137	11 388	2 734	724	7 374	96 033
1968	5 441	11 131	5 491	3 947	4 585	16 082	5 515	3 747	10 166	7 440	11 992	2 617	662	7 559	96 375
1969	5 146	11 582	6 028	3 922	4 856	17 014	5 383	3 778	11 011	7 509	12 031	2 697	707	7 774	99 438
1970	5 314	10 663	6 297	3 744	4 060	16 598	4 938	3 887	9 562	7 340	11 654	2 559	660	8 868	96 144
1971	5 306	9 897	5 612	3 608	3 845	16 272	4 682	3 954	10 719	7 997	11 672	2 310	670	9 287	95 831
1972	6 268	9 948	6 200	3 740	4 215	17 651	4 695	4 732	10 817	8 240	12 045	2 367	651	9 540	101109
1973	5 288	10 965	6 206	3 736	4 863	18 877	5 001	4 871	10 790	9 233	12 840	2 555	724	9 935	105 884
1974	5 845	12 054	6 162	3 779	4 877	19 535	5 289	4 666	11 602	9 219	12 915	2 676	840	10 359	109 818
1975	5 785	11 480	5 672	3 240	4 573	17 614	5 042	4 577	11 201	9 541	11 779	2 318	790	10 684	104 296
1976	5 546	10 365	6 255	3 297	5 354	17 573	4 791	4 517	10 773	9 128	11 836	2 535	804	10 637	103 411
1977	5 634	10 459	6 884	3 183	4 703	17 886	4 553	4 265	10 001	8 521	11 204	2 557	828	10 579	101 257
1978	6 289	10 472	7 060	3 586	5 268	18 823	4 366	4 520	10 486	9 520	11 595	2 678	784	11 787	107 234
1979	6 480	10 520	7 698	3 728	6 292	19 765	4 947	4 828	9 766	9 332	11 835	2 660	925	12 455	111 231
1980	6 514	9 245	6 627	3 230	5 749	18 529	4 875	4 791	9 280	9 348	11 967	2 628	1 003	12 116	105 902
1981	7 531	8 358	6 512	3 031	5 182	17 309	4 145	4 726	9 121	10 053	12 003	2 571	968	11 682	103 192
1982	6 017	8 163	6 255	2 541	4 694	14 575	3 004	4 317	8 245	8 034	11 016	2 170	895	10 268	90 194
1983	4 521	7 364	6 415	2 744	4 827	13 493	3 008	4 057	7 286	8 390	11 896	1 852	862	10 099	86 814
1984	5 482	7 911	6 661	2 971	5 274	14 212	3 070	3 771	7 657	8 802	12 754	1 949	876	10 015	91 405
1985	5 978	7 750	6 196	3 012	5 620	15 354	2 727	3 533	8 336	9 210	12 872	1 895	783	11 249	94 515
1986	4 829	7 547	6 200	3 059	6 357	15 262	3 770	3 514	9 174	10 422	13 448	1 827	778	10 557	96 744
1987	4 964	7 860	6 143	2 828	6 403	14 943	3 930	3 646	10 309	11 910	13 605	1 693	784	10 945	99 963
1988	6 008	8 095	6 124	3 040	7 049	15 154	3 261	3 388	11 386	12 461	13 336	1 917	873	11 215	103 307
1989	5 438	7 538	6 285	3 119	6 645	15 077	3 044	3 350	11 505	12 377	12 664	2 039	871	11 467	101 419
1990e	5 058	6 546	5 813	2 594	5 761	13 835	2 896	3 362	10 911	11 142	11 212	1 940	829	12 178	94 078
1991p	5 595	5 489	7 612a	2 030	4 514	11 727	2 444	2 326	9 168	10 365	9 678	1 637	699	9 979	83 263
1992f	5 285	4 870	9 176a	1 740	4 541	12 242	2 596	2 255	8 409	10 991	7 962	1 593	694	9 807	82 160

Sources: Energy, Mines and Resources Canada; Statistics Canada.
e Estimated; f Forecast; p Preliminary.
a Increase is primarily due to the reclassification of an establishment from SIC 295 to SIC 296 effective May 1991.
1 Includes sales and head offices. 2 Includes sealed window manufacturers until 1969; thereafter, these are included in Stage IV - Ornamental Metal Products.

TABLE 39. CANADA, EMPLOYMENT IN THE MINERAL INDUSTRY, STAGE IV - METALLIC MINERAL MANUFACTURING (TOTAL ACTIVITY),[1] 1961-92

	Boilers	Structural Metal Products	Ornamental Metal Products	Stamped, Pressed and Coated Products	Hardware Tool and Cutlery	Heating Equipment	Machine Parts	Other Metal Fabricating	Total Mineral Manufacturing
SIC no.	301	302	303	304	306	307	308	309	
					(number)				
1961	4 709	14 231	10 641	21 156	9 135	5 137	7 756	15 249	88 014
1962	4 886	14 802	11 640	23 606	10 223	5 349	8 603	16 283	95 392
1963	5 350	14 212	12 459	24 024	11 112	5 586	9 179	16 627	98 549
1964	5 429	14 602	12 808	25 192	13 110	5 673	10 137	18 088	105 039
1965	6 496	18 072	13 439	27 925	13 570	5 711	11 618	20 017	116 848
1966	7 239	21 038	13 488	29 577	14 326	5 464	13 235	21 431	125 798
1967	6 622	18 547	12 994	29 830	14 056	5 461	13 810	21 007	122 327
1968	7 962	17 150	12 664	29 560	14 166	4 930	13 501	20 825	120 758
1969	7 494	18 203	12 784	30 463	14 401	5 059	14 517	20 895	123 816
1970	7 661	19 104	12 417	29 709	15 241	4 670	14 221	20 543	123 566
1971	7 847	17 556	12 614	28 710	14 920	4 749	13 097	20 755	120 248
1972	8 136	17 113	13 611	27 939	16 386	4 238	11 731	21 504	120 658
1973	8 013	18 164	13 937	30 026	18 819	4 453	10 138	22 494	126 044
1974	8 681	20 020	14 470	31 276	20 234	4 930	10 936	23 663	134 210
1975	10 211	19 101	15 241	30 273	18 990	4 717	10 922	23 810	133 265
1976	10 704	18 056	15 541	31 487	19 316	4 977	10 764	23 704	134 549
1977	9 660	17 209	14 800	30 888	17 867	4 536	10 762	23 298	129 022
1978	9 124	16 759	16 753	34 181	18 856	5 086	12 029	24 904	137 692
1979	9 477	18 676	18 018	33 548	21 090	5 818	13 081	23 705	143 413
1980	10 374	17 700	17 890	32 266	20 830	5 993	13 449	24 217	142 719
1981	11 215	18 445	17 603	32 459	19 575	5 806	14 297	22 123	141 523
1982	10 965	17 021	15 228	29 865	17 342	5 317	13 083	18 167	126 988
1983	5 413	18 437	13 537	27 947	16 609	5 032	12 881	16 044	115 900
1984	4 548	17 162	13 538	27 758	17 308	4 220	14 200	16 256	114 990
1985	4 455	18 083	15 598	31 021	19 297	5 607	15 356	14 927	124 344
1986	4 990	19 213	17 462	31 584	21 164	5 779	17 259	15 170	132 621
1987	4 816	18 615	19 770	35 329	22 129	6 252	18 398	16 358	141 667
1988	6 182	19 689	20 795	36 976	23 042	6 390	22 681	17 887	153 642
1989	5 407	23 006	22 591	36 707	25 626	7 076	24 639	20 099	165 151
1990e	5 708	21 115	22 212	33 170	23 956	6 414	24 780	19 417	156 771
1991p	6 038	16 593	15 875	30 818	21 983	5 261	21 239	17 043	134 852
1992f	6 002	14 854	14 964	25 099	26 952	5 425	23 312	17 385	133 993

Sources: Energy, Mines and Resources Canada; Statistics Canada.
e Estimated; f Forecast; p Preliminary.
1 Total activity includes sales and head offices.

TABLE 40. CANADA, EMPLOYMENT FOR SERVICES INCIDENTAL TO MINES, QUARRIES AND OIL WELLS, 1961-92[1]

	Petroleum and Natural Gas Contract Drilling	Mining Diamond Drilling	Other Services Incidental to Mines, Quarries and Oil Wells	Total
		(number)		
1961	4 144	2 025	1 409	7 578
1962	3 800	1 926	1 720	7 446
1963	4 179	2 201	1 491	7 871
1964	4 158	2 401	2 077	8 636
1965	4 648	2 776	3 137	10 561
1966	4 428	2 887	4 317	11 632
1967	4 249	2 669	5 425	12 343
1968	4 434	2 985	6 350	13 769
1969	4 821	3 109	6 967	14 897
1970	4 267	3 207	7 894	15 368
1971	4 093	2 514	7 710	14 317
1972	4 817	2 083	6 139	13 039
1973	5 680	2 123	5 193	12 996
1974	5 054	2 317	5 017	12 388
1975	5 096	1 899	4 139	11 134
1976	5 486	1 548	5 043	12 077
1977	6 054	1 682	5 723	13 459
1978	7 419	1 681	7 492	16 592
1979	9 076	2 420	8 436	19 932
1980	11 097	2 959	9 327	23 383
1981	8 448	2 721	9 856	21 025
1982	6 882	1 880	7 752	16 514
1983	12 032	1 575	12 254	25 861
1984	27 059	1 684	10 602	39 345
1985	30 146	1 625	12 191	43 962
1986	25 290	2 198	11 582	39 069
1987	24 527	3 353	11 174	39 054
1988	26 216	3 201	12 384	41 801
1989	23 513	2 072	11 052	36 637
1990	22 779	1 848	9 540	34 166
1991[p]	24 058	1 395	8 606	34 059[r]
1992[f]	18 788	1 395	7 166	27 348

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[f] Forecast; [p] Preliminary; [r] Revised.
[1] From 1961 to 1983, Petroleum and Natural Gas Contract Drilling included SIC Code 0911, Mining Diamond Drilling included SIC Code 0921, and Other Services Incidental to Mines, Quarries and Oil Wells included both SIC Codes 0919 and 0929. For data beginning in the year 1984, these series changed. Petroleum and Natural Gas Contract Drilling includes both SIC Codes 0911 and 0919, Mining Diamond Drilling includes SIC Code 0921, and Other Services Incidental to Mines and Quarries (excluding Oil Wells) includes SIC Code 0929 only.

TABLE 41. CANADA, EMPLOYMENT, SALARIES AND WAGES IN THE MINERAL INDUSTRY,[1] 1983-90

	Unit	1983	1984	1985	1986	1987	1988	1989	1990
METALS									
Production and related workers	Number	37 270	39 181	36 618	34 941	34 329	36 140	37 451	33 895
Salaries and wages	$000	1 110 308	1 296 157	1 288 990	1 308 956	1 327 119	1 539 838	1 707 653	1 674 050
Annual average salary and wage	$	29 791	33 081	35 201	37 462	38 659	42 608	45 597	49 389
Administrative and office workers	Number	14 924	13 502	12 054	11 546	11 167	12 137	11 954	11 353
Salaries and wages	$000	533 517	518 644	487 398	489 402	489 609	561 205	600 238	603 486
Annual average salary and wage	$	35 749	38 412	40 435	42 387	43 844	46 239	50 212	53 157
Total metals									
Employees	Number	52 194	52 683	48 672	46 487	45 496	48 277	49 405	45 248
Salaries and wages	$000	1 643 825	1 814 801	1 776 388	1 798 358	1 816 728	2 101 043	2 307 891	2 277 536
Annual average salary and wage	$	31 495	34 448	36 497	38 685	39 932	43 521	46 714	50 335
INDUSTRIALS[2]									
Production and related workers	Number	12 768	13 008	12 535	12 376	12 989	12 969	12 976	12 702
Salaries and wages	$000	329 201	356 828	354 460	361 039	401 626	429 111	440 750	438 725
Annual average salary and wage	$	25 783	27 431	28 278	29 173	30 920	33 087	33 967	34 540
Administrative and office workers	Number	3 805	4 250	4 380	4 887	4 930	4 627	4 619	4 189
Salaries and wages	$000	115 378	138 012	148 090	169 237	183 979	189 650	191 558	181 420
Annual average salary and wage	$	30 323	32 473	33 811	34 630	37 318	40 988	41 472	43 309
Total industrials									
Employees	Number	16 573	17 258	16 915	17 263	17 919	17 596	17 595	16 891
Salaries and wages	$000	444 579	494 840	502 550	530 276	585 605	618 761	632 308	620 145
Annual average salary and wage	$	26 825	28 673	29 710	30 717	32 681	35 165	35 937	36 715
FUELS									
Production and related workers	Number	16 591	17 461	17 792r	17 043r	17 052r	18 251r	18 277r	18 109
Salaries and wages	$000	524 264	642 271	703 634r	708 529r	716 189r	780 402r	837 158r	877 561
Annual average salary and wage	$	31 599	36 783	39 548r	41 573r	42 000r	42 759r	45 804r	48 460
Administrative and office workers	Number	28 473	28 388	33 004r	28 640	27 209	26 633	25 698	25 321
Salaries and wages	$000	1 075 245	1 154 137	1 438 982r	1 408 406	1 330 835	1 376 003	1 455 629	1 415 378
Annual average salary and wage	$	37 764	40 656	43 600r	49 176	48 912	51 665	56 644	55 897
Total fuels									
Employees	Number	45 064	45 849	50 796r	45 683r	44 261r	44 884r	43 975r	43 430
Salaries and wages	$000	1 599 509	1 796 408	2 142 616r	2 116 935r	2 047 024r	2 156 405r	2 292 787r	2 292 939
Annual average salary and wage	$	35 494	39 181	42 181r	46 340r	46 249r	48 044r	52 138r	52 796
TOTAL MINERAL INDUSTRY									
Production and related workers	Number	66 629	69 650	66 945r	64 360r	64 370r	67 360r	68 704r	64 706
Salaries and wages	$000	1 963 773	2 295 256	2 347 084r	2 378 524r	2 444 934r	2 749 351r	2 985 561r	2 990 336
Annual average salary and wage	$	29 473	32 954	35 060r	36 957r	37 983r	40 816r	43 455r	46 214
Administrative and office workers	Number	47 202	46 140	49 438r	45 073	43 306	43 397	42 271	40 863
Salaries and wages	$000	1 724 140	1 810 793	2 074 470r	2 067 045	2 004 423	2 126 857	2 247 425	2 200 284
Annual average salary and wage	$	36 527	39 246	41 961r	45 860	46 285	49 009	53 167	53 845
Total mineral industry									
Employees	Number	113 831	115 790	116 383r	109 433r	107 676r	110 757r	110 975r	105 569
Salaries and wages	$000	3 687 913	4 106 049	4 421 554r	4 445 569r	4 449 357r	4 876 209r	5 232 986r	5 190 620
Annual average salary and wage	$	32 398	35 461	37 991r	40 624r	41 322r	44 026r	47 155r	49 168

Sources: Energy, Mines and Resources Canada; Statistics Canada.
r Revised.
[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. [2] Includes structural materials.
Note: Numbers may not add to totals due to rounding.

TABLE 42. CANADA, EMPLOYMENT, SALARIES AND WAGES IN THE MINERAL MANUFACTURING INDUSTRIES, 1983-89

	Unit	1983	1984	1985	1986	1987	1988	1989
PRIMARY METAL INDUSTRIES								
Production and related workers	Number	87 769	92 336	92 695	90 035	..	95 967	94 037
Salaries and wages	$000	2 445 267	2 818 413	2 940 777	2 924 986	..	3 387 100	3 505 958
Annual average salary and wage	$	27 860	30 523	31 725	32 487	..	35 294	37 283
Administrative and office workers	Number	31 076	30 826	29 467	28 738	..	27 861	27 454
Salaries and wages	$000	1 055 120	1 131 842	1 159 060	1 182 287	..	1 249 200	1 314 630
Annual average salary and wage	$	33 953	36 717	39 334	41 140	..	44 837	47 885
Total primary metal industries[1]								
Employees	Number	118 845	123 162	122 162	118 773	119 372	123 828	121 491
Salaries and wages	$000	3 500 387	3 950 387	4 099 837	4 107 273	4 244 950	4 636 300	4 820 588
Annual average salary and wage	$	29 453	32 074	33 561	34 581	35 561	37 441	39 679
NONMETALLIC MINERAL PRODUCTS INDUSTRIES								
Production and related workers	Number	34 097	36 155	38 763	42 011	..	45 974	46 019
Salaries and wages	$000	800 755	883 604	1 001 780	1 121 460	..	1 309 600	1 374 934
Annual average salary and wage	$	23 485	24 439	25 844	26 694	..	28 486	29 878
Administrative and office workers	Number	13 353	12 738	11 842	11 479	..	11 863	11 298
Salaries and wages	$000	391 901	394 620	397 131	406 427	..	464 600	466 153
Annual average salary and wage	$	29 349	30 980	33 536	35 406	..	39 164	41 260
Total nonmetallic mineral products								
Employees	Number	47 450	48 893	50 605	53 490	56 822	57 837	57 317
Salaries and wages	$000	1 192 656	1 278 224	1 398 911	1 527 887	1 668 869	1 774 200	1 841 087
Annual average salary and wage	$	25 135	26 143	27 644	28 564	29 370	30 676	32 121
FABRICATED METAL PRODUCTS INDUSTRIES								
Production and related workers	Number	87 661	88 787	100 650	109 634	..	129 187	141 465
Salaries and wages	$000	1 910 181	1 983 782	2 298 665	2 518 297	..	3 172 100	3 682 263
Annual average salary and wage	$	21 791	22 343	22 838	22 970	..	24 554	26 029
Administrative and officer workers	Number	28 239	26 203	23 694	22 987	..	24 455	23 686
Salaries and wages	$000	785 881	778 057	751 973	746 041	..	882 700	893 706
Annual average salary and wage	$	27 830	29 693	31 737	32 455	..	36 095	37 731
Total fabricated metal products industries								
Employees	Number	115 900	114 990	124 344	132 621	141 667	153 642	165 151
Salaries and wages	$000	2 696 062	2 761 839	3 050 638	3 264 338	3 547 954	4 054 800	4 575 969
Annual average salary and wage	$	23 262	24 018	24 534	24 614	25 044	26 391	27 708
PETROLEUM AND COAL PRODUCTS INDUSTRIES								
Production and related workers	Number	7 417	6 538	6 436	6 359	..	6 837	7 769
Salaries and wages	$000	264 104	262 827	265 859	265 156	..	318 600	375 216
Annual average salary and wage	$	35 608	40 200	41 308	41 698	..	46 599	48 297
Administrative and office workers	Number	11 500	10 726	10 303	8 707	..	8 773	9 452
Salaries and wages	$000	490 465	466 006	456 202	399 264	..	407 100	469 461
Annual average salary and wage	$	42 649	43 446	44 279	45 856	..	46 404	49 668
Total petroleum and coal products								
Employees	Number	18 917	17 264	16 739	15 066	15 148	15 610	17 221
Salaries and wages	$000	754 569	728 833	722 061	664 420	708 308	725 700	844 677
Annual average salary and wage	$	39 888	42 217	43 136	44 101	46 759	46 489	49 049
TOTAL MINERAL MANUFACTURING INDUSTRIES								
Production and related workers	Number	216 944	223 816	238 544	248 039	..	277 965	289 290
Salaries and wages	$000	5 420 307	5 948 626	6 507 081	6 829 899	..	8 187 400	8 938 371
Annual average salary and wage	$	24 985	26 578	27 278	27 536	..	29 455	30 898
Administrative and office workers	Number	84 168	80 493	75 306	71 911	..	72 952	71 890
Salaries and wages	$000	2 723 367	2 770 525	2 764 366	2 734 019	..	3 003 600	3 143 950
Annual average salary and wage	$	32 356	34 419	36 708	38 019	..	41 172	43 733
Total mineral manufacturing industries								
Employees	Number	301 112	304 309	313 850	319 950	333 009	350 917	361 180
Salaries and wages	$000	8 143 674	8 719 151	9 271 447	9 563 918	10 170 081	11 191 000	12 082 321
Annual average salary and wage	$	27 045	28 652	29 541	29 892	30 540	31 891	33 452

Source: Statistics Canada.
.. Not available.
[1] Wire and wire products have been included in the Primary Metal Industries group.

TABLE 43. CANADA, NUMBER OF WAGE EARNERS EMPLOYED IN THE NONFUEL MINERAL INDUSTRY (SURFACE, UNDERGROUND AND MILL), 1984-90

	1984	1985	1986	1987	1988	1989	1990
METALS							
Surface	9 724	10 093	9 674	9 557	9 637	9 358	8 608
Underground	16 668	14 798	13 982	13 747	14 968	16 116	14 454
Mill	12 789	11 727	11 285	11 025	11 535	11 977	10 833
Total	39 181	36 618	34 941	34 329	36 140	37 451	33 895
INDUSTRIALS							
Surface	4 948	4 921	5 396	5 771	5 908	5 744	5 387
Underground	2 487	2 337	2 112	2 234	2 173	2 251	2 309
Mill	5 573	5 277	4 868	4 984	4 888	4 981	5 006
Total	13 008	12 535	12 376	12 989	12 969	12 976	12 702
TOTAL MINERAL INDUSTRY							
Surface	14 672	15 014	15 070	15 328	15 545	15 102	13 995
Underground	19 155	17 135	16 094	15 981	17 141	18 367	16 763
Mill	18 362	17 004	16 153	16 009	16 423	16 958	15 839
Total	52 189	49 153	47 317	47 318	49 109	50 427	46 597

Sources: Energy, Mines and Resources Canada; Statistics Canada.
Note: Numbers may not add to totals due to rounding.

TABLE 44. CANADA, MINE AND MILL WORKERS, BY SEX, EMPLOYED IN THE NONFUEL MINERAL INDUSTRY, 1990

	Mine Workers				Mill Workers		Total	
	Underground		Surface					
	Male	Female	Male	Female	Male	Female	Male	Female
METALLIC MINERALS								
Nickel-copper-zinc[1]	6 401	20	3 780	111	3 266	127	13 447	258
Gold	5 401	43	1 602	59	2 414	72	9 417	174
Iron ore	34	1	1 145	49	3 022	133	4 201	183
Uranium	1 515	7	697	11	780	56	2 992	74
Silver-lead-zinc	939	3	685	30	629	18	2 253	51
Miscellaneous metal mines[2]	90	–	431	8	300	16	821	24
Total	14 380	74	8 340	268	10 411	422	33 131	764
INDUSTRIAL MINERALS								
Potash	1 373	10	65	3	1 333	26	2 771	39
Stone	–	–	1 922	28	317	3	2 239	31
Asbestos	221	7	538	–	1 241	73	2 000	80
Sand and gravel	–	–	1 358	40	298	–	1 656	40
Miscellaneous nonmetals[3]	517	–	363	6	888	30	1 768	36
Peat	–	–	652	16	694	24	1 346	40
Gypsum	180	1	395	1	78	1	653	3
Total	2 291	18	5 293	94	4 849	157	12 433	269
Total mining[4]	16 671	92	13 633	362	15 260	579	45 564	1 033

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil.
[1] Includes copper-zinc and nickel-copper mines. [2] Includes molybdenum mines. [3] Includes salt mines. [4] Coal no longer included. Beginning in 1986, the count of employees for coal, broken down by surface, underground and mill workers by sex, is no longer available.

TABLE 45. CANADA, LABOUR COSTS FOR METAL MINES IN RELATION TO TONNES MINED, 1988-90

	Number of Wage Earners	Total Wages	Average Annual Wage	Tonnage of Ore Mined	Average Annual Tonnes Mined per Wage Earner	Wage Cost per Tonne Mined
		($000)	($)	(kilotonnes)		($)
1988						
Uranium	3 476	159 469	45 877	6 337	1 823	25.16
Gold	7 021	303 270	43 195	18 746	2 670	16.18
Silver-lead-zinc	1 954	83 297	42 629	12 758	6 529	6.53
Nickel-copper-zinc[1]	10 395	444 952	42 804	127 119	12 229	3.50
Miscellaneous metals[2]	530	17 595	33 198	47 747	27 824	1.19
Iron ore	1 229	56 953	46 341	102 392	83 313	0.56
Total	24 605	1 065 535	43 306	282 098	11 465	3.78
1989						
Uranium	3 128	149 763	47 878	6 405	2 048	23.38
Gold	7 446	356 905	47 933	20 335	2 731	17.55
Silver-lead-zinc	2 152	93 697	43 539	12 784	5 941	7.33
Nickel-copper-zinc[1]	10 934	491 909	44 989	126 169	11 539	3.90
Miscellaneous metals[2]	597	25 599	42 879	18 135	30 377	1.41
Iron ore	1 217	62 907	51 690	99 962	82 138	0.63
Total	25 474	1 180 780	46 352	283 790	11 140	4.16
1990						
Uranium	2 230	118 272	53 037	5 888	2 640	20.90
Gold	7 105	371 387	52 271	22 802	3 209	16.29
Silver-lead-zinc	1 657	73 202	44 177	11 677	7 047	6.27
Nickel-copper-zinc[1]	10 312	497 875	48 281	129 701	12 578	3.84
Miscellaneous metals[2]	529	24 398	46 121	18 359	34 705	1.33
Iron ore	1 229	67 101	54 598	92 146	74 976	0.73
Total	23 062	1 152 235	49 962	280 573	12 166	4.11

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Includes copper-zinc and nickel-copper mines. [2] Includes molybdenum mines.

TABLE 46. CANADA, PERSON-HOURS PAID FOR PRODUCTION AND RELATED WORKERS, AND TONNES OF ORE MINED AND ROCK QUARRIED IN METAL MINES AND OTHER MINERAL OPERATIONS, 1984-90

	Unit	1984	1985	1986	1987	1988	1989	1990
METAL MINES[1]								
Ore mined	Mt	246.4	245.0	256.3	266.2	282.1	283.8	280.6
Person-hours paid[2]	million	78.2	77.1	73.6	74.9	79.1	81.8	74.6
Person-hours paid per tonne mined	number	0.32	0.31	0.29	0.28	0.28	0.29	0.27
Tonnes mined per person-hour paid	t	3.15	3.18	3.48	3.55	3.57	3.47	3.76
OTHER MINERAL OPERATIONS[3]								
Ore mined and rock quarried	Mt	132.3	138.2	127.4	134.7r	152.5r	147.7	143.4
Person-hours paid[2]	million	34.0	31.3	28.9	29.9	30.4	31.4r	30.7
Person-hours paid per tonne mined	number	0.26	0.23	0.23	0.22r	0.20r	0.21r	0.21
Tonnes mined per person-hour paid	t	3.89	4.42	4.41	4.50r	5.01r	4.70r	4.67

Sources: Energy, Mines and Resources Canada; Statistics Canada.
r Revised.
1 Excludes placer mining. 2 Person-hours paid for production and related workers only. 3 Includes asbestos, potash, gypsum and coal.

TABLE 47. CANADA, AVERAGE WEEKLY WAGES AND HOURS WORKED (INCLUDING OVERTIME) FOR HOURLY-RATED EMPLOYEES IN MINING, MANUFACTURING AND CONSTRUCTION INDUSTRIES, 1986-91

	1986r	1987r	1988r	1989r	1990r	1991r
MINING						
Average hours per week	39.7	39.7	40.7	39.8	40.0	39.5
Average weekly wage ($)r	623.10	645.01	700.67	730.35	764.82	812.25
METALS						
Average hours per week	38.2	38.7	39.5	39.6	40.2	39.6
Average weekly wage ($)	644.58	664.12	735.17	777.06	824.66	887.30
MINERAL FUELS						
Coal Mines						
Average hours per week	41.4	40.8	42.4	41.6	42.0	41.2
Average weekly wage ($)	715.52	715.09	786.06r	809.58	843.30	868.98
Crude Petroleum and Natural Gas						
Average hours per week	46.3	45.3	45.3	44.0	45.9	42.3
Average weekly wage ($)	730.42	753.40	803.18	876.80	934.65	970.19
NONMETALS						
Average hours per week	37.5	38.4	39.1	39.5	38.8	39.1
Average weekly wage ($)	573.19	591.05	624.90	653.84	680.65	712.13
MANUFACTURING						
Average hours per week	38.4	38.7	38.9	38.7	38.2	37.8
Average weekly wage ($)r	459.92	479.10	500.39r	523.98	544.63	565.11
CONSTRUCTION						
Average hours per week	37.6	38.1	38.5	38.1	38.1	37.2
Average weekly wage ($)r	533.30	557.99	577.24	610.92	644.42	653.29

Source: Statistics Canada.
SIC Standard Industrial Classification.
r Revised.
Note: Data have been revised due to a change from the 1970 SIC to the 1980 SIC.

TABLE 48. CANADA, INDUSTRIAL FATALITIES PER THOUSAND WORKERS BY INDUSTRY GROUP,[1] 1988-90

	Fatalities			Number of Workers			Rate per 1000 Workers		
	1988r	1989r	1990p	1988r	1989r	1990p	1988r	1989r	1990p
	(number)			(000)					
Agriculture	12	14	15	444	428	428	0.03	0.03	0.04
Forestry and fishing[2]	83	78	75	112	109	103	0.74	0.72	0.73
Mining[3]	120	99	78	182	179	180	0.66	0.55	0.43
Manufacturing	188	121	149	2 104	2 126	2 001	0.09	0.06	0.07
Construction	155	157	160	726	764	778	0.21	0.21	0.21
Transportation[4]	134	146	133	905	961	951	0.15	0.15	0.14
Trade	67	69	53	2 168	2 186	2 247	0.03	0.03	0.02
Finance[5]	22	30	25	728	733	755	0.03	0.04	0.03
Service[6]	55	46	44	4 064	4 159	4 299	0.01	0.01	0.01
Public administration[7]	60	56	70	812	841	831	0.07	0.07	0.08
Unknown	28	26	75	. .	. .	. .	. .	. .	. .
Total	924	842	877	12 245	12 486	12 573	0.08	0.07	0.07

Source: Labour Canada.
. . Not available; p Preliminary; r Revised.
1 Includes fatalities resulting from occupational chest illnesses such as silicosis, lung cancer, etc. 2 Includes trapping and hunting. 3 Includes quarrying and oil wells. 4 Includes storage, communication, electric power and water utilities, and highway maintenance. 5 Includes insurance and real estate. 6 Includes community, business and personal services. 7 Includes defence.

TABLE 49. CANADA, RATE OF INDUSTRIAL FATALITIES PER THOUSAND WORKERS BY INDUSTRY GROUP,[1] 1986-90

	1986r	1987r	1988r	1989r	1990p
Agriculture	0.03	0.04	0.03	0.03	0.04
Forestry and fishing[2]	0.61	0.84	0.74	0.72	0.73
Mining[3]	0.69	0.79	0.66	0.55	0.43
Manufacturing	0.07	0.08	0.09	0.06	0.07
Construction	0.26	0.22	0.21	0.21	0.21
Transportation[4]	0.16	0.16	0.15	0.15	0.14
Trade	0.04	0.04	0.03	0.03	0.02
Finance[5]	0.03	0.02	0.03	0.04	0.03
Service[6]	0.01	0.01	0.01	0.01	0.01
Public administration[7]	0.09	0.08	0.07	0.07	0.08
Total	0.08	0.08	0.08	0.07	0.07

Source: Labour Canada.
p Preliminary; r Revised.
1 Includes fatalities resulting from occupational chest illnesses such as silicosis, lung cancer, etc.
2 Includes trapping and hunting. 3 Includes quarrying and oil wells. 4 Includes storage, communication, electric power and water utilities, and highway maintenance. 5 Includes insurance and real estate.
6 Includes community, business and personal services. 7 Includes defence.

TABLE 50. CANADA, NUMBER OF STRIKES AND LOCKOUTS BY INDUSTRY, 1990-92

	1990			1991			1992p		
	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	–	–	–	–	–	–	–	–	–
Forestry	1	50	810	5	627	44 330	4	128	4 090
Fishing and trapping	–	–	–	1	500	2 000	1	1 000	1 000
Mining	15	7 381	396 510	7	2 547	153 920	5	2 618	275 510
Manufacturing	237	66 575r	2 440 830r	163	18 632	571 580	151	40 054	882 590
Construction	25	123 767	1 149 550	31	3 820	35 040	22	22 125	151 270
Transportation and utilities	50	23 208r	392 210r	53	96 364	321 140	37	6 025	148 700
Trade	73	3 910r	156 420	54	4 363	135 830	63	4 707	114 090
Finance, insurance and real estate	15	861r	17 420r	8	284	20 020	12	372	14 240
Service	126r	37 419r	457 610r	114	38 481	468 230	72	53 189	519 880
Public administration	37	7 313	68 030	27	88 120	779 510	28	20 927	90 160
Various industries	–	–	–	–	–	–	–	–	–
Total, all industries		270 484	5 079 390	463	253 738	2 531 600	395	151 145	2 201 530

Source: Labour Canada.
– Nil; p Preliminary; r Revised.

TABLE 51. CANADA, NUMBER OF STRIKES AND LOCKOUTS BY MINING AND MINERAL MANUFACTURING INDUSTRIES, 1990-92

	1990			1991			1992p		
	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
MINES	15	7 381	396 510	7	2 547	153 920	5	2 618	275 510
Metals	11	4 393	292 270	5	2 467	151 360	3	615	39 810
Mineral fuels	2	2 313	59 810	–	–	–	2	2 003	235 700
Nonmetals	2	675	44 430	–	–	–	–	–	–
Quarries	–	–	–	2	80	2 560	–	–	–
MINERAL MANUFACTURING	44	25 372	1 333 160	22	1 966	152 680	31	2 475	80 890
Primary metals	24	23 426	1 295 190	6	1 127	94 810	6	1 035	30 470
Nonmetallic mineral products	19	1 656	29 890	16	839	57 870	25	1 440	50 420
Petroleum and coal products	1	290	8 080	–	–	–	–		–

Source: Labour Canada.
– Nil; p Preliminary.

TABLE 52. CANADA, MINING WAGES AND SALARIES BY PROVINCE AND BY MINERAL CLASS, 1989 AND 1990

	1989					1990				
	Metals	Nonmetals	Mineral Fuels	Quarries and Sand Pits	Total	Metals	Nonmetals	Mineral Fuels	Quarries and Sand Pits	Total
			($000)					($000)		
Newfoundland	130 439	16 317	–	1 215	147 971	143 607	16 393	–	1 747	161 747
Prince Edward Island	–	–	–	–	–	–	–	–	–	–
Nova Scotia	x	x	89 699	6 929	129 476	x	x	84 067	6 689	130 313
New Brunswick	x	x	7 161	x	131 102	x	x	7 858	x	117 775
Quebec	462 191	116 306	–	64 554	643 051	475 001	115 660	–	61 130	651 791
Ontario	969 112	63 368	7 073r	100 962	1 140 515r	907 712	50 989	9 809	92 101	1 060 611
Manitoba	176 040	4 597	3 030	6 097	189 764	178 345	4 937	3 007	5 800	192 089
Saskatchewan	52 968	133 566	x	x	269 385r	x	136 877	x	x	258 294
Alberta	x	x	x	7 713	1 765 689r	x	x	x	8 247	1 774 772
British Columbia	296 440	18 608	310 743r	14 059	639 850r	289 686	19 910	330 771	14 449	654 998
Yukon and Northwest Territories	133 252	–	38 530	–	171 782	160 252	–	20 889	–	181 141
Offshore	–	–	4 402	–	4 402	–	–	7 091	–	7 091
Total	2 307 891	425 783	2 292 787r	206 525	5 232 986r	2 277 536	426 064	2 292 939	194 081	5 190 620
Services incidental to mineral extraction[1]					1 314 097r					1 278 980
Grand total					6 547 083					6 469 600

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; r Revised; x Confidential.
1 Includes establishments primarily engaged in providing contract drilling and other services to petroleum and natural gas industries.

TABLE 53. CANADA, SOURCE OF ORES HOISTED OR REMOVED FROM SELECTED TYPES OF MINES, 1988-90

Mines	1988			1989			1990		
	Underground	Open-Pit	Total	Underground	Open-Pit	Total	Underground	Open-Pit	Total
					(kilotonnes)				
Nickel-copper-zinc	26 177	100 942	127 119	27 070	99 099	126 169	27 156	102 545	129 701
Iron ore	1 346	101 045	102 392	1 310	98 652	99 962	758	91 388	92 146
Gold	13 768	4 977	18 746	16 795	3 540	20 335	19 924	2 878	22 802
Silver-lead-zinc	8 297	4 461	12 758	7 736	5 049	12 785	11 487	189	11 677
Miscellaneous metals	1 006	13 741	14 747	1 187	16 948	18 135	996	17 363	18 359
Uranium	5 791	546	6 337	5 797	607	6 404	4 781	1 107	5 888
Potash	38 965	. .	38 965	34 494	. .	34 494	31 760	. .	31 760
Asbestos	288	15 085	15 373	1 390	15 757	17 147	1 463	13 020	14 484
Gypsum	1 597r	7 607r	9 204	1 572	7 927	9 499	737	6 466	7 203
Rock salt	7 960	–	7 960	8 560	–	8 560	11 226	–	11 226
Miscellaneous nonmetals	233	1 504	1 737	401	1 584	1 985	424	1 759	2 184
Coal	5 286	83 970	89 256	4 015	83 668	87 683	4 951	84 511	89 462
Total	110 715	333 877	444 592	110 327	332 831	443 159	115 664	321 228	436 892
Percentage	24.9	75.1	100.0	24.9	75.1	100.0	26.5	73.5	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available.
Note: Numbers may not add to totals due to rounding.

TABLE 54. CANADA, SOURCE OF MATERIAL HOISTED OR REMOVED FROM SELECTED TYPES OF MINES, 1990

	Underground		Open-Pit			
	Ore	Waste	Ore	Waste	Over-burden	Tailings
			(kilotonnes)			
Nickel-copper-zinc	27 156	5 524	102 545	120 576	7 861	126 784
Iron ore	758	–	91 388	45 496	14 640	56 224
Gold	19 924	4 158	2 878	16 891	5	23 609
Silver-lead-zinc	11 487	379	189	2 609	–	10 626
Miscellaneous metals	996	9	17 363	13 579	–	13 854
Uranium	4 781	277	1 107	4 080	3 496	5 121
Potash	31 760	15	. .	. .	. .	20 313
Asbestos	1 463	–	13 020	16 794	–	7 979
Gypsum	737	61	6 466	1 915	4 262	506
Rock salt	11 226	–	–	–	–	2 442
Miscellaneous nonmetals	424	14	1 759	1 977	291	441
Coal	4 951	. .	84 511	. .	. .	. .
Total	115 664	10 437	321 228	223 918	30 554	267 899

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available.
Note: Numbers may not add to totals due to rounding.

TABLE 55. CANADA, ORE MINED AND ROCK QUARRIED IN THE MINING INDUSTRY, 1984-90

	1984	1985	1986	1987	1988	1989	1990
				(kilotonnes)			
METALS							
Nickel-copper-zinc	124 682	117 169	126 298	130 452	127 119	126 169	129 701
Iron	89 210	94 587	88 231	87 077	102 392	99 962	92 146
Gold	11 225	11 997	14 072	15 326	18 746	20 335	22 802
Silver-lead-zinc	10 084	9 970	12 083	15 147	12 758	12 785	5 049
Miscellaneous metals	3 627	4 067	8 361	11 787	14 747	1 187	18 359
Uranium	7 608	7 182	6 933	6 383	6 337	6 404	5 888
Total	246 436	244 972	255 978	266 172	282 098	283 790	273 946
NONMETALS							
Potash	36 542	34 843	33 563	34 875	38 965	34 494	31 760
Asbestos	15 726	17 118	11 808	13 526	15 373	17 147	14 484
Gypsum	8 869	9 608	9 175	9 439	9 204	9 499	7 927
Rock salt	6 706	7 101	8 460	7 091	7 960	8 560	–
Miscellaneous nonmetals	3 825	3 036	3 397	3 564	1 737	1 985	2 184
Total	71 668	71 706	66 403	68 496	73 239	71 685	56 354
STRUCTURAL MATERIALS							
Stone, all kinds quarried[1]	81 754	86 632	112 693	128 969	135 010	135 395	126 713
Stone used to make cement	10 101	8 467	11 535	12 543	12 539	13 899	12 991
Stone used to make lime	4 260	5 137	3 556	3 134	2 346	2 162	2 367
Total	96 115	100 236	127 784	144 646	149 895	151 456	142 071
FUELS							
Coal	71 207	76 667	72 736	77 452	89 256	87 683	89 462
Total ore mined and rock quarried	485 426	493 581	522 901	556 765	594 487	577 667	561 834

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil.
[1] Excludes stone used to manufacture cement and lime in Canada.
Note: Numbers may not add to totals due to rounding.

TABLE 56. CANADA, EXPLORATION, DEVELOPMENT AND CAPITAL EXPENDITURES IN THE MINING INDUSTRY[1] BY PROVINCE AND TERRITORY, 1990-92

		Capital						Repair			
		Construction									
		On-Property Exploration	On-Property Development	Structures	Sub-total	Machinery and Equipment	Total Capital	Construction	Machinery and Equipment	Total Repair	Total Capital and Repair
		($ millions)									
Newfoundland	1990	x	40.0	x	54.4	46.0	100.4	18.9	141.7	160.6	261.0
	1991p	–	45.0	2.5	47.5	58.7	106.2	8.1	142.0	150.1	256.3
	1992i	–	x	x	35.9	39.3	75.2	9.0	147.0	156.0	231.2
Prince Edward Island	1990	–	–	–	–	–	–	–	–	–	–
	1991p	–	–	–	–	–	–	–	–	–	–
	1992i	–	–	–	–	–	–	–	–	–	–
Nova Scotia	1990	x	x	14.4	28.8	40.5	69.3	2.0	55.2	57.2	126.5
	1991p	x	37.2	x	61.6	48.7	110.3	3.1	39.8	42.9	153.2
	1992i	x	x	10.5	16.5	38.4	54.9	3.2	32.2	35.4	90.3
New Brunswick	1990	2.0	18.3	5.7	26.0	34.1	60.1	5.2	62.9	68.1	128.2
	1991p	x	x	1.8	18.7	27.1	45.8	4.4	65.3	69.7	115.5
	1992i	x	19.7	x	30.0	30.0	60.0	11.7	87.3	99.0	159.0
Quebec	1990	38.5	244.3	69.6	352.4	92.5	444.9	33.0	250.4	283.4	728.3
	1991p	26.8	195.5	19.7	242.0	117.2	359.2	42.8	253.1	295.9	655.1
	1992i	18.5	174.9	29.4	222.8	96.1	318.9	41.0	243.0	284.0	602.9
Ontario	1990	30.8	419.2	99.8	549.8	202.8	752.6	65.7	476.3	542.0	1 294.6
	1991p	19.5	196.0	46.1	261.6	166.3	427.9	52.3	372.9	425.2	853.1
	1992i	15.2	203.3	37.0	255.5	160.6	416.1	48.9	360.3	409.2	825.3
Manitoba	1990	13.4	84.1	36.2	133.7	20.6	154.3	4.7	90.9	95.6	249.9
	1991p	x	47.1	x	62.7	36.0	98.7	2.5	49.8	52.3	151.0
	1992i	x	x	x	80.2	48.6	128.8	2.6	51.7	54.3	183.1
Saskatchewan	1990	6.4	83.8	35.2	125.4	40.8	166.2	13.0	143.8	156.8	323.0
	1991p	11.9	74.2	33.3	119.4	51.5	170.9	13.2	123.1	136.3	307.2
	1992i	13.2	75.7	14.9	103.8	58.4	162.2	13.1	132.5	145.6	307.8
Alberta	1990	2.9	21.7	1.3	25.9	56.3	82.2	0.3	143.6	143.9	226.1
	1991p	0.9	23.4	0.9	25.2	22.6	47.8	0.3	119.5	119.8	167.6
	1992i	0.7	8.8	2.4	11.9	31.1	43.0	0.5	117.3	117.8	160.8
British Columbia	1990	11.6	263.0	64.9	339.5	92.3	431.8	36.9	445.2	482.1	913.9
	1991p	4.9	232.9	36.2	274.0	85.2	359.2	28.2	449.1	477.3	836.5
	1992i	7.1	186.0	45.7	238.8	114.5	353.3	29.2	445.2	474.4	827.7

TABLE 56 (cont'd)

		Capital						Repair			
		Construction									
		On-Property Exploration	On-Property Development	Structures	Sub-total	Machinery and Equipment	Total Capital	Construction	Machinery and Equipment	Total Repair	Total Capital and Repair
		($ millions)									
Yukon	1990	1.3	x	x	42.0	11.5	53.5	2.3	14.1	16.4	69.9
	1991p	x	x	88.5	112.2	1.4	113.6	0.4	22.3	22.7	136.3
	1992i	–	x	x	34.8	3.5	38.3	0.9	27.1	28.0	66.3
Northwest Territories	1990	3.9	41.5	43.8	89.2	46.6	135.8	6.8	49.4	56.2	192.0
	1991p	x	x	3.3	30.4	12.2	42.6	3.3	40.1	43.4	86.0
	1992i	1.8	x	x	34.6	20.2	54.8	3.5	40.4	43.9	98.7
Canada	1990	111.2	1 251.9	404.0	1 767.1	684.0	2 451.1	188.8	1 873.6	2 062.4	4 513.5
	1991p	83.9	914.3	256.8	1 255.0	626.9	1 881.9	158.7	1 676.7	1 835.4	3 717.3
	1992i	77.3	800.8	186.5	1 064.6	640.7	1 705.3	163.7	1 683.9	1 847.6	3 552.9

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; i Intentions; p Preliminary; x Confidential, included in total.
1 Excludes crude oil and natural gas industries.
Note: Numbers may not add to totals due to rounding.

TABLE 57. CANADA, EXPLORATION , DEVELOPMENT AND CAPITAL EXPENDITURES IN THE MINING INDUSTRY[1] BY TYPE OF MINING, 1990-92

		Capital						Repair			
		Construction									
		On-Property Explora-tion	On-Property Develop-ment	Structures	Sub-total	Machinery and Equipment	Total Capital	Construc-tion	Machinery and Equipment	Total Repair	Total Capital and Repair
		($ millions)									
METAL MINES											
Copper-gold-silver	1990	25.8	114.2	67.7	207.7	61.0	268.7	18.9	284.2	303.1	571.8
	1991p	19.9	83.6	38.4	141.9	68.2	210.1	20.3	253.1	273.4	483.5
	1992i	24.6	85.6	51.1	161.3	86.8	248.1	20.1	255.3	275.4	523.5
Gold	1990	41.8	313.2	109.8	464.8	125.3	590.1	44.9	220.9	265.8	855.9
	1991p	25.6	151.2	21.2	198.0	81.6	279.6	39.7	189.9	229.6	509.2
	1992i	19.7	153.3	17.6	190.6	89.1	279.7	37.8	185.8	223.6	503.3
Iron	1990	x	x	33.4	125.7	61.6	187.3	16.5	213.4	229.9	417.2
	1991p	x	112.1	x	118.3	116.7	235.0	14.6	218.1	232.7	467.7
	1992i	x	x	13.2	89.9	48.6	138.5	15.5	219.0	234.5	373.0
Silver-lead-zinc	1990	17.7	64.1	26.6	108.4	32.7	141.1	9.9	81.8	91.7	232.8
	1991p	x	x	x	163.7	19.7	183.4	6.9	97.2	104.1	287.5
	1992[2]	2.3	x	43.0	82.1	29.7	111.8	14.2	124.3	138.5	250.3
Uranium	1990	x	x	31.7	133.3	5.1	138.4	6.3	121.7	128.0	266.4
	1991p	x	x	x	53.7	12.6	66.3	5.6	80.9	86.5	152.8
	1992i	x	51.5	x	69.3	20.3	89.6	4.2	74.4	78.6	168.2
Other metal mining[2]	1990	14.4	233.5	71.1	319.0	135.0	454.0	44.5	217.4	261.9	715.9
	1991p	x	166.8	x	201.6	113.6	315.2	34.6	152.7	187.3	502.5
	1992i	12.6	142.0	22.1	176.7	111.8	288.5	32.8	142.5	175.3	463.8
Total metal mining	1990	101.8	916.7	340.3	1 358.8	420.6	1 779.4	141.0	1 139.2	1 280.2	3 059.6
	1991p	71.9	590.3	214.8	877.0	412.5	1 289.5	121.7	991.9	1 113.6	2 403.1
	1992i	62.9	545.9	160.8	769.6	386.3	1 155.9	124.7	1 001.2	1 125.9	2 281.9
NONMETAL MINES											
Asbestos	1990	x	x	1.9	63.1	1.2	64.3	2.7	37.2	39.9	104.2
	1991p	x	x	x	29.1	3.1	32.2	4.5	44.5	49.0	81.2
	1992i	x	x	x	57.4	1.0	58.4	5.1	46.5	51.6	110.0

TABLE 57 (cont'd)

		Capital						Repair			
		Construction									
		On-Property Exploration	On-Property Development	Structures	Sub-total	Machinery and Equipment	Total Capital	Construction	Machinery and Equipment	Total Repair	Total Capital and Repair
		($ millions)									
Coal	1990	3.5	176.3	24.9	204.7	125.1	329.8	24.0	451.8	475.8	805.6
	1991p	2.6	230.2	29.8	262.6	98.1	360.7	13.1	389.7	402.8	763.5
	1992i	2.8	154.7	12.5	170.0	126.0	296.0	13.2	379.9	393.1	689.1
Other nonmetal mining[3]	1990	x	x	37.0	140.6	137.0	277.6	21.1	245.4	266.5	544.1
	1991p	x	x	x	86.5	113.1	199.6	19.3	250.6	269.9	469.5
	1992i	x	x	x	67.1	127.4	194.5	20.7	256.3	277.0	471.5
Total nonmetal mining	1990	9.4	335.1	63.8	408.3	263.3	671.6	47.8	734.4	782.2	1 453.8
	1991p	12.1	324.0	42.0	378.1	214.3	592.4	37.0	684.8	721.8	1 314.2
	1992i	14.4	254.9	24.9	294.2	254.3	548.5	39.1	682.7	721.8	1 270.3
Total mining	1990	111.2	1 251.9	404.0	1 767.1	684.0	2 451.1	188.8	1 873.6	2 062.4	4 513.5
	1991p	83.9	914.3	256.8	1 255.0	626.9	1 881.9	158.7	1 676.7	1 835.4	3 717.3
	1992i	77.3	800.8	186.5	1 064.6	640.7	1 705.3	163.7	1 683.9	1 847.6	3 552.9

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

i Intentions; p Preliminary; x Confidential, included in total.

1 Excludes expenditures in the petroleum and natural gas industries. 2 Includes nickel-copper mines, silver-cobalt mines and other metal mines. 3 Includes gypsum mines, salt mines, potash mines, quarries, sand and gravel pits, and other nonmetal mines.

Note: Numbers may not add to totals due to rounding.

TABLE 58. CANADA, DIAMOND DRILLING IN THE MINING INDUSTRY BY MINING COMPANIES WITH OWN EQUIPMENT AND BY DRILLING CONTRACTORS, 1988-90

		1988			1989			1990		
		Exploration	Other	Total	Exploration	Other	Total	Exploration	Other	Total
						(metres)				
METAL MINES										
Gold	Own equipment	39 604	23 941	63 545	70 359	35 936	106 295	24 193	188 565	212 758
	Contractors	672 825	–	672 825	735 297	123 330	858 627	734 105	–	734 105
	Total	712 429	23 941	736 370	805 656	159 266	964 922	758 298	188 565	946 863
Iron	Own equipment	10 038	365 123	375 161	241 854	–	241 854	166 877	–	166 877
	Contractors	–	–	–	309 652	–	309 652	303 952	–	303 952
	Total	10 038	365 123	375 161	551 506	–	551 506	470 829	–	470 829
Nickel-copper-zinc	Own equipment	127 441	–	127 441	6 886	377 764	384 650	8 328	131 708	140 036
	Contractors	233 841	9 000	242 841	25 920	–	25 920	11 366	–	11 366
	Total	361 282	9 000	370 082	32 806	377 764	410 570	19 694	131 708	151 402
Silver-lead-zinc	Own equipment	60 858	–	60 858	51 287	–	51 287	23 717	–	23 717
	Contractors	72 280	–	72 280	47 866	–	47 866	12 100	–	12 100
	Total	133 138	–	133 138	99 153	–	99 153	35 817	–	35 817
Uranium	Own equipment	34 175	–	34 175	32 379	–	32 379	21 015	–	21 015
	Contractors	10 250	–	10 250	31 507	–	31 507	12 233	–	12 233
	Total	44 425	–	44 425	63 886	–	63 886	33 248	–	33 248
Miscellaneous metal mining	Own equipment	–	–	–	–	–	–	–	–	–
	Contractors	13 878	–	13 878	31 906	–	31 906	26 536	–	26 536
	Total	13 878	–	13 878	31 906	–	31 906	26 536	–	26 536
Total metal mining	Own equipment	272 116	389 064	661 180	402 765	413 700	816 465	244 130	320 273	564 403
	Contractors	1 003 074	9 000	1 012 074	1 182 148	123 330	1 305 478	1 100 292	–	1 100 292
	Total	1 275 190	398 064	1 673 254	1 584 913	537 030	2 121 943	1 344 422	320 273	1 664 695
NONMETAL MINES										
Gypsum	Own equipment	–	–	–	–	–	–	6 100	–	6 100
	Contractors	4 145	3 444	7 589	–	1 778	1 778	3 188	–	3 188
	Total	4 145	3 444	7 589	–	1 778	1 778	9 288	–	9 288
Other nonmetal mines	Own equipment	–	–	–	–	–	–	812	–	812
	Contractors	2 300	–	2 300	7 064	–	7 064	1 450	–	1 450
	Total	2 300	–	2 300	7 064	–	7 064	2 262	–	2 262
Asbestos	Own equipment	–	–	–	–	–	–	–	–	–
	Contractors	2 289	–	2 289	9 508	–	9 508	7 909	–	7 909
	Total	2 289	–	2 289	9 508	–	9 508	7 909	–	7 909
Potash	Own equipment	–	–	–	10 674	–	10 674	12 817	–	12 817
	Contractors	–	–	–	1 065	–	1 065	3 045	–	3 045
	Total	–	–	–	11 739	–	11 739	15 862	–	15 862
Total nonmetal mining	Own equipment	–	–	–	10 674	–	10 674	19 729	–	19 729
	Contractors	8 734	3 444	12 178	17 637	1 778	19 415	15 592	–	15 592
	Total	8 734	3 444	12 178	28 311	1 778	30 089	35 321	–	35 321
Total mining industry	Own equipment	272 116	389 064	661 180	413 439	413 700	827 139	263 859	320 273	584 132
	Contractors	1 011 808	12 444	1 024 252	1 199 785	125 108	1 324 893	1 115 884	–	1 115 84
	Total	1 283 924	401 508	1 685 432	1 613 224	538 808	2 152 032	1 379 743	320 273	1 7000 016

Sources: Energy, Mines and Resources Canada; Statistics Canada, Catalogue Nos. 26-223 and 26-224.
– Nil.
Note: Numbers may not add to totals due to rounding.

TABLE 59. CANADA, ORE MINED AND ROCK QUARRIED IN THE MINING INDUSTRY, 1960-90

	Metals	Industrial[1]	Coal	Total
		(million tonnes)		
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	. .	162.1
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	274.9	162.6	. .	437.4
1974	278.7	178.8	. .	457.5
1975	264.2	158.7	. .	422.9
1976	296.5	167.1	. .	463.6
1977	299.5	205.2	33.8	538.5
1978	248.1	205.5	36.3	489.9
1979	274.8	200.1	39.8	514.6
1980	290.1	193.5	43.9	527.5
1981	301.5	172.5	48.2	522.2
1982	238.4	121.2	53.0	412.5
1983	219.0	137.0	54.8	410.8
1984	246.4	167.8	71.2	485.4
1985	245.0	171.9	76.7	493.6
1986	256.0	194.2	72.7	522.9
1987	266.2	213.1	77.5	556.8
1988	282.1	223.1	89.3	594.5
1989	283.8	223.1	87.7	594.6
1990	273.9	198.4	89.5	561.8

Sources: Energy, Mines and Resources Canada; Statistics Canada.
. . Not available.
[1] Includes nonmetallic mineral mining and all stone quarried, including stone used to make cement and lime. From 1979 onwards, coverage includes miscellaneous nonmetal mines previously excluded.
Note: Numbers may not add to totals due to rounding.

TABLE 60. CANADA, TOTAL DIAMOND DRILLING, METAL DEPOSITS, 1960-90

	Gold Deposits	Copper-Zinc and Nickel-Copper Deposits	Silver-Lead-Zinc Deposits	Other Metal-Bearing Deposits[1]	Total Metal Deposits
			(metres)		
1960	628 016	1 267 792	226 027	315 067	2 436 902
1961	595 180	1 128 091	255 101	221 079	2 199 451
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	1 826 767
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	346 722	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
1984	406 060	830 536	273 238	281 661	1 791 495
1985	429 565	475 582	152 692	286 764	1 344 603
1986	774 896	434 325	163 756	278 642	1 651 619
1987	650 688	503 509	125 291	359 011	1 638 499
1988	736 370	370 282	133 138	433 464	1 673 254
1989	964 922	551 506	99 153	506 362	2 121 943
1990	946 863	470 829	35 817	211 186	1 664 695

Sources: Energy, Mines and Resources Canada; Statistics Canada, Catalogue No. 26-223.
[1] Includes iron, titanium, uranium, molybdenum and other metal deposits.

TABLE 61. CANADA, EXPLORATION DIAMOND DRILLING, METAL DEPOSITS, 1960-90

	Mining Companies with Own Personnel and Equipment	Diamond Drilling Contractors	Total
		(metres)	
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
1984	357 680	936 459	1 294 139
1985	382 490	725 310	1 107 800
1986	347 154	915 809	1 262 963
1987	290 510	1 022 446	1 312 956
1988	272 116	1 003 074	1 275 190
1989	402 765	1 182 148	1 584 913
1990	244 130	1 100 292	1 344 422

Sources: Energy, Mines and Resources Canada; Statistics Canada, Catalogue No. 26-223.

TABLE 62. CANADA, DIAMOND DRILLING, OTHER THAN FOR EXPLORATION, METAL DEPOSITS, 1960-90

	Mining Companies with Own Personnel and Equipment	Diamond Drilling Contractors	Total
		(metres)	
1960	450 246	308 860	759 106
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
1984	492 939	4 417	497 356
1985	230 501	6 302	236 803
1986	378 823	9 833	388 656
1987	325 543	–	325 543
1988	389 064	9 000	398 064
1989	413 700	123 330	537 030
1990	320 273	–	320 273

Sources: Energy, Mines and Resources Canada; Statistics Canada, Catalogue No. 26-223.
– Nil.
Note: Non-producing companies excluded since 1964.

TABLE 63. CANADA, CRUDE MINERALS TRANSPORTED BY CANADIAN RAILWAYS, 1988-90

	1988	1989	1990
		(kilotonnes)	
METALLIC MINERALS			
Iron ores and concentrates	39 835	41 594	35 801
Nickel-copper ores and concentrates	3 742	2 961	3 261
Alumina and bauxite	3 224	3 841	3 909
Zinc ores and concentrates	1 554	1 231	973
Copper ores and concentrates	1 185	955	1 048
Lead ores and concentrates	590	465	192
Metallic ores and concentrates, n.e.s.	63	80	46
Nickel ores and concentrates	–	–	7
Total	50 193	51 127	45 237
NONMETALLIC MINERALS			
Potash (KCl)	12 337	10 559	11 316
Sulphur, n.e.s.	6 559	4 227	4 925
Gypsum	5 418	5 621	5 258
Limestone, n.e.s.	3 008	2 939	1 955
Phosphate rock	1 236	1 275	1 040
Clay	1 025	786	109
Sulphur, liquid	1 002	1 016	568
Sand, industrial	985	854	275
Salt, rock	688	828	984
Sodium carbonate	659	631	531
Limestone, industrial	396	368	173
Nepheline syenite	302	321	294
Sodium sulphate	297	291	519
Nonmetallic minerals, n.e.s.	170	270	105
Salt, n.e.s.	161	137	77
Limestone, agricultural	122	55	6
Stone, n.e.s.	107	94	46
Silica	23	19	2
Abrasives, natural	21	27	9
Sand, n.e.s.	17	4	2
Barite	9	11	14
Asbestos	5	3	3
Peat and other mosses	1	2	2
Total	34 550	30 338	28 213
MINERAL FUELS			
Coal, bituminous	47 117	38 856	34 861
Coal, lignite	2 976	1 856	1 757
Natural gas and other crude bituminous substances	34	87	70
Coal, n.e.s.	24	2	5
Oil, crude	12	12	8
Total	50 163	40 813	36 701
Total crude minerals	134 906	122 278	110 151
Total revenue freight[1] moved by Canadian railways	269 354	247 041	226 338
Crude minerals as a percentage of total revenue freight	50.1	49.5	48.7

Source: Statistics Canada.
– Nil; n.e.s. Not elsewhere specified.
[1] Revenue freight refers to a local or interline shipment from which earnings accrue to a carrier.

TABLE 64. CANADA, FABRICATED MINERAL PRODUCTS TRANSPORTED BY CANADIAN RAILWAYS, 1988-90

	1988	1989	1990
		(kilotonnes)	
METALLIC MINERAL PRODUCTS			
Ferrous mineral products			
Iron and steel scrap	2 068	2 254	1 252
Sheets and strips, steel	1 191	1 196	1 053
Ingots, blooms, billets, slabs of iron and steel	674	818	658
Bars and rods, steel	593	654	571
Structural shapes and sheet piling, iron and steel	476	453	239
Plates, steel	311	260	193
Pipes and tubes, iron and steel	275	459	265
Rails and railway track material	91	191	68
Castings and forgings, iron and steel	83	62	53
Pig iron	36	55	40
Ferroalloys	27	20	17
Other primary iron and steel	9	10	6
Wire, iron or steel	4	4	2
Total ferrous mineral products	5 838	6 436	4 417
Nonferrous mineral products			
Aluminum and aluminum alloy fabricated material, n.e.s.	760	822	705
Zinc and alloys	517	492	389
Copper and alloys, n.e.s.	391	373	381
Aluminum paste, powder, pigs, ingots, shot	352	191	377
Other nonferrous base metals and alloys	167	150	120
Lead and alloys	163	134	87
Nonferrous metal scrap	94	107	56
Slag, dross, etc.	49	99	51
Copper matte and precipitates	–	22	1
Total nonferrous mineral products	2 493	2 390	2 167
Total metallic mineral products	8 332	8 826	6 584
NONMETALLIC MINERAL PRODUCTS			
Fertilizers and fertilizer materials, n.e.s.	2 424	2 283	2 143
Portland cement, standard	1 813	1 716	1 559
Sulphuric acid	1 806	1 767	2 102
Gypsum basic products, n.e.s.	282	248	45
Cement and concrete basic products, n.e.s.	223	187	189
Nonmetallic mineral basic products, n.e.s.	210	178	159
Lime, hydrated and quick	185	168	181
Natural stone basic products, chiefly structural	166	152	115
Dolomite and magnesite, calcined	50	51	15
Glass basic products	45	36	3
Bricks and tiles, clay	30	50	3
Fire brick and similar shapes	24	21	6
Asbestos and asbestos-cement basic products	22	20	25
Plaster	9	9	2
Refractories, n.e.s.	6	3	4
Total	7 295	6 889	6 551
MINERAL FUEL PRODUCTS			
Refined and manufactured gases, fuel type	2 671	2 744	2 377
Diesel fuel	1 531	1 397	1 349
Gasoline	675	612	531
Fuel oil, n.e.s.	654	802	1 186
Coke, n.e.s.	623	459	355
Other petroleum and coal products	517	509	442
Petroleum coke	341	340	266
Lubricating oils and greases	304	331	267
Asphalts and road oils	248	211	191
Total	7 566	7 405	6 964
Total fabricated mineral products	23 193	23 120	20 099
Total revenue freight[1] moved by Canadian railways	269 354	247 041	226 338
Fabricated mineral products as a percentage of total revenue freight	8.6	9.4	8.9

Source: Statistics Canada.
– Nil; n.e.s. Not elsewhere specified.
[1] Revenue freight refers to a local or interline shipment from which earnings accrue to a carrier.

TABLE 65. CANADA, CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS TRANSPORTED BY CANADIAN RAILWAYS, 1960-90

	Total Revenue Freight[1]	Total Crude Minerals	Total Fabricated Mineral Products	Total Crude and Fabricated Minerals	Crude and Fabricated Minerals as Percent of Revenue Freight
	(million tonnes)				
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	78.4	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	94.8	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	125.9	59.5
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	56.1
1979	257.9	127.2	26.6	153.8	59.6
1980	254.4	124.8	24.6	149.4	58.7
1981	246.6	120.7	26.4	147.1	59.7
1982	212.5	95.7	21.0	116.7	54.9
1983	222.8	95.3	22.7	118.0	53.0
1984	254.6	121.1	25.1	146.2	57.4
1985	250.6	125.2	24.3	149.5	59.7
1986	249.8	121.2	23.0	144.2	57.7
1987	261.4	122.2	22.7	144.9	55.4
1988	269.4	134.9	23.2	158.1	58.7
1989	247.0	122.3	23.1	145.4	58.9
1990	226.3	110.2	20.1	130.3	57.5

Source: Statistics Canada.
[1] Revenue freight refers to a local or interline shipment from which earnings accrue to a carrier.

TABLE 66. CANADA, CRUDE MINERALS LOADED AND UNLOADED IN COASTWISE SHIPPING, 1991

	Loaded					Unloaded				
	Atlantic	St. Lawrence	Great Lakes	Pacific	Total	Atlantic	St. Lawrence	Great Lakes	Pacific	Total
	(tonnes)									
METALLIC MINERALS										
Iron ore and concentrates	–	6 022 920	44 810	–	6 067 730	–	1 234 959	4 832 772	–	6 067 731
Aluminum ores and concentrates	–	21 675	–	–	21 675	–	–	21 675	–	21 675
Other ores and concentrates	199	1 659 930	284 852	–	1 944 981	199	1 659 930	284 852	–	1 944 981
Total metallic minerals	199	7 704 525	329 662	–	8 034 386	199	2 894 889	5 139 299	–	8 034 387
NONMETALLIC MINERALS										
Limestone	102	–	1 677 289	311 321	1 988 712	102	49 892	1 627 397	311 321	1 988 712
Sand and gravel	112 909	–	212 031	706 885	1 031 825	112 909	–	212 031	706 885	1 031 825
Gypsum	429 723	–	–	27 367	457 090	–	329 828	99 895	27 367	457 090
Salt	1 373 108	47 337	1 606 560	14 966	3 041 971	281 343	1 440 026	1 305 636	14 966	3 041 971
Sulphur	–	1 930	–	1 973	3 903	–	1 930	–	1 973	3 903
Potash	–	–	83 304	–	83 304	–	34 526	48 778	–	83 304
Other mineral products	572 737	216 505	1 533 198	100 373	2 422 813	518 573	624 091	1 179 776	100 373	2 422 813
Total nonmetallic minerals	2 488 579	265 772	5 112 382	1 162 885	9 029 618	912 927	2 480 293	4 473 513	1 162 885	9 029 618
MINERAL FUELS										
Coal	100 162	42 486	2 296 566	114 665	2 553 879	51 098	91 550	2 296 566	114 665	2 553 879
Crude petroleum	–	6 606	–	–	6 606	–	6 606	–	–	6 606
Total mineral fuels	100 162	49 092	2 296 566	114 665	2 560 485	51 098	98 156	2 296 566	114 665	2 560 485
Total crude minerals	2 588 940	8 019 389	7 738 610	1 277 550	19 624 489	964 224	5 473 338	11 909 378	1 277 550	19 624 490
Total all commodities[1]	6 610 357	12 234 536	22 778 036	16 806 989	58 429 918	5 265 338	21 066 029	15 301 479	16 797 072	58 429 918
Crude minerals as a percentage of all commodities	39.2	65.5	34.0	7.6	33.6	18.3	26.0	77.8	7.6	33.6

Source: Statistics Canada.
– Nil.
1 Includes metallic minerals, nonmetallic minerals and mineral fuels, along with all other cargo loaded and unloaded in coastwise shipping.
Notes: Numbers may not add to totals due to rounding. Data for the St. Lawrence ports are shown as a separate category this year; previously, they were included with the Atlantic ports.

TABLE 67. CANADA, FABRICATED MINERALS LOADED AND UNLOADED IN COASTWISE SHIPPING, 1991

	Loaded					Unloaded				
	Atlantic	St. Lawrence	Great Lakes	Pacific	Total	Atlantic	St. Lawrence	Great Lakes	Pacific	Total
	(tonnes)									
METALLIC MINERAL PRODUCTS										
Iron, steel and alloys	2 817	11 413	76 736	17 404	108 370	11 310	74 216	5 440	17 404	108 370
Aluminum and aluminum products	–	194 812	–	–	194 812	–	194 812	–	–	194 812
Other base-metal products	2 686	5 370	–	–	8 056	7 887	170	–	–	8 057
Total metallic mineral products	5 503	211 595	76 736	17 404	311 238	19 197	269 198	5 440	17 404	311 239
NONMETALLIC MINERAL PRODUCTS										
Cement and related products	961	126	441 904	6 882	449 873	1 088	93 492	348 412	6 882	449 874
Other fabricated nonmetallic minerals, n.e.s.	18 484	39 467	250 676	228 723	537 350	45 523	104 562	158 541	228 723	537 349
Total nonmetallic mineral products	19 445	39 593	692 580	235 605	987 223	46 611	198 054	506 953	235 605	987 223
MINERAL FUEL PRODUCTS										
Gasoline	1 490 451	1 188 165	398 146	397 796	3 474 558	1 205 741	1 407 354	463 667	397 796	3 474 558
Other fabricated mineral fuels, n.e.s.	2 098 237	1 843 749	1 073 795	581 131	5 596 912	2 072 576	2 163 237	780 531	580 566	5 596 910
Total mineral fuel products	3 588 688	3 031 914	1 471 941	978 927	9 071 470	3 278 317	3 570 591	1 244 198	978 362	9 071 468
Total fabricated mineral products	3 613 636	3 283 102	2 241 257	1 231 936	10 369 931	3 344 125	4 037 843	1 756 591	1 231 371	10 369 930
Total all commodities[1]	6 610 357	12 234 536	22 778 036	16 806 989	58 429 918	5 265 338	21 066 029	15 301 479	16 797 072	58 429 918
Crude minerals as a percentage of all commodities	54.7	26.8	9.8	7.3	17.7	63.5	19.2	11.5	7.3	17.7

Source: Statistics Canada.
– Nil; n.e.s. Not elsewhere specified.
[1] Includes metallic mineral products, nonmetallic mineral products and mineral fuel products, along with all other cargo loaded and unloaded in coastwise shipping.
Notes: Numbers may not add to totals due to rounding. Data for the St. Lawrence ports are shown as a separate category this year; previously they were included with the Atlantic ports.

TABLE 68. CANADA, CRUDE AND FABRICATED MINERALS LOADED AT CANADIAN PORTS IN COASTWISE SHIPPING, 1960-91

	Total All Commodities[1]	Total Crude Minerals	Total Fabricated Minerals	Crude and Fabricated Minerals as Percentage of All Products
		(kilotonnes)		
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	49.6
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
1984	68 698	22 798	11 909	50.5
1985	61 717	19 867	10 291	48.9
1986	60 506	19 901	10 264	49.9
1987	67 572	20 969	11 118	47.5
1988	69 974	23 325	11 676	50.0
1989	61 122	22 963	11 825	56.9
1990	60 360	22 430	16 096	63.8
1991	58 430	19 624	10 370	51.3

Source: Statistics Canada.
[1] Includes metallic mineral products, nonmetallic mineral products and mineral fuel products, along with all other cargo loaded and unloaded in coastwise shipping.

TABLE 69. CANADA, CRUDE MINERALS LOADED AND UNLOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE,[1] 1989-91

	1989		1990		1991	
	Loaded	Unloaded	Loaded	Unloaded	Loaded	Unloaded
	(tonnes)					
METALLIC MINERALS						
Iron ore and concentrates	31 921 555	6 993 891	29 227 639	4 590 480	28 842 400	5 530 400
Aluminum ores and concentrates	21 561	4 660 980	19 162	4 251 610	755	2 506 141
Lead and zinc ores and concentrates	914 834	6 528	895 731	138 419	620 254	302 976
Copper and nickel ores and concentrates	1 249 357	172 477	1 223 635	97 430	1 196 012	97 223
Other ores and base-metal products	1 858 624	412 828	1 365 310	222 720	1 074 545	78 048
Total metallic minerals	35 965 931	12 246 704	32 731 477	9 300 659	31 733 966	8 514 788
NONMETALLIC MINERALS						
Limestone	1 149 695	684 279	1 153 471	484 877	1 238 636	417 760
Sand and gravel	466 352	1 361 671	485 993	1 379 781	494 771	1 348 947
Gypsum	5 711 513	301 545	5 307 978	408 273	4 779 328	260 324
Salt	1 983 508	1 510 057	1 962 923	1 507 466	2 564 940	677 604
Sulphur	4 448 002	55 027	4 913 004	178	4 544 358	2 234
Potash	6 084 022	184 452	6 411 306	112 629	6 079 029	30 068
Other nonmetallic minerals, n.e.s.	3 531 299	4 893 287	3 291 966	5 012 974	4 490 644	2 928 547
Total nonmetallic minerals	23 374 391	8 990 318	23 526 641	8 906 178	24 191 706	5 665 484
MINERAL FUELS						
Coal	29 940 842	15 180 835	30 929 789	14 097 683	32 750 231	11 362 713
Crude petroleum	1 434 497	18 242 493	1 315 721	19 392 330	1 489 166	18 018 389
Other mineral fuels	91 153	–	194	238	–	–
Total mineral fuels	31 466 492	33 423 328	32 245 704	33 490 251	34 239 397	29 381 102
Total crude minerals	90 806 814	54 660 350	88 503 822	51 697 088	90 165 069	43 561 374
Total all commodities[1]	156 568 302	79 670 214	159 039 270	73 296 005	168 009 713	66 117 151
Crude minerals as a percentage of all commodities	58.0	68.6	55.6	70.5	53.7	65.9

Source: Statistics Canada.
– Nil; n.e.s. Not elsewhere specified.
[1] Includes metallic minerals, nonmetallic minerals and mineral fuels, along with all other cargo loaded and unloaded at Canadian ports.
Note: Numbers may not add to totals due to rounding.

TABLE 70. CANADA, FABRICATED MINERAL PRODUCTS LOADED AND UNLOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE,[1] 1989-91

	1989		1990		1991	
	Loaded	Unloaded	Loaded	Unloaded	Loaded	Unloaded
	(tonnes)					
METALLIC MINERALS						
Iron, steel and alloys	1 898 150	1 982 130	2 494 124	1 769 750	2 745 360	1 309 350
Nonferrous metals, n.e.s.	762 061	204 929	1 046 627r	484 174r	1 194 058	2 940 088
Total metallic minerals	2 660 211	2 187 059	3 540 751r	2 253 924r	3 939 418	4 249 438
NONMETALLIC MINERALS						
Cement and related products	1 494 839	625 672	1 164 806r	473 564r	1 552 827	396 660
Other nonmetallic minerals, n.e.s.	270 415	492 025	1 167 413r	879 879r	1 666 767	1 532 368
Total nonmetallic minerals	1 765 254	1 117 697	2 332 219	1 353 443	3 219 594	1 929 028
MINERAL FUELS						
Gasoline	1 944 466	1 348 571	2 596 345	841 980	2 743 888	628 298
Fuel oil	5 193 961	6 172 370	4 054 455	3 973 134	4 486 712	4 293 526
Coke, petroleum and coal products	2 060 017	2 364 253	232 225	1 067 483	311 138	684 225
Other mineral fuels, n.e.s.	..	..	2 350 898	2 569 567	1 437 542	1 202 321
Total mineral fuels	9 198 444	9 885 194	9 233 923	8 452 164	8 979 280	6 808 370
Total fabricated mineral products	13 623 909	13 189 950	15 106 893r	12 059 531r	16 138 292	12 986 836
Total all commodities[1]	156 568 302	79 670 214	159 039 270	73 296 005	168 009 713	66 117 151
Fabricated minerals as a percentage of all commodities	8.7	16.6	9.5	16.5	9.6	19.6

Source: Statistics Canada.
. . Not available; n.e.s. Not elsewhere specified; r Revised.
1 Includes metallic products, nonmetallic minerals and mineral fuels, along with all other cargo loaded and unloaded at Canadian ports.
Note: Numbers may not add to totals due to rounding.

TABLE 71. CANADA, CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS LOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE, 1960-91

	Total All Commodities[1]	Total Crude Minerals	Total Fabricated Minerals	Crude and Fabricated Minerals as Percentage of All Products
		(kilotonnes)		
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	65.2
1970	95 807	55 849	4 965	63.5
1971	95 887	53 245	5 022	60.8
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	63.3
1982	125 282	65 594	7 115	58.0
1983	129 490	67 152	6 197	56.6
1984	145 322	82 752	7 986	62.4
1985	143 421	83 878	10 814	66.0
1986	144 561	84 720	8 303	64.3
1987	158 994	86 085	10 488	60.7
1988	171 064	98 934	12 227	65.0
1989	156 568	90 807	13 624	66.7
1990	159 039	88 504	15 107r	65.1r
1991p	168 010	90 165	16 138	63.3

Source: Statistics Canada.
p Preliminary; r Revised.
[1] Includes metallic products, nonmetallic products and mineral fuel products, along with all other cargo loaded and unloaded at Canadian ports.

TABLE 72. CANADA, CAPITAL AND REPAIR EXPENDITURES BY SELECTED INDUSTRIAL SECTOR, 1990-92

		Capital Expenditures			Repair Expenditures			Capital and Repair Expenditures		
		Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total
						($ millions)				
Agriculture and Fishing	1990	957.7	1 895.1	2 852.8	501.1	1 677.5	2 178.6	1 458.8	3 572.6	5 031.4
	1991p	913.1	1 701.4	2 614.5	474.6	1 654.6	2 129.2	1 387.7	3 356.0	4 743.7
	1992i	888.1	1 692.8	2 580.9	486.7	1 699.8	2 186.5	1 374.8	3 392.6	4 767.4
Construction	1990	356.8	1 707.4	2 064.2	72.2	1 203.6	1 275.8	429.0	2 911.0	3 340.0
	1991p	299.7	1 553.2	1 852.9	65.9	1 096.3	1 162.2	365.6	2 649.5	3 015.1
	1992i	296.6	1 537.2	1 833.8	69.7	1 148.0	1 217.7	366.3	2 685.2	3 051.5
Forestry	1990	119.2	134.8	254.0	84.6	247.0	331.6	203.8	381.8	585.6
	1991p	70.2	49.7	119.9	74.1	196.6	270.7	144.3	246.3	390.6
	1992i	104.0	55.9	159.9	76.6	199.0	275.6	180.6	254.9	435.5
Housing	1990	36 973.1	–	36 973.1	4 038.9	–	4 038.9	41 012.0	–	41 012.0
	1991p	32 832.1	–	32 832.1	3 944.0	–	3 944.0	36 776.1	–	36 776.1
	1992i	34 208.3	–	34 208.3	3 949.0	–	3 949.0	38 157.3	–	38 157.3
Manufacturing	1990	4 169.5	15 692.6	19 862.1	1 318.1	8 329.0	9 647.1	5 487.6	24 021.6	29 509.2
	1991p	3 448.4	13 507.6	16 956.0	1 238.7	7 758.1	8 996.8	4 687.1	21 265.7	25 952.8
	1992i	2 253.1	13 990.6	16 243.7	1 224.2	7 932.2	9 156.4	3 477.3	21 922.8	25 400.1
Mining[1]	1990	6 702.9	956.7	7 659.6	517.8	2 697.9	3 215.7	7 220.7	3 654.6	10 875.3
	1991p	6 679.2	1 003.2	7 682.4	499.4	2 473.6	2 973.0	7 178.6	3 476.8	10 655.4
	1992i	5 469.7	924.5	6 394.2	503.7	2 485.4	2 989.1	5 973.4	3 409.9	9 383.3
Trade	1990	1 166.5	2 166.7	3 333.2	325.1	519.7	844.8	1 491.6	2 686.4	4 178.0
	1991p	1 064.8	2 138.4	3 203.2	307.5	495.5	803.0	1 372.3	2 633.9	4 006.2
	1992i	957.2	2 015.5	2 972.7	314.8	506.8	821.6	1 272.0	2 522.3	3 794.3
Utilities	1990	11 215.5	11 208.1	22 423.6	2 504.7	6 320.4	8 825.1	13 720.2	17 528.5	31 248.7
	1991p	12 859.9	11 332.3	24 192.2	2 596.1	6 017.1	8 613.2	15 456.0	17 349.4	32 805.4
	1992i	12 838.1	12 480.0	25 318.1	2 833.0	6 102.4	8 935.4	15 671.1	18 582.4	34 253.5
Other[2]	1990	25 498.5	15 288.6	40 787.1	5 844.1	2 612.9	8 457.0	31 342.6	17 901.5	49 244.1
	1991p	22 902.0	14 280.1	37 182.1	5 854.3	2 499.9	8 354.2	28 756.3	16 780.0	45 536.3
	1992i	21 301.0	15 455.2	36 756.2	5 879.3	2 563.0	8 442.3	27 180.3	18 018.2	45 198.5
Total	1990	87 159.7	49 050.0	136 209.7	15 206.6	23 608.0	38 814.6	102 366.3	72 658.0	175 024.3
	1991p	81 069.4	45 565.9	126 635.3	15 054.6	22 191.7	37 246.3	96 124.0	67 757.6	163 881.6
	1992i	78 316.1	48 151.7	126 467.8	15 337.0	22 636.6	37 973.6	93 653.1	70 788.3	164 441.4
Mining as a percentage of total	1990	7.7	2.0	5.6	3.4	11.4	8.3	7.1	5.0	6.2
	1991p	8.2	2.2	6.1	3.3	11.1	8.0	7.5	5.1	6.5
	1992i	7.0	1.9	5.1	3.3	11.0	7.9	6.4	4.8	5.7

Source: Statistics Canada.
– Nil; i Intentions; p Preliminary.
1 Includes mines, quarries and oil wells. 2 Includes finance, real estate, insurance, commercial services, institutions and government departments.
Note: Numbers may not add to totals due to rounding.

TABLE 73. CANADA, CAPITAL AND REPAIR EXPENDITURES IN MINING[1] BY GEOGRAPHICAL REGION, 1990-92

		Capital Expenditures			Repair Expenditures			Capital and Repair Expenditures		
		Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total
						($ millions)				
Atlantic region	1990	304.7	120.7	425.4	26.1	259.9	286.0	330.8	380.6	711.4
	1991p	720.4	134.7	855.1	15.5	247.0	262.5	735.9	381.7	1 117.6
	1992i	631.2	107.7	6.0	23.9	266.5	290.4	655.1	374.2	1 029.3
Quebec	1990	352.5	92.6	445.1	33.0	250.3	283.3	385.5	342.9	728.4
	1991p	245.0	117.0	362.0	42.9	253.0	295.9	287.9	370.0	657.9
	1992i	227.8	96.0	323.8	40.9	243.0	283.9	268.7	339.0	607.7
Ontario	1990	568.5	203.6	772.1	66.1	476.7	542.8	634.6	680.3	1 314.9
	1991p	286.6	166.5	453.1	52.7	373.2	425.9	339.3	539.7	879.0
	1992i	267.1	161.0	428.1	49.4	360.4	409.8	316.5	521.4	837.9
Prairie region	1990	4 438.9	386.8	4 825.7	301.5	1 185.1	1 486.6	4 740.4	1 571.9	6 312.3
	1991p	4 400.5	473.6	4 874.1	300.3	1 056.1	1 356.4	4 700.8	1 529.7	6 230.5
	1992i	3 756.3	416.0	4 172.3	295.5	1 073.6	1 369.1	4 051.8	1 489.6	5 541.4
British Columbia	1990	821.3	92.8	914.1	81.0	461.0	542.0	902.3	553.8	1 456.1
	1991p	850.8	88.3	939.1	83.6	477.4	561.0	934.4	565.7	1 500.1
	1992i	483.5	115.9	599.4	88.9	469.7	558.6	572.4	585.6	1 158.0
Yukon and Northwest Territories	1990	217.0	60.2	277.2	10.1	64.9	75.0	227.1	125.1	352.2
	1991p	175.9	23.1	199.0	4.4	66.9	71.3	180.3	90.0	270.3
	1992i	103.8	27.9	131.7	5.1	72.2	77.3	108.9	100.1	209.0
Total	1990	6 702.9	956.7	7 659.6	517.8	2 697.9	3 215.7	7 220.7	3 654.6	10 875.3
	1991p	6 679.2	1 003.2	7 682.4	499.4	2 473.6	2 973.0	7 178.6	3 476.8	10 655.4
	1992i	5 469.7	924.5	6 394.2	503.7	2 485.4	2 989.1	5 973.4	3 409.9	9 383.3

Source: Statistics Canada.
i Intentions; p Preliminary.
1 Includes mines, quarries and oil wells.
Note: Numbers may not add to totals due to rounding.

TABLE 74. CANADA, CAPITAL AND REPAIR EXPENDITURES IN MINING[1] AND MINERAL MANUFACTURING INDUSTRIES,[2] 1990-92

	1990			1991[p]			1992[I]		
	Capital	Repair	Total	Capital	Repair	Total	Capital	Repair	Total
					($ millions)				
MINING									
Metal mines									
Copper-gold-silver	268.7	303.0	571.7	210.1	273.3	483.4	248.2	275.3	523.5
Gold	590.2	265.9	856.1	279.6	229.6	509.2	279.6	223.7	503.3
Iron	187.3	229.8	417.1	235.0	232.8	467.8	138.5	234.5	373.0
Silver-lead-zinc	141.0	91.5	232.5	183.4	104.1	287.5	111.8	138.5	250.3
Other metal mines	592.4	389.7	982.1	381.5	273.7	655.2	378.0	253.8	631.8
Total	1 779.6	1 279.9	3 059.5	1 289.6	1 113.5	2 403.1	1 156.1	1 125.8	2 281.9
Nonmetal mines									
Asbestos	64.2	39.9	104.1	32.2	49.1	81.3	58.4	51.6	110.0
Other nonmetal mines[3]	607.7	742.1	1 349.8	560.4	672.8	1 233.2	490.4	669.9	1 160.3
Total	671.9	782.0	1 453.9	592.6	721.9	1 314.5	548.8	721.5	1 270.3
Mineral fuels									
Petroleum and gas[4]	5 208.1	1 153.8	6 361.9	5 800.1	1 137.7	6 937.8	4 689.3	1 141.8	5 831.1
Total mining industries	7 659.6	3 215.7	10 875.3	7 682.3	2 973.1	10 655.4	6 394.2	2 989.1	9 383.3
MINERAL MANUFACTURING									
Primary metal industries									
Aluminum rolling, casting and extruding	81.5	60.7	142.2	51.8	64.8	116.6	87.1[e]	65.6	152.7[e]
Copper and copper alloy, rolling, casting and extruding	1.8	6.8	8.6	6.9	6.3	13.2	9.0[e]	6.2	15.2[e]
Iron and steel mills	647.4	1 050.3	1 697.7	616.1	914.8	1 530.9	398.5[e]	975.8	1 374.3[e]
Iron foundries	36.4	57.4	93.8	42.7	70.0	112.7	15.8[e]	69.8	85.6[e]
Metal rolling, casting and extruding	25.5	20.3	45.8	24.9	28.5	53.4	22.4[e]	34.3	56.7[e]
Smelting and refining	2 063.5	684.8	2 748.3	1 712.6	625.4	2 338.0	790.9[e]	636.9	1 427.8[e]
Steel pipe and tube mills	47.2	88.7	135.9	49.3	113.2	162.5	41.7[e]	112.8	154.5[e]
Total	2 903.3	1 969.0	4 872.3	2 504.3	1 823.0	4 327.3	1 365.2	1 901.4	3 266.6
Nonmetallic mineral products									
Abrasives	9.4	17.3	26.7	5.3	12.7	18.0	7.9[e]	12.2	20.1[e]
Cement	123.8	133.0	256.8	89.2	95.2	184.4	50.0[e]	95.5	145.5[e]
Clay products	x	x	29.8	4.7	9.8	14.5	28.2[e]	9.8	38.0[e]
Concrete products	38.1	35.6	73.7	29.8	37.2	67.0	25.8[e]	40.0	65.8[e]
Glass and glass products	190.6	29.2	219.8	47.9	29.6	77.5	70.3[e]	30.5	100.8[e]
Lime	22.6	7.0	29.6	x	x	x	x	x	26.3[e]
Ready-mix concrete	51.6	84.6	136.2	46.2	80.2	126.4	45.9[e]	76.2	122.1[e]
Stone products	x	x	3.2	x	x	x	x	x	0.9[e]
Other nonmetallic mineral products	90.7	67.9	158.6	35.9	50.7	86.6	44.8[e]	51.4	96.2[e]
Total	540.9	393.5	934.4	283.6	325.0	608.6	289.7	326.1	615.8
Metal-fabricating industries									
Boiler and plate works	14.0	14.3	28.3	9.6	10.7	20.3	19.5[e]	11.3	30.8[e]
Fabricated structural metal	21.9	17.1	39.0	22.4	13.2	35.6	18.2[e]	12.5	30.7[e]
Hardware, tool and cutlery	34.2	25.7	59.9	26.9	31.7	58.6	44.7[e]	34.6	79.3[e]
Heating equipment	11.0	5.8	16.8	5.1	6.1	11.2	10.6[e]	6.1	16.7[e]
Machine ships	17.4	5.3	22.7	18.4	7.5	25.9	23.7[e]	6.9	30.6[e]
Metal stamping, pressing and coating	76.0	66.2	142.2	96.8	47.9	144.7	123.7[e]	48.0	171.7[e]
Miscellaneous metal fabricating	46.2	27.7	73.9	34.7	23.8	58.5	51.0[e]	23.4	74.4[e]
Ornamental and architectural metal	42.2	13.2	55.4	18.0	12.3	30.3	26.5[e]	12.1	38.6[e]
Wire and wire products	65.6	56.7	122.3	45.1	42.9	88.0	68.3[e]	46.0	114.3[e]
Total	328.5	232.0	560.5	277.0	196.1	473.1	386.3	200.9	587.2

TABLE 74 (cont'd)

	1990			1991p			1992i		
	Capital	Repair	Total	Capital	Repair	Total	Capital	Repair	Total
					($ millions)				
Petroleum and coal products									
Petroleum and coal products	x	x	22.3	x	x	20.5	x	x	25.9
Petroleum refineries	x	x	1 487.3	x	x	1 523.1	x	x	1 273.9
Total	1 008.9	500.7	1 509.8	1 045.4	498.2	1 543.6	828.1	471.7	1 299.8
Total mineral manufacturing industries	4 781.6	3 095.2	7 876.8	4 110.3	2 842.3	6 952.6	2 869.3	2 900.1	5 769.4
Total mining and mineral manufacturing industries	12 441.2	6 310.9	18 752.1	11 792.6	5 815.4	17 608.0	9 263.5	5 889.2	15 152.7

Source: Statistics Canada.
e Estimated (breakdown estimated by EMR); i Intentions; p Preliminary; x Confidential.
[1] Does not include cement, lime and clay products (domestic clay) manufacturing, smelting and refining. [2] All years have been revised to include the metal-fabricating industries. [3] Includes coal mines, gypsum, salt, potash and miscellaneous nonmetal mines and quarrying. [4] The total of capital expenditures shown under "petroleum and gas" is equal to the total capital expenditure under the columns entitled "petroleum and natural gas extraction," "natural gas processing plants" and "oil and gas drilling contractors" of Table 77.
Note: Numbers may not add to totals due to rounding.

TABLE 75. CANADA, CAPITAL AND REPAIR EXPENDITURES IN THE MINING INDUSTRY,[1] 1986-92

	1986	1987	1988	1989	1990	1991p	1992i
				($ million)			
METAL MINES							
Capital							
Construction	979.7	1 328.2	1 609.0	1 356.4	1 358.7	877.2	769.9
Machinery	319.4	372.9	566.5	578.6	420.9	412.5	386.2
Subtotal	1 299.1	1 701.1	2 175.5	1 935.0	1 779.6	1 289.7	1 156.1
Repair							
Construction	99.6	109.8	123.2	153.0	140.9	121.5	124.4
Machinery	811.3	880.8	1 033.6	1 062.1	1 139.0	991.9	1 001.4
Subtotal	910.9	990.6	1 156.8	1 215.1	1 279.9	1 113.4	1 125.8
Total capital and repair	2 210.0	2 691.7	3 332.3	3 150.1	3 059.5	2 403.1	2 281.9
NONMETAL MINES[2]							
Capital							
Construction	502.4	421.7	432.9	417.1	408.4	378.3	294.5
Machinery	256.6	251.6	263.4	270.1	263.5	214.3	254.3
Subtotal	759.0	673.3	696.3	687.2	671.9	592.6	548.8
Repair							
Construction	31.2	23.2	38.3	40.7	47.8	37.0	38.9
Machinery	565.4	608.8	634.6	682.4	734.2	684.9	682.6
Subtotal	596.6	632.0	672.9	723.1	782.0	721.9	721.5
Total capital and repair	1 355.6	1 305.3	1 369.2	1 410.3	1 453.9	1 314.5	1 270.3
MINERAL FUELS							
Capital							
Construction	5 142.4	4 096.0	5 134.4	4 444.9	4 935.8	5 423.7	4 405.3
Machinery	496.4	505.8	744.2	306.1	272.3	376.4	284.0
Subtotal	5 638.8	4 601.8	5 878.6	4 751.0	5 208.1	5 800.1	4 689.3
Repair							
Construction	316.5	307.0	241.8	235.2	329.1	340.9	340.4
Machinery	705.5	673.9	761.5	788.3	824.7	796.8	801.4
Subtotal	1 022.0	980.9	1 003.3	1 023.5	1 153.8	1 137.7	1 141.8
Total capital and repair	6 660.8	5 582.7	6 881.9	5 774.5	6 361.9	6 937.8	5 831.1
TOTAL MINING							
Capital							
Construction	6 624.5	5 845.9	7 176.3	6 218.4	6 702.9	6 679.2	5 469.7
Machinery	1 072.4	1 130.3	1 574.1	1 154.8	956.7	1 003.2	924.5
Subtotal	7 696.9	6 976.2	8 750.4	7 373.2	7 659.6	7 682.4	6 394.2
Repair							
Construction	447.3	440.0	403.3	428.9	517.8	499.4	503.7
Machinery	2 082.2	2 163.5	2 429.7	2 532.8	2 697.9	2 473.6	2 485.4
Subtotal	2 529.5	2 603.5	2 833.0	2 961.7	3 215.7	2 973.0	2 989.1
Total capital and repair	10 226.4	9 579.7	11 583.4	10 334.9	10 875.3	10 655.4	9 383.3

Source: Statistics Canada.
i Intentions; p Preliminary.
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.
Note: Numbers may not add to totals due to rounding.

TABLE 76. CANADA, CAPITAL AND REPAIR EXPENDITURES IN THE MINERAL MANUFACTURING INDUSTRIES,[1] 1986-92

	1986	1987	1988	1989	1990	1991p	1992I
	($ millions)						
PRIMARY METAL INDUSTRIES[2]							
Capital							
Construction	400.2	265.7	287.3	611.7	1 110.0	867.1	213.9
Machinery	1 333.6	1 223.2	1 242.8	1 729.4	1 793.3	1 637.2	1 151.3
Subtotal	1 733.8	1 488.9	1 530.1	2 341.1	2 903.3	2 504.3	1 365.2
Repair							
Construction	126.9	119.0	134.0	186.4	166.4	171.3	168.3
Machinery	1 279.0	1 409.4	1 616.8	1 721.3	1 802.8	1 651.7	1 733.1
Subtotal	1 405.9	1 528.4	1 750.8	1 907.7	1 969.0	1 823.0	1 901.4
Total capital and repair	3 139.7	3 017.3	3 280.9	4 248.8	4 872.3	4 327.3	3 266.6
NONMETALLIC MINERAL PRODUCTS[3]							
Capital							
Construction	36.0	73.5	88.1	120.5	69.8	24.5	17.7
Machinery	295.1	282.6	352.5	447.6	471.1	259.1	272.0
Subtotal	331.1	356.1	440.6	568.1	540.9	283.6	289.7
Repair							
Construction	24.7	23.3	24.0	23.1	27.8	17.9	19.7
Machinery	285.7	277.5	313.9	339.1	365.7	307.1	306.4
Subtotal	310.4	300.8	337.9	362.2	393.5	325.0	326.1
Total capital and repair	641.5	656.9	778.5	930.3	934.4	608.6	615.8
METAL-FABRICATING INDUSTRIES							
Capital							
Construction	194.7	107.1	112.2	84.5	70.6	44.4	29.7
Machinery	525.4	356.3	355.2	340.6	257.9	232.6	356.6
Subtotal	720.1	463.4	467.4	425.1	328.5	277.0	386.3
Repair							
Construction	22.7	24.2	27.8	29.6	27.7	24.2	23.5
Machinery	209.1	194.7	197.1	201.1	204.3	171.9	177.4
Subtotal	231.8	218.9	224.9	230.7	232.0	196.1	200.9
Total capital and repair	951.9	682.3	692.3	655.8	560.5	473.1	587.2
PETROLEUM AND COAL PRODUCTS							
Capital							
Construction	272.3	464.9	437.9	626.0	665.3	781.0	615.3
Machinery	125.9	205.0	261.0	335.1	343.6	284.4	212.8
Subtotal	398.2	669.9	698.9	961.1	1 008.9	1 045.4	828.1
Repair							
Construction	212.0	252.8	255.6	274.3	335.3	358.9	338.6
Machinery	91.9	112.8	115.7	129.7	165.4	139.3	133.1
Subtotal	303.9	365.6	371.3	404.0	500.7	498.2	471.7
Total capital and repair	702.1	1 035.5	1 070.2	1 365.1	1 509.8	1 543.6	1 299.8
TOTAL MINERAL MANUFACTURING INDUSTRIES							
Capital							
Construction	903.2	911.2	925.5	1 442.7	1 915.7	1 717.0	876.6
Machinery	2 280.0	2 067.1	2 211.5	2 852.7	2 865.9	2 393.3	1 992.7
Subtotal	3 183.2	2 978.3	3 137.0	4 295.4	4 781.6	4 110.3	2 869.3
Repair							
Construction	386.3	419.3	441.4	513.4	557.2	572.3	550.1
Machinery	1 865.7	1 994.4	2 243.5	2 391.2	2 538.0	2 270.0	2 350.0
Subtotal	2 252.0	2 413.7	2 684.9	2 904.6	3 095.2	2 842.3	2 900.1
Total capital and repair	5 435.2	5 392.0	5 821.9	7 200.0	7 876.8	6 952.6	5 769.4

Source: Statistics Canada.
I Intentions; p Preliminary.
1 All years have been revised to include the metal-fabricating industries. 2 Includes smelting and refining. 3 Includes cement, lime and clay products manufacturing.
Note: Numbers may not add to totals due to rounding.

TABLE 77. CANADA, CAPITAL EXPENDITURES IN THE PETROLEUM, NATURAL GAS AND ALLIED INDUSTRIES,[1] 1982-92

	Petroleum and Natural Gas Extraction	Transportation (Pipelines)	Marketing (Chiefly Outlets of Oil Companies)	Natural Gas Distribution	Petroleum and Coal Products Industries	Natural Gas Processing Plants	Oil and Gas Drilling Contractors	Total Capital Expenditures
	($ millions)							
1982	6 743.4	1 994.3	320.5	517.6	1 224.5	522.8	173.5	11 496.6
1983	6 563.5	660.5	374.5	516.8	840.8	195.8	155.4	9 307.3
1984	6 946.4	795.4	422.9	604.1	432.4	340.0	43.8	9 585.0
1985	8 187.6	664.2	356.8	603.5	335.7	337.7	80.1	10 565.6
1986	5 401.1	586.9	344.9	573.9	398.2	207.8	29.9	7 542.7
1987	4 414.6	503.0	412.4	571.8	669.9	174.1	13.1	6 758.9
1988	5 589.9	828.9	478.4	602.8	698.9	271.8	16.9	8 487.6
1989	4 309.7	1 520.7	501.7	570.4	961.4	427.4	14.0	8 305.3
1990	4 750.8	1 817.2	380.2	666.9	1 008.9	445.3	12.1	9 081.4
1991p	5 115.3	2 706.0	408.6	773.8	1 045.4	671.6	13.1	10 733.8
1992i	4 529.9	2 976.7	443.8	854.0	828.1	445.2	13.0	10 090.7

Source: Statistics Canada.
i Intentions; p Preliminary.
1 The petroleum and natural gas industries in this table include all companies engaged in whole or in part in oil and gas activities.
Note: Numbers may not add to totals due to rounding.