

THE MINERAL INDUSTRY OF

CANADA

By David B. Doan

A continuing decline in metals prices from 1997 and throughout 1998 led to a decrease in Canadian mine output of base and precious metals that was compensated in part by greater production of industrial minerals and so-called structural mineral materials. Overall value of production in 1998 dropped by 12.3% to about \$30 billion,¹ the lowest since 1991. The metals price decline was widely seen to be the result of lowered demand amidst a world overcapacity in metals production resulting from the financial turmoil that began in Asia in mid-1997 and spread to much of the rest of the world. During 1997, Canada's economy as a whole fostered an increase of about 3.8% in the gross domestic product (GDP), but GDP slowed for most of 1998. In the fourth quarter of 1998, however, gross national expenditures (in 1992 dollars) had risen by 2.8% over those of the fourth quarter of 1997, and growth accelerated to more than 4% from October to December 1998. Unemployment remained at about 8% at the end of the year, with Quebec and the Maritime Provinces the hardest hit, while inflation remained moderate (Early Economic Outlook, 1999).

During the year,² world market prices were soft for copper, lead, and nickel and remained soft for zinc. Moreover, gold prices weakened as the central banks of several nations lowered their inventories by selling in world markets. Seemingly endless discussion by other countries as to possible central bank gold sales did nothing to buoy the world market price. Much comment regarding possible gold selling by the International Monetary Fund (IMF) added further uncertainty as the IMF's intentions threatened to become a political issue not only in the United States, but in several other gold-producing countries. In Canada, as in some other parts of the world, various mines went on suspension or, in some cases, closed, pending improvements in economic incentives to mine base and precious metals.

After spreading to most of Canada, exploration for diamond continued with less public excitement than previously but with an increasing number of "finds." With the opening of the Ekati Mines in the Northwest Territories, Canada, for the first time, became a factor in world diamond markets.

¹Where necessary, values have been converted from Canadian dollars (CAN\$) to U.S. dollars at an average rate of CAN\$1.483=US\$1.00 for 1998. All values in this report, unless otherwise specified, are expressed in U.S. dollars.

²For more detailed information on the mineral production in Canada, see the Canadian Minerals Yearbooks for 1997 and 1998, prepared by the Mining Sector, Natural Resources Canada, Ottawa, Canada, which were used extensively as source material for this report. The U.S. Department of the Interior has arranged to have these Canadian publications placed in selected depository libraries of the 50 States and Puerto Rico. Any datum or statistic not referenced elsewhere may be assumed to be from either the Yearbook or the related series of separate, preliminary topical papers presenting information compiled by Statistics Canada and issued by Natural Resources Canada.

One of the biggest news makers in the Canadian mining industry continued to be Inco's huge nickel-copper-cobalt deposit at Voisey's Bay on the Labrador coast where drilling results had confirmed an unusually large, high-grade ore body. First Nation (aboriginal peoples) interests, environmental issues, and low nickel prices had created problems in the previous 2 years or so, delaying development of this ore body, but a new dispute arose with the Provincial Government of Newfoundland, which demanded that the ore smelting and refining be performed in that Province rather than elsewhere (Financial Times, 1998).

Although a large number of Canadian mining companies have been exploring in other countries, such discoveries as Voisey's Bay and the Ekati diamond mines reaffirmed that there is much still to be found in Canada. Overall outlay for 1998 exploration costs in Canada were projected to be about \$518 million, comprising a little more than \$210 million by the junior sector and a little less than \$308 million by 133 senior companies, down about 10% from the \$578 million spent in 1997, and reflecting lower markets prices for metals (Mining Journal, 1999). Expenditures in 1998 by Canadian companies in countries other than Canada, by contrast, amounted to \$652 million.

The Bre-X Minerals Ltd. fraud in Kalimantan, Indonesia, in which drill-core samples from its Busang property were salted with gold, became a world-class scandal that involved the loss of hundreds of millions of dollars in connection with the collapse of Bre-X share prices from more than \$200 to \$0.08 on the Toronto Exchange. Financings of junior mining companies became more difficult to negotiate, and not only in Canada. Various exchanges, particularly the Toronto Exchange, promulgated new requirements for registration and sale of mining-oriented securities in public offerings.

Environmental concerns continued to interact with mineral exploration and development activity throughout Canada. Some Canadian companies sought mineral properties in Central America and South America where they saw that foreign investment was welcomed, mining laws were coherent and reasonable, and profits could be repatriated.

Nongeologic criteria seem to have become increasingly important in considering exploration in Canada. Land use, never given much attention in the past, has become an issue. After years of neglect, First Nation rights are now receiving long-awaited consideration. According to the Mining Journal (1998c), the antimining lobby in Canada is hardy enough that many mining supporters are urging the industry to be more vocal in defending its interests (Mining Journal, 1998c). Canada's Minister of Natural Resources stated that Federal and Provincial Governments are working on reform of the present

regulations that should afford an improved regulatory climate for mineral exploration throughout Canada.

Government Policies and Programs

New Canadian tax proposals have alarmed the mining industry throughout Canada. After an academic-based economic study recommended lowering taxes on the service sector and raising those on the resource and manufacturing sectors, the industry responded that such tax provisions would increase the burden on all mining companies and lead to the closing down of mining operations that provide jobs in areas where this is an important factor. Specifically the new tax structure would reduce the property development write-off from 30% to 25%; it would also reduce the resource allowance, which presently (1998) allows sheltering of 25% of net production profits before the write-off of exploration and development expenses and interest charges. Although this allowance is presently equivalent to a 25% tax reduction, it is more than offset by royalties and other levies imposed by Canada's Provinces (Journal of Commerce, 1998).

Primary jurisdiction over mineral resources in Canada is exercised by the Provinces. Through their mining acts, the Provincial Governments regulate most aspects of exploration and mining. Exceptions have been the Yukon Territory and the Northwest Territories, which, while still under the resource-management control of the Federal Government, were slowly accumulating more independent powers. Federal and Provincial policies (though not entirely consistent among Provinces) are generally stable and have traditionally favored research and information services relating to the mining industry. The Federal Government had negotiated multiyear Mineral Development Agreements with Provincial Governments that fund initiatives intended to strengthen the mining industry in each region. Although new environmental assessment legislation was passed in 1992, the Government has been deliberate in producing regulations to implement the new laws. One subsequent measure, however, was tax deductibility for funds set aside for the cleanup of closed mine sites, thus complementing emerging Provincial reclamation requirements. The recent shift of international mining investment away from Canada had prompted industry representatives to urge changes in the regulation and taxation of the mining industry.

In Ottawa, the Supreme Court of Canada handed down a unanimous landmark decision that a case brought in 1987 on behalf of about 6,500 indigenous peoples in British Columbia concerning rights to 58,000 square kilometers (km²) resource-rich lands should be retried. This decision, which appeared to establish the principle that the native Indian rights were not extinguished by European settlement in Canada, had far-reaching implications for much of Canada (Mining Journal, 1997a). Other court actions were pending that asserted the rights of the First Nation peoples to control access to their lands by mining companies.

Environmental Issues

Toronto health officials reported that air quality in southern Ontario has worsened sharply since the temporary closure of

seven nuclear powerplants in 1997 and will probably deteriorate further after deregulation of the Province's electricity market in 2000. The report laid much of the blame on a sharp increase in emissions from five coal-fired plants operated by Ontario Hydro. Since 1996, sulfur dioxide emissions from the plants have increased by 68%, and nitrogen oxide emissions have increased by 58%. Sulfur dioxide is a major contributor to acid rain. Nitrogen oxide emissions are the principal source of ground-level ozone that produces visible smog. Ontario Hydro planned to reintroduce upgraded nuclear plants next year (Financial Times, 1999).

After imposing a ban on the importation and interprovincial trade of methylcyclopentadienyl manganese tricarbonyl, an octane enhancer for gasoline in 1997, the Government reversed its ruling and lifted the ban, saying that evidence was insufficient to demonstrate risk to automobile emission systems or human health (Chemical Week, 1998).

Natural Resources Canada issued a wide-ranging statement of policy goals linking environmental considerations with minerals, metals, markets, labor, investment, and taxation in a concerted effort to devise national policy fundamentals aimed at forestalling the kinds of shutdown actions represented by the multibillion dollar Windy Craggy cobalt-copper-gold-silver-zinc mine development in British Columbia (Natural Resources Canada, 1996, p. 1-25). This statement addressed life-cycle management, safe use, health and the environment, reclamation, recycling of minerals and metals, the role of science and technology, and First Nation concerns, aiming to establish the equilibrium among interests necessary for sustainability.

In addition to this effort to define goals, approaches, and alternatives in the name of sustainable development, the Prospectors & Developers Association of Canada (PDAC) has issued a paper titled "Total Landscape Management (TLM): An Integrated Approach to Conservation Protection and Resource Development." The PDAC asserted that TLM goes beyond the growing reliance on multiple-use exclusive areas to achieve conservation objectives, which has produced unsatisfactory results because the complex and changing needs of the landscape require a more comprehensive, integrated approach. The paper acknowledged that access to land and certainty of title are both crucial to resource development, while biological diversity, wilderness protection, and the preservation of unique and exceptional areas are fundamental to conservation objectives. TLM prescribes management of entire ecological landscapes, employing the over-arching principal of conservation diversity; a system of "floating reserves" designed to accomplish protection in a constantly changing, dynamic landscape; adaptive management, allowing the flexibility to accommodate new information, evolving ecosystems, and natural disturbances; and comanagement, ensuring the provision of local community input (Mining Journal, 1998a). Too comprehensive to detail here, this paper appears to be a carefully crafted and far-reaching attempt to rationalize and harmonize the honest differences between reasonable, albeit adversarial, viewpoints by PDAC, a private-sector organization.

After the Provincial Government ruled that processing of Voisey's Bay ore must take place in Newfoundland or Labrador rather than anywhere else, Inco Ltd. announced plans for a

smelter and refinery at Argentia, Newfoundland. Inco projected that 99% of sulfur dioxide (SO₂) emissions would be captured and that the complex would produce less atmospheric SO₂ than any existing industry in Newfoundland. This did not satisfy environmental activists, who launched a campaign against the smelter per the Canadian Environmental Assessment Act (Engineering and Mining Journal, 1997b).

Canada's commitment at the Kyoto meetings to reduce "greenhouse" gas emissions by 6% by no later than 2012 received mixed reviews domestically. Provincial officials from Alberta, Ontario, and Saskatchewan publicly expressed reservations about the Federal Government's intentions, as well as the unilateral way the Government shifted its position before and during the Kyoto talks (U.S. Embassy, Ottawa, Canada, 1997, p. 1).

Production

Total value of production of all mineral commodities, including mineral fuels, was \$29.883 billion, down by more than 12% from that of 1997, reversing an upward trend of several years. The previous growth in value of production was stalled essentially by uncertainty in connection with lower metals prices and the unpredictability of price recovery in the midst of serious financial problems elsewhere in the world.

In the three nonfuels groups (metals, nonmetals, and structural materials), changes from the previous year were mixed. Compared with 1997, production values of metals dropped by almost 11% to \$6,958 million, nonmetals gained 8.3% for a total of \$2,210 million, and structural materials increased by 2.2%, to a total of \$1,988 million in 1998, although the decrease in value of the Canadian dollar against the U.S. dollar negated all this gain. The performance of the fuels group, totaling \$18,725 million, showed a 16% decline from the previous year, primarily because of critically weak world market prices for crude oil. Value of natural gas production, however, climbed by more than 3% to about \$7.550 billion, and market prices were significantly more stable than those for crude. Value of natural gas byproducts, however, declined by about 31% to \$1.207 billion. Petroleum crude output increased by 4% versus 1997, but value dropped by 27% to \$8.760 billion because of the aforesaid sag in world crude prices. Finally, the value of coal production decreased by almost 7% to \$1.209 billion in 1998. Geographically, the sources of mineral fuels production were Alberta, 78% of the total; British Columbia, 9.3%; Saskatchewan, 8.8%; and all other Provinces and Territories, 2.5%. In terms of value of production in 1998, the top nonfuel commodities were gold at \$1.55 billion; copper, \$1.15 billion; potash, \$1.15 billion; iron ore, \$1.08 billion; zinc, \$1.01 billion; and nickel, \$0.94 billion.

Market prices played a changing role in the mineral commodity values, particularly for gold, whose production decreased by more than 3% and production value decreased by more than 8%, indicating the effect of the fall in market pricing. Copper output increased from that of 1997, but the value of this production dropped sharply, again reflecting market price weakness. Nickel production increased significantly in 1998, but the value of this output decreased by

twice the proportion of gain, owing to lower nickel prices. Finally, 1998 zinc production fell moderately, but the value of this production declined by more than five times as much, thanks to the slump in market prices. Of interest is the fact that these changes in output tonnages were accompanied by declines of two to five times in value of production, illustrating the destructive effect of price deterioration in relation to mineral production.

Ontario was the leading producer of nonfuel mineral commodities, accounting for 30.2% of the total value, followed by Quebec, 20.8%; Saskatchewan, 13.3%; British Columbia, 11.6%; Newfoundland, 6.1%; Manitoba, 5.5%; New Brunswick, 5.0%; and other Provinces and Territories, 7.5%. Although production of fuels tended to be concentrated in the western plains Provinces, the output of nonfuel mineral commodities was characterized by a much wider distribution throughout Canada.

Trade

As the world's largest exporter of minerals and metals, Canada enjoyed economic benefits from its mineral industry that included a significant contribution to its trade surplus and, hence, to its merchandise trade balance, as well as major support of the national standard of living.

Mineral and mineral-product exports, including fuels, totaled \$45.94 billion in 1998, a decrease of 11% compared with that of 1997, and represented about 23% of all Canadian exports for that year. Of total mineral and mineral-product exports, metals registered 51%; fuels, 37.3%; nonmetals, about 10.3%; and building materials, about 1.4%. Value of exports of nonfuel minerals (but including coal) was \$30.5 billion, representing a decrease of 4.7% compared with that of 1997. Included in these exports were crude minerals, smelted and refined products, and semifabricated and fabricated products. Prominent among the crude minerals exported were iron ore, potash, and sulfur to the United States; copper concentrates to Japan; iron ore and zinc concentrates to the European Union (EU); smelted and refined metals, including aluminum, copper, gold, iron and steel, nickel, silver, and zinc to the United States; aluminum and gold to Japan; and copper and nickel to the EU; coal exports went mostly to Japan.

Mineral and mineral-product imports, including fuels, were valued at \$36.2 billion, amounting to more than 12% of the value of all imports. In terms of net trade, the mineral (including fuels) surplus was valued at \$9.8 billion. Total trade between the United States and Canada exceeded that of any other two countries in the world. Exports of mineral commodities and mineral related products, including fuels, to the United States from Canada were \$38.1 billion in 1998 according to preliminary information.

Structure of the Mineral Industry

The Canadian mineral industry comprised about 3,000 domestic and perhaps 150 foreign companies, although less than 10% of these companies were actively engaged in actual mining. Many were engaged in exploration, some were in advanced stages of mine development, and some (especially

very junior companies) were relatively dormant while seeking sources of investment or finance. Companies whose corporate voting rights were at least 50% non-Canadian were considered to be foreign, although other distinctions could apply in some large companies. More than 200 mine sites, including coal, were active (Southam Mining Publications Group, 1998). Another 3,000 mines and quarries produced sand, gravel, and other construction materials. About 40 smelters and refineries were operating, plus other processing plants in the cement, sodium chlorate, and sulfuric acid industries. Foreign companies were subject to the same taxes as domestic companies, but repatriation of earnings was unimpeded.

Most of the Canadian mineral industry was privately owned, with the notable exception of Government participation in potash and petroleum, but even these were in transition to private ownership. Some companies, such as Potash Corp. of Saskatchewan Inc. (PCS) and Saskatchewan Oil & Gas Corp., had been owned, in part, by the Province of Saskatchewan. The Province of Alberta had owned part of Alberta Energy Co. Ltd. The proportion of Provincial Government ownership was changeable, but the trend here was also toward privatization. Petro-Canada has been owned partly by Federal and partly by Provincial Governments but was completely privatized. A large proportion of the total number of mining and petroleum companies was partly publicly owned, with shares trading on various exchanges in Canada and, in many cases, the United States.

Overall, the mineral industry in Canada consisted of underground mines, open pits, leaching operations, concentrators, smelters, and refineries, as well as drilling and production operations characteristic of the petroleum industry. Table 2 shows the structure of the mineral industry by sectors of the major mineral commodities.

Employment in the mining and mineral manufacturing industries stabilized after a decline that began in 1989 when the number of jobs in those industries peaked at 422,000. Preliminary employment estimates for 1997 (the latest year for which data are available) by Statistics Canada indicated that total employment in mining and mineral manufacturing, including coal, was about 368,000, up 5% from that of 1996. The total number of employees in metal, nonmetal, and coal mining, and quarrying was estimated by Statistics Canada to be 64,000, up about 5,000 jobs compared with the 1996 level. Employment in nonferrous smelting and refining was estimated to be 59,000, about the same as that of 1996. About 8,900 people were also employed in diamond drilling and other support services incidental to mining operations.

Commodity Review

Metals

Aluminum.—Production of primary aluminum was 2.374 million metric tons (Mt), an increase of about 2.0% compared with that of 1997. This put Canada third, after the United States and Russia, in the world in volume of production and first, with Russia second, in volume of exports to the United States. Primary aluminum exports during the year were valued at \$4.81 billion.

The start of 1998 was dramatic—a tremendous ice storm that paralyzed parts of Ontario and Quebec, destroying high-tension electric trunk lines, putting a major part of the population without power, and closing down business in many places throughout eastern Canada. One consequence of the power blackout was that molten aluminum froze in the potlines of Alcan Aluminum Ltd.'s 48,000-metric-ton (t) Beauharnois smelter near Montreal, causing major damage. Alcan's smelters in the Saguenay-Lac-St. Jean region of Quebec were not affected by power outages prevailing farther south.

In Quebec, after completing public hearings on the potential environmental impact of a 375,000-metric-ton-per-year (t/yr) smelter at Alma and filing the results with the Ministry of Environment late the previous year, Alcan announced plans to build the huge new smelter at Alma, Quebec, costing more than \$1 billion. Because of the new plant's capacity, requiring 620 megawatts (MW) of power, 270 MW would come from Alcan's own grid and 350 MW from Provincial utility Hydro-Quebec. The company had negotiated a projected 22-year power-exchange project with Hydro-Quebec. With Hydro-Quebec furnishing the additional power that Alcan might need for modernization and expansion of its various smelters in Quebec, Alcan's hydroelectric power system stood ready to accommodate Hydro-Quebec's requirements when feasible. Alcan projected that it would require an average market price of \$1,400 per metric ton to meet its cost of capital. The new potlines would comprise 432 pots in two lines. This new facility would raise Alcan's overall yearly primary aluminum capacity from all of its plants to 1.9 million metric tons per year (Mt/yr) (Metal Bulletin Monthly, 1998).

Cobalt.—Mine production of cobalt reached 6,039 t, an increase of nearly 6% compared with that of 1997, reflecting increased nickel production as producers of that metal combated lower market prices. Rising demand for cobalt for alloys, catalysts, magnets and batteries, and even pigment, its oldest use, has focused new attention on cobalt resources in Canada, led by the Voisey's Bay discovery of at least 40,000 t, with further results expected as exploration progresses.

Cobatec Inc., which operated a cobalt-nickel solvent extraction plant in North Cobalt, Ontario, had negotiated a long-term supply agreement with the Cuban Government to process cobalt-nickel sulfate precipitates from Cuba. During the first 3-year period of the agreement, recovery was expected to average more 454 t/yr of cobalt (reported as 1 million pounds per year) and 1,134 t/yr of nickel (reported as 2.5 million pounds per year). Processing began early in the year, never amounting to more than minimal output from this \$15 million facility established by Ego Resources Inc., renamed Cobatec. The operation filed for bankruptcy protection in October, which was not granted, and was closed near the end of the year.

The company had developed a proprietary hydrometallurgical process for extracting cobalt from ore, tailings, or mine spoil that involves crushing, grinding, flotation, and solvent extraction. Pure cobalt is then further treated to produce simple salts, such as carbonates. Their process has been endorsed by the Ontario Government as being consistent with its "green" industries strategy, to demonstrate that resource development can coexist with environmental responsibility.

Copper.—Mine output of copper climbed 6.3%, reflecting an agreeable increase following the 4.5% decline of 1997. Weakness of world copper prices, and the spectre of worldwide overcapacity, however, resulted in a 17.4% drop in the value of 1998 copper production in spite of the greater production. Canada exported \$1.61 billion worth of copper during the year.

Production of primary refined copper increased slightly. Copper production by solvent extraction-electrowinning (SX-EW) decreased by 33% compared with that of 1997 as a result of the year's low market prices for copper. In spite of the fact that the SX-EW technique for copper production leads to significant cost savings, no byproduct credits are gained in the process. The revenue flow is thus completely dependent on the price of copper itself. By normally conferring a so-called risk-reduction advantage as byproduct prices help buoy the revenue stream, Canada's many polymetallic copper deposits lose this benefit during SX-EW operations.

After firming to a peak in 1995, the softening of copper prices into 1997 and 1998 resulted in the suspension or shutdown of some copper production. The first casualty was Highland Valley Copper (HVC), a high-throughput and relatively high cost producer, that went on indefinite suspension in May. HVC mined copper at an average grade of 0.39% and processed about 45 Mt/yr, producing copper in concentrate at a cost of about \$0.68 per pound. Operations at the Gibraltar copper mine in British Columbia were suspended, and the mine was placed on care and maintenance after 1997 production of about 33,000 t of copper at a production cost approaching \$0.91 per pound (Wall Street Journal, 1998).

Princeton Mining Corp. pursued its British Columbia Huckleberry project on schedule, expecting production of 37,000 t/yr of contained copper after startup in November 1997 when it made its first shipment of concentrates to Japan. This polymetallic ore body would also yield 218 kilograms per year (kg/yr) of gold, 11,800 kg/yr of silver, and 670 t/yr of molybdenum. Princeton merged with Imperial Metals Corporation, operator and 55% owner of the Mount Polley copper-gold mine near Williams Lake, British Columbia, to form a new company to be called New Princeton. Late in 1996, Princeton suspended production at its Similco Mine in British Columbia, pending exploration results on-site and the hoped-for improvement of copper prices after their collapse in conjunction with Sumitomo's copper-trading scandal in Japan. The mine has been on care and maintenance ever since.

Although MSV Resources Inc. closed its Copper Rand and Portage mines near Chibougamau, Quebec, as the result of depletion of their respective ore reserves, the company contemplated a new development program at Copper Rand that could reopen the mine sometime in 1999.

As 1998 drew to a close, Royal Oak Mines Inc. obtained court protection against bankruptcy under the Companies' Creditors Arrangement Act after having staked its future on the recent opening of the Kemess gold-copper mine that was projected to yield 27,000 t/yr of byproduct copper.

Still overshadowing all potential copper production in Canada, the Voisey's Bay discovery, still being evaluated, suggested that Canada, ranking third after Chile and the United States, will continue to be a major world copper producer. Expectations were that Voisey's Bay might yield 99,000 t/yr of

contained copper, but, in terms of a variety of administrative concerns, such as the dispute with the Newfoundland Provincial Government described above, the mine was a long way from production.

Gold.—Gold production output dropped to about 166 t, down 3.1% after the previous year's increase of about the same proportion. Predictions made in 1995 that output would reach 170 t by 1998 were then seen as somewhat pessimistic, although the record high of 171.4 was achieved in 1997. Price weakness since has been the deleterious influence on production throughout 1998. Canada was the fifth largest gold producer after South Africa, the United States, Australia, and China. Canada exported \$2.3 billion worth of gold in various forms during the year.

At the beginning of the year, about 42 primary gold mines in Canada accounted for 90.4% of the gold produced, with the remainder coming from base metal mines (7.2%) and placer operations (2.1%). By the end of the year, these figures changed to 92.2%, 6%, and 1.8% respectively. Total employment in primary gold mines totaled 9,656 in 1997 (the latest year for which data are available). Employment figures had been improving since 1993 when the steady decline from the 1988 peak of 12,600 was halted, but further decline in 1998-99 is predictable. Principal gold refiners were Noranda Inc. in southern Quebec, the Royal Canadian Mint at Ottawa, Ontario, and Johnson Matthey Ltd. near Mississauga, Ontario.

After finishing its reevaluation of the old San Antonio Mine at Bissett, Manitoba, which has previously produced more than 31 t, according to mining records held by various former owners, Rea Gold Corporation prepared for full production with a first pour in 1997. Rea carried out an intensive sampling program after pumping out all the levels of the 5,500-foot-deep mine. Reserves were projected to be 3.5 Mt grading 9 grams per metric ton (g/t), or about 30 t of gold, with a projected output of 3 t/yr. Rea, however, was financially overextended at other mines outside Canada, as well as in their San Antonio startup, at about the time gold prices confirmed a serious downward trend. San Antonio was closed at the end of the year, and the company was forced into bankruptcy and liquidation of its assets. Early in 1998, the entire project was purchased by Harmony Gold Mining Company Ltd. of South Africa, which began an immediate reevaluation of the mine while forecasting an output of about 1.3 t of gold in the first year of production.

Echo Bay Mines Ltd. put its Lupin gold mine in the Northwest Territories, 56 miles south of the Arctic Circle, on care and maintenance while it examined its options in the light of low market prices. By the same token, the closure of Royal Oak Mines Inc.'s Kemess copper-gold mine in British Columbia seemed to be further "handwriting on the wall" for Canada's gold mining industry. Officially opened in May 1998, and expected to produce about 7,800 kg/yr, the Kemess Mine's troubles (noted in the section on copper) helped deflate prospects for improvement in overall production in 1999.

Gold still seemed to be the principal targeted metal for exploration virtually throughout Canada, and in terms of value of production, gold led the list, exceeding copper (second) and iron ore (third). With the threat of more gold mine closures,

depending upon market confidence, gold seemed to have lost at least some of its traditional luster. Compounding the problem was the announced future sale of gold in the open market by the United Kingdom, the possibility of significant sales by the Swiss Government from their large holdings, and repeated suggestions that the IMF release much of its gold to the open market in order to pay for projects in Third-world countries.

Iron Ore.—Production of iron ore climbed to 38.9 Mt compared with 37.3 Mt in 1997 for an increase of more than 4%. This category comprised concentrates, pellets, and sinter from hematite and siderite ores. Major iron-ore-producing companies included Quebec Cartier Mining Co. (QCM), Iron Ore Co. of Canada (IOC), Wabush Mines Ltd., and the Algoma Ore Division (AOD) of The Algoma Steel Corp. Ltd.

Although data are not available for 1998, data for 1995, the latest year for which data are available, gave an approximation of the proportions of pellets and sinter versus concentrates. QCM produced 16.1 Mt of ore in 1995, of which 8.3 Mt was used for pelletization and the remainder, sinter feed. Shipments exceeded production so that stocks were drawn down to meet demand. IOC produced 15.9 Mt of ore, of which 10.8 Mt went to pelletization; the remainder went to concentrates that were not used for pellets. Wabush Mines turned out 5.3 Mt of iron ore pellets. AOD produced 975,000 t of sinter at its complex in Wawa, Ontario.

In 1997, AOD had announced that its Wawa operation would be closed as of June 1998. AOD operated a series of open pit and underground mines at Wawa starting in the mid-1930's and had opened a sinter line there in 1939.

After paying \$230 million in return for a 59.3% stake in IOC, North Ltd., a diversified Australian resources group, decided to reactivate IOC's dormant (since 1981) Sept-Iles pellet plant with port facilities on the Gulf of St. Lawrence in Quebec. This expansion will increase IOC's capacity for production of high-quality pellets to 17 Mt/yr from the present capacity of 11 Mt/yr. A redesigned plant at Sept-Iles was expected to reduce IOC's average production costs by \$5 per ton. Exploration continued in various parts of Canada, including Roche Bay in the Northwest Territories, the Peace River area of Alberta, and Ungava Bay and Schefferville in Quebec.

Pig iron production increased to 9.14 Mt from 8.68 Mt in 1997, a change of more than 5%. The proportion of direct-reduced iron to pig iron produced was about 14%, thus increasing the ratio of 10% forecast 2 years before. Crude steel production was about 15.8 Mt compared with 15.5 Mt in 1997, both exceeding the old peak of 15.46 Mt in 1989.

Lead and Zinc.—Canada was the world's second largest mine producer of zinc and the fifth largest producer of lead with totals of 1,064,541 t of zinc and 189,297 t of lead in concentrate, respectively. After showing a sharp decrease of 28% in 1997 compared with that of 1996, lead production gained about 1.6% in 1998. Zinc showed a loss of about 1% in 1998, so that the continually weakening market prices instigated much less of a production decline than in 1997.

Anvil Range Mining Corp.'s Faro lead-zinc mine, one of the world's largest, had reached its capacity of 150,000 t/yr of zinc

and 98,000 t/yr of lead in concentrate in August 1996. It was then put on hiatus (processing only stockpiled material) in December 1996 because of the then-low zinc prices. In March, the entire operation went on standby, dewatered and ventilated, but with no production. After the zinc price run-up culminating in August 1997, the mine was reopened in October, just in time for the steep drop in zinc prices. The reopening had a depressing effect on already soft lead prices, thus being somewhat self-defeating for Anvil Range so far as the economics of lead were concerned. At the end of 1997, it was rumored that the Faro Mine might close again, and in January 1998, the mine was placed on care and maintenance.

Breakwater Resources Ltd. established milling improvements at its Nanisivik zinc mine on Baffin Island in the form of a regrind circuit that improved the zinc concentrate grade from 55.5% to 57.5% and increased recovery by 0.5% to 96.5%, resulting in significant savings in shipping and treatment costs. The operation generated a profit of \$12.4 million in 1997, the year of the zinc price slump, and boded well to repeat the performance in subsequent years.

Hudson Bay Mining and Smelting Co., Ltd. began an underground development program at its Chisel North zinc deposit at Chisel Lake, Manitoba, not far from Snow Lake. A decline is to be driven from the 140-meter (m) level of the main deposit to the north deposit for drilling and bulk sampling to confirm the surface-drill indicated resource of 2.4 Mt grading 10.8% zinc (Northern Miner, 1998a).

Late in the year, Inmet Mining Corporation suspended operations at the Winston Lake zinc mine, on the north shore of Lake Superior, after studies showed that it was not economic at the current low zinc prices. Although the small high-grade mine had been nearing the projected end of its mine life, Inmet sought to extend it another 4 years by developing the lower Pick Lake zone, estimated to include 1.2 Mt grading about 16% zinc, but development work failed to confirm this resource (Northern Miner, 1998b).

After closing its operations in the Matagami district of northern Quebec with the exhaustion of the Isle Dieu and the Norita East zinc-copper mines, Noranda continued development of its Bell Allard zinc-copper project, also in the Matagami district. With construction of surface facilities, the shaft will be sunk, and underground workings, undertaken. The projected startup in early 1999 would counter the exhaustion of Isle Dieu and Norita East. Bell Allard was expected to have a capacity of 80,000 t/yr of zinc and 5,000 t/yr of copper.

After suspending operations at about the same time as the Faro mine and for the same reasons in late 1966, Cambior Inc. resumed operations in July 1997 at its Gonzague Langlois (formerly Grevet) zinc-copper mine near Lebel-sur-Quevillon, Quebec. The mining method was modified to use sublevels, thus reducing the size of stopes in some sectors, reducing ore dilution, and increasing efficiency. As a result, the mine's capacity was upgraded to 36,000 t/yr of zinc in concentrate.

Magnesium.—The processing of asbestos commonly leaves tailings very rich in magnesium silicate. After successfully competing a 250-t/yr pilot operation, Noranda Inc. committed to the construction of a \$486 million primary magnesium plant

at Asbestos, Quebec, where 250 Mt of tailings will be the feedstock for a 58,000-t/yr throughput beginning in 2000. Magnola Metallurgy Inc. (Noranda, 80%; Societe Generale de Financement du Quebec, 20%) will be the operator. Using a hydrochloric acid continuous-leaching process, the resulting magnesium chloride will be electrolyzed to yield magnesium metal (Mining Journal, 1998b).

Nickel.—Mine output climbed from 190,529 t in 1997 to 208,201 t in 1998, an increase of more than 9%, presumably reflecting an attempt to offset sagging market prices by boosting production. This tactic could not be effective because of the magnitude of the slump in prices, which resulted in a drop in value of 1998 output exceeding 20%. As with other base metals, these low prices engendered a ferocity of financial problems in keeping certain high-cost mines alive.

Falconbridge Ltd. pressed development of its Raglan nickel-copper property in northern Quebec sufficiently to begin production ahead of schedule at yearend 1997 and targeted April 1998 for commercial production and the following July for full production. Reserves at this property now stand at 20.6 Mt grading 3.17% nickel and 0.88% copper. The \$360 million operation was scheduled to produce about 20,800 t/yr of nickel in concentrate and about 5,200 t/yr of copper in concentrate by mid-1999. Raglan concentrates will be shipped from Deception Bay, 100 kilometers (km) north of the mine, to Quebec City and continue by rail to Falconbridge's Sudbury smelter in Ontario. Projecting credits for the Raglan mine's copper, cobalt, and precious metals, it was likely that its principal metal, nickel, would be produced at about \$1.50 per pound, making Raglan one of the world's lowest cost nickel mines.

Possibly the world's biggest newsmaker in nickel continued to be Inco's nickel-copper-cobalt project at Voisey's Bay, Labrador, where the saga involving exploration, environmental activism, aboriginal claims, financial straits, and provincial politics, continued to unfold. While exploration progressed, other developmental problems (see Environmental Issues) came to the fore. As a result, Inco announced in 1997 that the entire project would be delayed for at least 1 year as First Nation claims and environmental challenges arose that, by law, required adjudication before development could proceed. After settlement of some, but not all, of these issues, Inco announced in December that the 1-year delay had stretched to at least 18 months beginning after receipt of environmental and other permits (Mining Journal, 1997b). Existing plans had proposed mining 15,000 metric tons per day (t/d) from an open pit, forming a concentrate, and shipping to a smelter-refinery complex at Argentia, Newfoundland, where refinery output would be 122,500 t/yr. Total capital costs would exceed \$1 billion. This operation would clearly affect the economics of nickel production and marketing for some time to come. In the meantime, however, Inco felt the pinch of low nickel prices and in the first quarter of 1998 found it necessary to cut jobs, as well as production, at its Ontario and Manitoba Divisions and contemplated the closing of four of its highest cost operations in Ontario including the Shebandowan, the McCreeley West, the Levack, and the Little Stobie mines. Shareholders' dividends were slashed, Standard and Poor's revised its ratings of Inco from "stable" to "negative," and Inco began to believe

that, rather than build the \$1 billion smelter at Argentia, it would be more economical to ship concentrates all the way to the company's existing smelter and refinery complex in Ontario. The prospect of such a move was anathema to the Government of Newfoundland, the poorest province in Canada, which reminded Inco that it could award rights to the Voisey's Bay discovery to some other entity if Inco did not follow through with the Argentia plan and the 1,500 new jobs that would thus be created, not to mention indirect enhancement of many other supporting jobs in the Province.

At yearend, Inco and the Government of Newfoundland stood by their positions in a stalemate that probably could only be resolved when world market pricing of nickel showed signs of improvement. Also affecting Inco was the tentative agreement on Inuit land claims after negotiations among the Government of Canada, the Provincial Government of Newfoundland and Labrador, and the Labrador Inuit Association. No agreement, however, seemed to have been achieved in land and claims negotiations with the Innu Nation.

Platinum-Group Metals.—Mine production of platinum-group metals (PGM) increased by almost 23% compared with that of 1997, reflecting the increased production of nickel. Output data for these metals represent captive recovery from nickel ore rather than response to market demand. Most production has been from Inco's and Falconbridge's Sudbury mines plus a smaller amount in Manitoba from Inco's Thompson Mine and by Hudson Bay Mining and Smelting and Outokumpo Mines Ltd.'s Namew Lake Mine near Flin Flon, which was to be decommissioned.

As an approximation based on past experience, Inco's ratio of PGM produced worked out to about 12 to 7.6 to 1 for the group members palladium, platinum, and rhodium, respectively. Although rhodium amounted to only slightly more than one-twentieth of PGM, its prices have traditionally been significantly higher than those for other members of the group, having traded at \$4,000 per ounce at one point in the past decade. Beginning in 1995, however, rhodium prices dipped to levels only slightly higher than those of gold.

PGM recovery was expected to continue with new nickel mining in the Sudbury district. Inco's Victor discovery contains an estimated 18 Mt grading 11.6 g/t PGM plus gold. Its McCreeley discovery, contains 5 Mt grading 10.6 g/t PGM plus gold.

Silver.—Canada ranked fourth in world silver production after Mexico, Peru, and the United States. Canadian silver production has been largely a coproduct of base metal and gold mining, subject to whatever mining incentive applies to the major product, whether gold, copper, or lead-zinc. Accordingly, silver output suffers when mines close or go on suspension for reasons involving supply, demand, and pricing for other major mineral commodities. Production of silver in concentrate declined nearly 4% from that of 1997. This was mostly a reflection of a net overall decline in certain polymetallic base-metal production during the year. Although the copper coproduct output was up slightly, the decrease in production of gold, lead, and zinc was more than enough to counter the effect of the increased copper output.

Production increased significantly in 1995 when Prime Resources Group Inc.'s Eskay Creek gold mine in British Columbia came on-stream as the largest producer of silver in Canada; output of silver from this mine was expected to be 340 t/yr.

Titanium.—Output of titanium was estimated to have risen to 950,000 t, an increase of almost 12%, since 1997. QIT-Fer et Titane (QIT) of Canada scheduled an investment of \$260 million in construction of a plant at Sorel, Quebec, to produce an upgraded slag, called UDS, containing 95% titanium dioxide (TiO₂) compared with its previous Sorelslag containing 80% TiO₂ (Industrial Minerals, 1996).

Uranium.—The previous upward trend in production of uranium oxide (U₃O₈) came to an end with a decrease of 8% compared with that of 1997. As the world's leading supplier of uranium, Canada was well placed in terms of resources, reserves, mining labor experience, and technology to maintain this position amidst increasing long-term world demand in spite of weak prices during the year. As older mines were shut down in the Elliot Lake district of Ontario, newer ones were being developed and mined in the Rabbit Lake, Key Lake, Cluff Lake, and Cigar Lake districts of Saskatchewan.

Industrial Minerals

Asbestos.—Canadian asbestos production dropped almost 32% compared with that of 1997, continuing a decrease that involved an earlier drop in output of 10% from 1996 to 1997. After Russia, Canada was the second largest producer of asbestos. Increasing concern regarding chrysotile substitutes were expected to benefit the chrysotile industry over the near to medium term. Marginal gains were expected in Latin American consumption of Canadian chrysotile, but Asia, already a significant market taking more than 50% of exports, was seen as expanding the demand for Canadian fibers. Asbestos-cement product demand was consistent as many users continued to favor this combination over substitute fibers and steel.

After a 6-year suspension of operations, the Cassiar asbestos mine in British Columbia was slated to be put back into production by the then-named Mineral Resources Corp., which aimed for a startup in July with production of 1,000 metric tons per month. At about this time, Canada appealed to the World Trade Organization concerning France's ban on asbestos imports, although France was the 9th or 10th member state in the EU to restrict or ban imports. This may have been the "straw that broke the camel's back" and in more than one direction. Canada disputed France, while within Canada, the future of asbestos production was virtually in limbo, at least at the time of the projected Cassiar startup. In December, Minroc Mines Inc., the renamed Mineral Resources Corp., was arranging financing to revive the project, with the intent to start an additional operation to recover magnesium from the asbestos mining waste.

Cement.—Production of cement increased about 3% from that of 1997, with an increase in value of production of 6%,

reflecting continued strengthening of the export market in the midst of prices that had previously been declining since 1978 (valued in 1986 dollars). Weakening of the Canadian dollar versus the U.S. dollar since the beginning of the 1990's, especially in early 1995, has made Canadian cement prices attractive to U.S. consumers across the border at a time when domestic consumption held fairly steady in the face of diminishing residential and nonresidential construction. There were signs that consumption was improving near the end of the year. Canada was usually the chief exporter of cement to the United States, except for a brief period in the 1980's when Mexico moderately exceeded Canadian shipments. The 1990 International Trade Commission ruling against dumping of cement by Mexican producers essentially removed them as competitors, leaving the field to Canada as the principal foreign source. For the immediate future, certainly, the success of Canadian cement producers seemed to be based significantly on exports to the United States and, hence, upon the prospects for U.S. economic growth. Canadian growth and construction, particularly in Ontario, the largest cement market, will play the key role in determining a balance between domestic and U.S. consumption.

Blue Circle Industries, Britain's biggest cement producer, moved into Canada with its first acquisition there, paying \$261 million for St. Mary's Cement Corp., which supplied about 25% of Ontario's needs.

Diamond.—Canada's first commercial production of diamond by BHP/Dia Met Joint Venture (Dia Met) began in October, with project construction essentially completed, including extensive support facilities, such as arctic living quarters and a powerplant. Output of the mining complex, newly named Ekati, in 1998 was 278,000 carats. Company officials reported that the quality of diamond recovered to date from the five kimberlite pipes at their Lac de Gras property, about 300 km northeast of Yellowknife, compared favorably with the best pipes in other parts of the world. The five pipes were located under lakes bearing the same names (Panda, Koala, Misery, Fox, and Leslie) and would be mined during a 30-year period. The centralized processing plant, southwest of the Koala pit, was to receive 9,000 t/d of ore during the first 9 years of operation and 18,000 t/d thereafter. The cutoff grade would be 0.01 carat. Processing was expected to involve mainly crushing, scrubbing, and dense-media separation, plus high-intensity magnetic separation, X-ray concentration, and sorting. The construction phase work force had been projected to reach 1,000 at its peak; after that about 650 workers would be employed during production. Future output was projected at 3 million to 4 million carats per year, or about 5% of the world's diamond supply. Capital investment was to be in excess of \$360 million, but observers expected that at least \$4 billion would be spent in association with the project over a period of time. As early as May, the majority interest holder in Ekati, BHP Diamonds Inc., noted that it would channel a portion of its production through DeBeers' marketing arm, the Central Selling Organization (CSO).

Meanwhile, the Rio Tinto PLC (60%) and Aber Resources Ltd. (40%) joint venture, called Diavik Diamond Mines Inc., proceeded with plans for a 2-Mt/yr operation beginning

probably in 2001 or 2002. Located about 35 km southeast of Ekati, and (like Ekati) 300 km northeast of Yellowknife, the project would mine four separate kimberlite pipes with projected production that could reach 8 million carats per year in the first years of an estimated mine life of 16 to 22 years. At least 90% of Diavik's production would be of gem quality.

More than 500 companies have been exploring for diamond, especially in the Northwest Territories, but also in Alberta, British Columbia, Labrador, Manitoba, Ontario, Quebec, and Saskatchewan. The field seemed to be narrowing somewhat as various kimberlite pipes proved disappointing upon testing. Some companies, however, persevered and progressed. Ashton Mining of Canada Inc. received tentative encouragement from the results of tests between the K-14 and K-91 kimberlites in its Buffalo Hills exploration project in north-central Alberta. In a joint venture with Caledonia Mining Corporation, BHP Minerals Canada Ltd. pressed its exploration of Caledonia's Dunvegan property about 90 km southwest of the Ekati diamond mine. Canabrava Diamond Corp. finished petrological studies on two kimberlite bodies on the company's Whitefish Lake property northeast of Wawa, Ontario.

Dia Met supported the establishment of a diamond valuation facility to be used for training, basic sorting, and valuation for Government royalty purposes in a community in the Northwest Territories. This could lead to more-skilled and detailed sorting, affording sales to qualified manufacturers in the northern region at prices, terms, and conditions similar to Dia Met's other marketing arrangements in Europe and with the CSO. In Montreal, the First Canadian Diamond Cutting Works, using artisans brought over from Belgium, became Canada's first fully integrated cutting and polishing factory with the aim of handling Canadian diamond production at lower cost than European competitors.

Graphite.—Exports of graphite and graphite products during the year amounted to about 127,000 t altogether, the greatest proportion of it going to the United States, followed by the European Union. Production was estimated to be about 45,000 t and was thought to have remained flat compared with that of 1997. Production data are not publicly disclosed because Canada has only one graphite producer. Strategic Exploration Inc. (formerly Stratmin Graphite Inc.) was the only producer of natural flake graphite in North America and was probably the world's largest producer and exporter of natural flake graphite from its Kearney, Ontario, mine. In 1994, Applied Carbon Technology (ACT) ceased production in midyear at the Kearney plant. Stratmin purchased 49.5% of ACT's shares and advised that the plant would open at such time as the graphite market "regained its strength." Given the present dominant position of Strategic Exploration, the probabilities of success for other potential graphite mines were clearly marginal.

Gypsum and Anhydrite.—Production of gypsum and anhydrite decreased by about 6% compared with that of 1997, interrupting its overall climb from 1992. Production thus far in the 1990's, however, has not equaled the 1989 output of more than 12 Mt prior to Canada's economic recession and accompanying sag in domestic construction.

Production was mostly by Canadian subsidiaries of United States and British companies, such as USG Corp. and National Gypsum Co., governed by demand for wallboard in all building categories by consumers in the United States and Canada. Nova Scotia and Newfoundland produced the bulk of Canadian gypsum, with lesser amounts from Ontario, British Columbia, and Manitoba in about that order of commodity value. Although gypsum occurs widely in Canada and the world, the high unit weight, low unit cost, and vulnerability to damage of wallboard combine to give gypsum products a relatively high place value, discouraging long-distance transportation. Instead, gypsum industries tend to develop in localities that serve developing construction requirements. As with the cement industry, gypsum production in Canada and the United States has tended to develop in populous areas on both sides of the border in localized cross-border competition rather than among all the Provinces or all the States.

Production data for anhydrite are combined with those for gypsum but make up only about 2% or 3% of the total for the two materials. Heavier than gypsum and about twice as hard, anhydrite was produced in Nova Scotia by Fundy Gypsum Co. Ltd. at Wentworth and Little Narrows Gypsum Co. Ltd. at Little Narrows.

Tusket Mining Inc. proposed opening a gypsum mine in the Murchyville-Elderbank area of Halifax County, Nova Scotia, about 60 km from Sheet Harbour. With delineated possible reserves of more than 300 Mt, the Murchyville deposit was the first significant gypsum discovery in Nova Scotia since the 1970's (Nova Scotia Department of Mineral Resources, 1996).

Potash.—Potash production increased by about 3% compared with that of 1997, totaling 9.27 Mt of K_2O equivalent, mostly from mines in Saskatchewan, but with about 8% of it coming from New Brunswick. Value of production dropped by 9.1% reflecting lower market prices, as with other mineral commodities already cited. Most Canadian potash was shipped to the United States (about 57%), Asia (about 25%), Latin America (about 10%), with the remainder going to Oceania and Western Europe. Exports to the United States have risen steadily to satisfy agricultural needs. Exports to Asia, which climbed owing to an increase in shipments to China, accounted for about one-third of all offshore exports of potash from Canada.

The Potash Company of Canada Ltd. (Potacan) had to shut down its Cloverhill underground mine, near Sussex, New Brunswick, when it experienced water inflow in 1997. Despite continuous efforts to salvage the operation for the remainder of the summer, the mine flooded in the fall and was evidently beyond saving. The mine had been producing since 1985. Potacan was jointly owned by Enterprise Miniere et Chimique of France and Kali und Salz AG of Germany. Although IMC Kalium had been studying the feasibility of converting the flooded mine to solution mining, Potash Corp. of Saskatchewan (PCS) stepped in and arranged to purchase all the outstanding shares of Potacan.

Sulfur.—Production of all forms of sulfur increased compared with that of 1997. Sulfur from smelter gases climbed by almost 5% to 838,000 t but with an accompanying drop in

value of about 2%. Output of elemental sulfur from natural gas, crude oil, and byproducts increased by about 2% to a total of 8.4 Mt but with a drop in value of more than 35% compared with that of 1997. Most or all of the smelter-gas sulfur was converted to sulfuric acid. No Canadian production was derived from Frasch mining.

With a projected 19% share, Canada maintained its position as the world's second largest producer, after the United States, of elemental sulfur and remained a leading exporter with roughly a 38% slice of world trade in sulfur.

Canada has ordered refiners to cut sulfur levels in gasoline by more than 90% during the next 6 years, more or less matching the stringent sulfur standards of California. The move would add about \$0.01 per liter to the cost of gasoline, but could force the closure of 5 of Canada's 19 refineries. Coping with some of the highest gasoline-contaminant levels of the industrialized world and facing increasing levels of summer smog in the most densely populated areas of British Columbia, Ontario, and Quebec, Environment Canada projected that the new measures will result in 2,100 fewer deaths per year as well as 7,600 fewer cases of chronic bronchitis. The refining sector was faced with a \$1.2 billion capital investment to modify the refineries and \$80 million in higher annual operating costs (Petroleum Economist, 1998).

Mineral Fuels

Coal.—Coal production reached 75.386 Mt, declining from the record high of 78.9 Mt in 1997. The total value of production was \$1.793 billion, or about 6.6% lower than that of 1997, owing partly to price declines and partly to a progressively lower conversion rate for the Canadian dollar. Overall, production was down somewhat in Nova Scotia and British Columbia, up in New Brunswick, and about even in the Alberta and Saskatchewan. Domestic coal consumption in 1997 (the latest information available) was about 56 Mt, with 49.5 t for the generation of electricity, 4.5 Mt for steelmaking, and 2 Mt for other industrial uses, mainly in the manufacture of cement.

In eastern Canada, domestic supplies of coal generally have to be augmented by imports, mostly thermal coal from the United States, putting Canada in the unusual position of being a major exporter and a major importer of coal. This paradox reflects transportation costs between mines and consumers and is one more example of the natural integration of U.S. and Canadian interests in mineral commodities; others include cement and gypsum.

Although Canada accounted for only about 2% of the world's coal production, it exported almost one-half of its production, making it the world's fourth largest exporter after Australia, the United States, and South Africa. During 1998, Canada shipped 34.2 Mt of coal to at least 20 countries; much of it went to Brazil and the Pacific Rim countries. Traditionally, more than 80% of Canadian coal exports has been coking coal, sold mostly to Japan; about 70% of Canadian thermal coal was exported to Japan and the Republic of Korea. Imports of coal into Canada during 1997 were about 13.9 Mt. Normally, the United States furnishes more than 8 Mt of this coal, and Colombia furnishes the remainder.

Natural Gas.—Canada ranked third in the world, after Russia and the United States, in output of natural gas. Increasingly, the production of natural gas has played a major role in the mineral economy of Canada and has had a palpable effect on the GDP. Gross output increased to 204 billion cubic meters from 199 billion cubic meters in 1997. Production of marketable gas was 173 billion cubic meters; marketable gas is gross production minus reinjected gas, shrinkage, and producer consumption (plant use).

About 89.4 billion cubic meters (about 3.16 trillion cubic feet) of natural gas was exported to the United States, which was roughly 10% of the U.S. supply. Gas exports to the United States were expected to increase to about 100 billion cubic feet by 2006, anticipating the increasing inability of U.S. domestic production to meet demand. At the beginning of 1999, Canada's natural gas reserves were projected to be about 1.81 trillion cubic meters (about 64 trillion cubic feet), a net decrease of 1.8% from the preceding year.

Opposition to natural gas exploration, production, and transmission has grown in recent years. Environmental groups opposed construction of proposed pipelines to feed demand in the United States, and the Rocky Mountain Ecosystem Coalition attempted to slow the expansion of natural gas exploration and production activities in northern Alberta.

Petroleum, Crude.—Production of crude oil reached a record high of 807.6 million barrels (Mbbbl), 4% higher than that of 1997 and about 38% higher than that of 10 years before, in 1988. Value of the crude produced amounted to \$8.760 billion, down a striking 27% from the value of 1997's crude production and a result of price weakness in oil markets worldwide. Canada exported 482 Mbbbl of crude to the United States in 1998.

After selling 30% of the integrated oil company Petro-Canada (PC), the Government continued with privatization by offering much or most of the other 70%, with the aim of reducing its share to perhaps 20%. PC was lauded as a model for state-owned oil company privatization and appeared to be expanding its operations after upgrading by cost cutting and restructuring. PC owned a 25% share of the immense Hibernia petroleum field offshore Newfoundland and a 25% share in the Terra Nova field adjacent to Hibernia in the Jeanne d'Arc Basin, for which PC can claim discovery. Terra Nova drilling was expected to begin in mid-1999.

The Hibernia field, beneath 75 m of water, was thought to contain 615 Mbbbl of light waxy oil. The field was being developed in a \$6.5 billion project by PC plus a consortium of companies, including Mobil Oil Canada Ltd., Chevron Canada Resources, and Murphy Oil Company Ltd., plus large subsidies from the Canadian Government. Production began in late 1997, ahead of schedule, with an output of 24,000 barrels per day (bbl/d). The offshore platform, which was put on location earlier in the year, used new and unique technical design features to resist damage by icebergs. Mobil Oil Canada, which owned 33% of the project, predicted that output may eventually increase to 180,000 bbl/d, and upped its reserve estimate for the Hibernia field to 750 Mbbbl out of about 3 billion barrels in place.

The Athabasca oil sands north of Fort McMurray, Alberta, played an increasingly important role in Canadian oil production. Output from bitumen plus synthetic crude was 215 Mbbl, or about 27% of Canada's total production. Technological development and increased operating efficiencies have steadily reduced production costs by the two major operators, Suncor Inc. and Syncrude Canada Ltd., at their sites in Alberta and northern Saskatchewan, respectively. Suncor's operating costs at the Suncor oil sands plant in Alberta dropped from \$15 per barrel in 1992 to below \$12 per barrel in 1995 and was projected to drop to \$9 per barrel in 1997. Hence, the crude from the Athabasca sands has sold for \$6 or \$7 more than the cost of production. Canada's National Energy Board predicted that the oil sands could contribute 50% of national production by 2010.

The Athabasca, Peace River, and other bitumen and heavy oil deposits in Alberta amounted to 2.5 trillion barrels of oil in place, which was about 40% of the world's known bitumen. The 300 billion barrels presently considered to be recoverable exceeded the 265-billion-barrel reserves of Saudi Arabia, but the latter can be extracted for less than \$1 per barrel. The Province of Alberta lowered its royalty on oil sand crude late in 1995, stipulating that it be 1% on all production until companies pay off capital costs and earn a return that matched interest rates for long-term bonds. They would then pay a 25% royalty on each barrel produced.

Reserves

Table 3 lists the levels of Canadian reserves of copper, gold, lead, molybdenum, nickel, silver, zinc, and other selected mineral commodities on or about January 1, 1998. Data are shown in terms of metal contained in ore for the base and precious metals or recoverable quantities of other mineral commodities, including industrial minerals and mineral fuels. These mineral reserves represent "proven" and "probable" categories and exclude quantities reported as "possible." Reserves were defined as being well-delineated and economically minable ore from mines committed to production.

Yearly changes in assessment of reserves are, in simplest terms, the arithmetic result of additions to reserve, deletions from reserves, and production. A complication in Canada is that a large number of mines are polymetallic, thus necessitating close attention to market price and processing costs for two or possibly several mineral commodities simultaneously to enable production as coproducts.

Other than for gold, reserves of major metals fell steadily from 1977 to 1998. During this period, gold reserves trebled from about 500 t to more than 1,500 t as rising prices, and the possibility of more price increases provided a strong incentive to exploration. Silver reserves, however, fell by 45% from about 31,000 to less than 17,000 t during the same period.

From 1997 to 1998, reserves of the leading base metals decreased conspicuously. The only exception was molybdenum, which increased by 3%. Other base metals declined—lead, 32%; zinc, 22%; copper, 7%; and nickel, 9%. From 1980 to 1982, the absolute high values showed a clustering at a time when successful exploration had increased rapidly and extraction had not kept pace.

Reserves of major metals were distributed unevenly throughout Canada, influenced mostly by mineralization of the Precambrian shield, the Rockies (Cordillera), and the Coast Ranges. New Brunswick had more than 50% of the lead reserves and roughly 40% of the zinc and silver. Ontario had 75% of the nickel, about 57% of the gold, and slightly less than 50% of the copper. British Columbia had 100% of the molybdenum and about 33% of the copper. Discoveries yet to be made will alter the overall reserves relation.

Infrastructure

With a total land area of about 9,221,000 km², slightly larger than the United States, Canada has networks of highly developed infrastructure, as well as vast areas of trackless wilderness. The country had 1,021,000 km of roads, comprising 358,371 km of paved highway and 662,629 km of gravel or other loose surface roads. Bulldozed temporary roads were established for mining exploration in many remote places, but these deteriorate readily where not maintained.

A total of 72,963 km of railroads included two main systems, the Canadian National and the Canadian Pacific. The country also had about 3,000 km of inland waterways, including the St. Lawrence Seaway, one of the busiest in the world, leading into the Great Lakes and marking the boundary with the United States in many places. Principal ports were, on the east coast, Halifax, Montreal, Quebec, St. John (New Brunswick), St. John's (Newfoundland), Toronto and, on the west coast, Vancouver. Canada's merchant marine comprised about 75 ships of 1,000 or more gross registered tons.

The country had 1,393 airports. Among these, 515 had permanent-surface runways—17 had runways longer than 3,047 m, 16 had runways from 2,438 to 3,047 m long, and 149 had runways from 1,524 to 2,437 m long. Civil aviation included about 636 major transport aircraft, with Air Canada as the major carrier.

Canada generated electrical power from coal, natural gas, and nuclear fuels, as well as massive hydroelectric facilities. Total capacity was roughly 114 gigawatts. About 535 net terawatt hours, significantly less than capacity, was produced in 1995, the last year for which complete data are available. More than 62% of Canada's electricity was generated by hydroelectric plants; about 17%, nuclear reactors; 15%, coal; and 6%, oil and gas. Quebec and Ontario produced the most electricity, 154 and 141 megawatt hours, respectively. Nearly 97% of Quebec's electricity came from hydroelectric plants, with the remaining 3% produced mainly by nuclear facilities. In contrast, about 61% of Ontario's electric power was derived from nuclear plants, with the remainder from hydroelectric and coal-fired plants. The majority of Canada's electricity exports originated in the eastern Provinces of New Brunswick, Ontario, and Quebec, and were sold to consumers in New England and New York. The western Provinces of British Columbia and Manitoba also exported large amounts of electricity, mainly to California, Minnesota, Oregon, and Washington. Except for Alberta, all Canadian Provinces bordering the United States had transmission links to the neighboring systems. Canadian electricity exports to the United States surged in late 1993 and early 1994, largely as the result of favorable hydrological

conditions. In November 1994, Quebec announced cancellation of the controversial \$10 billion Great Whale hydroelectric power project. Under discussion since the mid-1970's, Great Whale was dealt a severe setback when New York's Power Authority, a major Hydro-Quebec customer, announced cancellation of a \$5 billion power contract, citing environmental concerns and decreased power needs.

An extensive system of pipelines connected oil- and gas-producing (mostly western Canada) and consuming areas, mostly central and eastern Canada and the United States. This system was dominated by the Interprovincial Pipe Line, which delivered oil from Edmonton east to Montreal, Quebec, and the U.S. Great Lakes region, and the TransMountain Pipe Line, which delivered oil mainly from Alberta west to refineries and terminals in the Vancouver area, as well as to the Puget Sound area of Washington. Canadian natural gas was transported largely by TransCanada PipeLines Ltd. of Calgary, which owned 13,600 km of mainline gas pipelines in Canada, as well as 56 compressor stations, linking western Canadian gas producers with consumers in eastern Canada and the United States. Total Canadian pipeline network included about 25,000 km for crude oil and refined products and 75,000 km for transmission of natural gas. Alberta's network represented the greatest length for any Province.

Outlook

After having been influenced by various economic factors in 1998, Canada's mineral industry faced near-term problems in the midst of longer term promise. Canada's dollar weakened further against the U.S. dollar, presumably helping exports but discouraging imports of certain necessary commodities, specialized equipment, and ad hoc professional expertise. Increased exports boded well for credit markets, but equity markets still suffered in the wake of the Bre-X scandal. Although Canadian Provincial and Federal Securities Commissions developed new rules governing public offerings, junior mining companies found themselves subjected to virtually paranoid scrutiny, and not without reason. Demand for base metals in world markets was weakened, at least in part, by Asian economic problems; prices were soft at a critical time for many companies, whether starting up or expanding; and relief was not in sight. Low prices jeopardized two of Canada's mainstay metals, gold and nickel, enough to cause (or threaten) sizable bankruptcies. A price was being paid by Canada, as well as some other major mining countries, for uncertainties in the formation of the EU banking system (particularly its large-scale gold selling) to complicate the Asian effect further.

On the plus side, the Canadian petroleum industry grew further. Exploration and production reached new levels of activity, and Canada became an expanding exporter to the United States of crude, natural gas, and refinery products. After years of doubts concerning the feasibility of the Hibernia offshore oil project, it began production with the promise of rich payoffs to come; comparisons continue to be heard between the Canadian offshore and the development of the now-legendary North Sea fields.

The nickel-copper-cobalt discovery at Voisey's Bay made an impressive case for more exploration in Canada, no matter how

attractive the situation in Latin America, Asia, or Australia. Furthermore, new prospects were found for gold in many parts of Canada, even though current market pricing promises little encouragement for the near future.

The concerted effort to reconcile conflicting interests in the formulation of policy concerning ownership, aboriginal issues, mining development, environmental constraints and remediation, social instabilities, and economic necessity in furthering the concept of sustainable development has been difficult to assess or predict. Active engagement of these issues will probably help provide outcomes that would support the future of the mining industry.

Canada is well positioned in terms of its mineral-resource base and its access to markets in the United States and the rest of the world. Its mineral industry is primarily export oriented with as much as 90% of the production of some commodities going to foreign purchasers. The United States will probably continue to be a major market for Canada's metals and minerals. In this regard, the industry's export capability is enhanced significantly by a lower exchange rate for the Canadian dollar.

Some issues facing Canada's mineral industry remain complex. Many of them are international in nature and may lie beyond Canada's direct industrial or market influence. No country can escape the realities of growing international competition, especially from mineral-rich developing countries that have liberalized economic and political systems to attract foreign investment. But Canada's greatest long-term asset may be its achievement of a popular consensus in support of sustainable development.

References Cited

- Chemical Week, 1998, Canada rescinds MMT restrictions: Chemical Week, v. 160, no. 28, p. 11.
- Early Economic Outlook, 1999, Canada—Needs less unemployment and restrained inflation: Foundation for International Business and Economic Research, Inc., June 1, 2 p.
- Engineering and Mining Journal, 1997, Voisey's Bay delayed for at least one year: Engineering and Mining Journal, v. 198, no. 11, November, p. ww-13.
- Financial Times, 1998, Inco and Newfoundland in stand-off over Voisey's Bay: Financial Times [London], August 19, p. 24.
- 1999, N-plants' closure harms air in Ontario: Financial Times [London], May 7, p. 4.
- Industrial Minerals, 1996, New upgraded Ti-slag plant for QIT: Industrial Minerals, no. 342, March, p. 9.
- Journal of Commerce, 1998, Mining firms blast Canadian tax proposals: Journal of Commerce, May 27, p. 12A.
- Metal Bulletin Monthly, 1998, Alcan's Alma smelter takes shape: Metal Bulletin Monthly [London], no. 336, December, p. 66.
- Mining Journal, 1997a, Lac de Gras revision: Mining Journal [London], v. 328, no. 8416, February 14, p. 130.
- 1997b, Voisey's Bay to take 18 months: Mining Journal [London], v. 329, no. 8459, December 12, p. 487.
- 1998a, An integrated approach: Mining Journal [London], v. 331, no. 8497, September 11, p. 202.
- 1998b, Cars fuel magnesium demand—Canadian initiative: Mining Journal [London], v. 331, no. 8500, October 2, p. 258.
- 1998c, Positive stance at the PDAC: Mining Journal [London], v. 330, no. 8473, March 20, p. 227.
- 1999, Trends in Canadian exploration: Mining Journal [London], v. 332, no. 8522, March 12, p. 179.
- Natural Resources Canada, 1996, The minerals and metals policy of the Government of Canada—Partnerships for sustainable development: Natural Resources Canada, Minerals and Metals Sector, p. 1-25.
- Northern Miner, 1998a, HBM&S launches program at Chisel North zinc deposit: Northern Miner, v. 84, no. 26, August 17, p. 1.

—1998b, Inmet suspends drilling at Winston Lake: *Northern Miner*, v. 84, no. 42, December 14, p. 1.
 Nova Scotia Department of Mineral Resources, 1996, The Murchyville gypsum deposit—Thirty years of geological surveys point the way: Department of Natural Resources Nova Scotia Minerals Update, v. 10, Fall, p. 1.
Petroleum Economist, 1998, Canada—Sulphur cuts hurt refiners, help humans: *Petroleum Economist*, v. 65, no. 11, November, p. 36.
 Southam Mining Publications Group, 1998, Canadian mines handbook 1998-99: Southam Mining Publications Group, August, p. 496-529.
 U.S. Embassy, Ottawa, Canada, 1997, Climate change—Canada's commitment under the Kyoto protocols gets mostly negative domestic reviews: Incoming State Department cable 3492126, U.S. Department of State, December 15, 3 p.
Wall Street Journal, 1998, Canadian copper mine to close down: *Wall Street Journal*, March 13, p. A10.

Major Sources of Information

Natural Resources Canada

580 Booth St.
 Ottawa, Ontario K1A 0E4
 Canada
 Minerals and Metals Sector
 Earth Sciences Sector
 Canada Centre for Mineral and Energy Technology
 (CANMET)
 Geological Survey of Canada
 601 Booth St.
 Ottawa, Ontario K1A 0E4

Statistics Canada

Tunney's Pasture
 Ottawa, Ontario K1A 0T6
 Canada

Indian and Northern Affairs Canada

Terrasses de la Chaudiere
 10 Wellington St., North Tower
 Ottawa, Ontario K1A 0H4
 Canada

Environment Canada

Terrasses de la Chaudiere
 27th Floor
 10 Wellington St.
 Ottawa, Ontario K1A 0H3
 Canada

The Mining Association of Canada

1105-350 Sparks St.
 Ottawa, Ontario K1R 7S8
 Canada

Provincial Sources

Ministry of Energy, Mines, and Petroleum Resources

Parliament Buildings
 Victoria, British Columbia V8V 1X4
 Canada

Department of Energy

Petroleum Plaza, North Tower, 9945 108 St.
 Edmonton, Alberta T5K 2G6
 Canada

Department of Energy and Mines

Room 306, Legislative Building
 Regina, Saskatchewan S4S 0B3
 Canada

Administration of Mining Lands

Toronto-Dominion Bank Building

1914 Hamilton St.
 Regina, Saskatchewan S4P 4V4
 Canada

Department of Energy and Mines

Room 301, Legislative Building
 Winnipeg, Manitoba R3C 0V8
 Canada

Ministry of Northern Development and Mines

10 Wellesley St. East
 Toronto, Ontario M4Y 1G2
 Canada

Ministry of Natural Resources

Mines and Minerals Division:
 Mineral Development and Lands Branch
 Ontario Geological Survey
 Southern Ontario Region
 Northeastern Region
 Northwestern Region

Ministere des Ressources Naturelles

5700, 4^e Avenue Ouest, 3^e Etage
 Charlesbourg (Quebec) G1H 6R1
 Canada

Department of Natural Resources and Energy

Minerals and Energy Division
 Hugh John Flemming Forestry Centre
 Fredericton, New Brunswick E3B 5H1
 Canada

Mines and Minerals Division:

Geological Surveys Branch
 Mineral Development Branch
 Planning and Administration Branch
 Energy Branch

Department of Mines and Energy

1701 Hollis St.
 P.O. Box 1087
 Halifax, Nova Scotia B3J 2X1
 Canada

Department of Energy and Forestry

P.O. Box 2000
 Charlottetown, Prince Edward Island C1A 7N8
 Canada

Newfoundland Department of Mines and Energy

P.O. Box 8700
 St. John's, Newfoundland A1B 4J6
 Canada

Northwest Territories Chamber of Mines

P.O. Box 2818
 Yellowknife, Northwest Territories X1A 2R1
 Canada

Yukon Chamber of Mines

P.O. Box 4427
 Whitehorse, Yukon Territory Y1A 2B7
 Canada

British Columbia and Yukon Chamber of Mines

840 West Hastings St.
 Vancouver, British Columbia V6C 1C8
 Canada

Chamber of Mines of Eastern British Columbia

215 Hall St.
Nelson, British Columbia V1L 5X4
Canada

Mining Association of British Columbia
P.O. Box 12540, 860, 1066 West Hastings St.
Vancouver, British Columbia V6E 3X1
Canada

Alberta Chamber of Resources
1410 Oxford Tower, 10235 101 St.
Edmonton, Alberta T5J 3G1
Canada

Saskatchewan Mining Association Inc.
1740 Avord Tower
Regina, Saskatchewan S4P 0R7
Canada

The Mining Association of Manitoba
700-305 Broadway
Winnipeg, Manitoba R3C 3J7
Canada

Ontario Mining Association
1114-111 Richmond Street West
Toronto, Ontario M5H 2G4
Canada

Quebec Asbestos Mining Association
410-1140 Sherbrooke St. West,
Montreal, Quebec H3A 2M8
Canada

Quebec Mining Association Inc.
942-2635 Boulevard
Hochelaga, Ste. Foy
Quebec G1V 4W2
Canada

The New Brunswick Mining Association
Suite 312-236 St. George St.
Moncton, New Brunswick E1C 1W1
Canada

Chamber of Mineral Resources of Nova Scotia
202-5525 Artillery Place
Halifax, Nova Scotia NS B3J 1J2
Canada

Major Publications

Canadian Geoscience Council, annual report.
Canadian Institute of Mining and Metallurgy, Bulletin, 10
issues per year.
Canadian Mineral Analysts, monthly.
Canadian Mining Journal, Canada's Top Mining Companies, 6
issues per year.
Natural Resources Canada:
Canadian Minerals Yearbook, annual.

Canadian Mineral Industry Reports, monthly.
Canada's Mining Industry—Current Situation,
February-March 1995.
Minerals and Metals Policy of the Government of
Canada—Partnerships for sustainable development, 1996.
Mineral Policy Sector, Canadian Minerals, annual.
Mining and Mineral Processing Operations in Canada,
Annual Mineral Bulletin.
Production of Canada's Leading Minerals, monthly.
Geological Association of Canada, Geoscience Canada,
quarterly.
Indian and Northern Affairs Canada, Mines and Mineral
Activities, annual.
Industrial Minerals [London], monthly: Industrial Minerals
Information Ltd.
International Mining of London, Canadian Mining, monthly.
The Journal of Commerce (U.S.) newspaper, weekdays.
L'Industrie Minière du Québec, annual.
Metal Industry, Trends and Outlook, monthly.
Mining Journal Ltd., London, Mineral Markets and Mining
Finance, monthly.
Mining Journal Ltd., London, Mining Journal, weekly.
Northern Miner Press Inc.:
Canadian Mines Handbook, annual.
Canadian Oil & Gas Handbook, annual.
The Northern Miner, weekly.
PennWell Publishing Co.:
Natural Gas Industry Directory, annual.
Oil & Gas Journal, Worldwide Report, monthly.
International Petroleum Encyclopedia, 1995.
Production et Investissements de l'Industrie Minière du
Québec—Statistiques, annual.
Prospectors and Developers Association of Canada, quarterly
“In Brief;” also annual “Exploration and Development
Highlights.”
Québec Prospectors Association, monthly.
Repertoire des Etablissements Menant des Operations Minières
Au Québec, annual.
Rock Products Register, annual: Intertec Publishing, Chicago,
Illinois.
Statistics Canada:
Coal and Coke Statistics, monthly.
Crude Petroleum and Natural Gas Production, monthly.
International Trade Division, Imports by Commodity, yearly;
Exports: Trade Merchandise, yearly.
U.S. Embassy, Ottawa:
Periodic Economic and Industrial Outlook reporting.
United Nations, Energy Statistics Yearbook, annual.
The Wall Street Journal, newspaper, daily.
Information Respecting Securities Laws.
Corporate Annual Reports of individual mining companies.

TABLE 1
CANADA: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
METALS					
Aluminum:					
Alumina, gross weight	1,170	1,064	1,060	1,165	1,229
Primary, metal	2,250,000	2,171,992	2,283,210	2,327,188	2,374,118
Antimony 3/	643	684	1,773	630 r/	660
Arsenic trioxide e/	250	250	250	250	250
Bismuth 3/	129	187	150	230 r/	256
Cadmium:					
Mine output, Cd content 3/	1,500	1,942	1,771	1,471 r/	1,600
Metal, refined	2,173	2,349	2,433	2,260 r/	2,067
Calcium	W	W	W	W	W
Cobalt:					
Mine output, Co content 3/	4,265	5,339	5,714	5,709 r/	6,039
Metal:					
Shipments 4/	1,846	2,016	2,150	2,168 r/	2,324
Refined, including oxide	2,950	3,269	3,601	3,792 r/	4,357
Columbium and tantalum:					
Pyrochlore concentrate:					
Gross weight	5,130	5,230	5,160	5,090	5,110
Cb content	2,310	2,350 r/	2,320	2,290	2,300
Tantalite concentrate:					
Gross weight	144	130	220	196 r/	244
Ta content	36	33	55	49 r/	61
Cb content	7	7	11	10 r/	12
Copper:					
Mine output, Cu content 3/	614,476	723,693	685,926	659,500 r/	703,245
Electrowon	2,300	2,600	2,500	2,700	1,800
Total	616,776	726,293	688,426	662,200 r/	705,045
Metal:					
Smelter:					
Primary, blister	515,088	522,761	529,349	529,525 r/	553,133
Secondary and scrap	45,445	90,929	83,344	96,957	71,338
Total	560,533	613,690	612,693	626,482 r/	624,471
Refined:					
Primary	549,869	479,100	477,500	464,000 r/	489,941
Secondary	45,000	93,500	81,700	99,300 r/	72,635
Total	594,869	572,600	559,200	563,300 r/	562,576
Gold, mine output	146,428	152,032	166,378	171,376 r/	165,911
Iron and steel:					
Ore and concentrate:					
Gross weight	37,703	38,560	34,400	37,277 r/	38,875
Fe content	24,235	24,561	21,911	24,914 r/	25,541
Metal:					
Pig iron	8,106	8,464	8,638	8,679	9,140 p/
Direct reduced iron	770	1,010	1,420	1,391	1,240
Ferroalloys, electric arc furnace: e/					
Ferrosilicon	55	56	56	56	56
Silicon metal	20	22	22	22	22
Ferrovandium	2	1	1	1	11
Total	77	79	79	79	79
Crude steel	13,897	14,415	14,735	15,554	15,800
Lead:					
Mine output, Pb content	167,584	210,826	257,253	186,234 r/	189,297
Metal, refined:					
Primary	153,035	178,019	192,877	139,736 r/	140,585
Secondary	98,605	103,372	117,914	131,659 r/	124,441
Total	251,640	281,391	310,791	271,395 r/	265,026
Lithium: Spodumene e/	20,000	21,000	22,000	22,500	22,500
Magnesium metal, primary e/	28,900	41,900	54,000	57,700	77,109
Molybdenum, mine output, Mo content	9,188	9,522	8,097	8,223 r/	8,592
Nickel:					
Mine output, Ni content 3/	149,886	181,820	192,649	190,529	208,201

See footnotes at end of table.

TABLE 1--Continued
CANADA: PRODUCTION OF MINERAL COMMODITIES 1/2/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
METALS -- Continued					
Nickel--Continued:					
Refined 5/	105,144	125,311	130,136	131,639	146,715
Platinum-group metals, mine output kilograms	14,313	16,068	14,668	12,459 r/	15,287
Selenium, refined 6/ do.	566,000	561,000	694,000	592,000 r/	384,000
Silver do.					
Mine output, Ag content do.	767,842	1,284,757	1,308,758	1,223,983 r/	1,178,560
Refined do.	915,128	1,040,866	1,402,983	1,322,779 r/	1,579,030
Tellurium, refined 6/ do.	42,000	102,000	59,000	59,000 r/	57,000 p/
Titanium Sorel slag 7/	764,000	815,000	825,000 e/	850,000 e/	950,000 e/
Uranium oxide (U ₃ O ₈)	11,372	12,337	13,784	14,174 r/	13,021
Zinc:					
Mine output, Zn content	1,010,712	1,121,174	1,222,388	1,076,385 r/	1,064,541
Metal, refined, primary	690,965	720,346	716,467	703,798 r/	743,170
INDUSTRIAL MINERALS					
Asbestos	531,000	524,000	506,000	455,000 r/	309,000
Barite	55,000	67,000	58,000	77,000 r/	86,000
Cement, hydraulic 8/ thousand tons	10,584	10,440	11,587	11,736	12,064
Clay and clay products 9/ value, thousands	\$120,000 e/	\$95,675	\$110,218	\$151,655	\$135,319
Diamond carats	--	--	--	--	278,431
Diatomite e/	10,000	10,000	10,000	10,000	10,000
Gemstones, amethyst and jade	1,212	459	294	394 r/	248
Gypsum and anhydrite thousand tons	8,500	8,055	8,202	9,117 r/	8,175
Lime 8/ do.	2,390	2,398	2,402	2,477 r/	2,514
Magnesite, dolomite, brucite e/	180,000	180,000	180,000	180,000	180,000
Mica, scrap and flake e/	17,500	17,500	17,500	17,500	17,500
Nepheline syenite	602,000	618,000	606,000	647,000 r/	641,000
Nitrogen, content of ammonia	3,474,000	3,773,000	3,839,600	4,081,000 r/	3,899,900
Potash, K ₂ O equivalent thousand tons	8,517	9,066	8,120	8,989 r/	9,270
Pyrite and pyrrhotite, gross weight e/	5,000	5,000	5,000	5,000	5,000
Salt thousand tons	11,700	10,875	12,248	13,534 r/	13,310
Sand and gravel do.	247,148	228,163	213,831	225,419 r/	218,421
Silica (quartz) 10/ do.	1,600 e/	1,689	1,558	1,896 r/	2,128
Sodium compounds, n.e.s.:					
Sodium carbonate (soda ash) e/ do.	300	300	300	300	300
Sodium sulfate, natural 11/ do.	317	315	323	326 r/	323
Stone 12/ do.	110,411	120,660	92,449	120,953 r/	117,741
Sulfur, byproduct:					
Metallurgy do.	870	886	789	801	838
Petroleum do.	7,980 r/	8,150 r/	8,329	8,280	8,410
Total do.	8,850	9,036	9,118 r/	9,081 r/	9,248
Talc, soapstone, pyrophyllite do.	130	108	77	73 r/	78
MINERAL FUELS AND RELATED MATERIALS					
Carbon black e/	160,000	165,000	165,000	165,000	165,000
Coal:					
Bituminous and subbituminous thousand tons	62,700	64,176	65,006	67,034	63,596
Lignite do.	10,100	10,740	10,854	11,653	11,790
Total do.	72,800	74,916	75,860	78,687	75,386
Coke, high-temperature do.	3,684	3,283	3,357	3,370	3,142
Gas, natural:					
Gross million cubic meters	183,000	192,530	198,107	199,422	204,022
Marketed do.	139,000	148,204	153,578	156,842	173,359
Natural gas liquids:					
Pentanes plus thousand 42-gallon barrels	55,900	56,450	61,832	67,439	68,370
Condensate do.	1,730	2,323	1,944	2,735	2,827
Total do.	57,630	58,773	63,776	70,174	71,197
Peat	914,000	877,000	901,000	100,100 r/	1,185
Petroleum:					
Crude 13/ thousand 42-gallon barrels	636,000	662,110	739,814	770,275	807,612

See footnotes at end of table.

TABLE 1--Continued
CANADA: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity	1994	1995	1996	1997	1998
MINERAL FUELS AND RELATED MATERIALS -- Continued					
Petroleum--Continued:					
Refinery products:					
Propane; butane; naphtha; LPG 14/ thousand 42-gallon barrels.	14,900	13,745	26,454	15,265	14,990
Gasoline:					
Aviation do.	835	846	789	726	933
Other do.	239,000	243,455	245,618	254,386	256,372
Petrochemical feedstocks do.	28,200	33,554	33,137	33,746	33,530
Jet fuel do.	26,800	29,315	32,048	33,935	34,953
Kerosene do.	2,690	5,470	18,446	3,106	1,995
Distillate fuel oil, diesel and light do.	186,000	183,597	184,738	201,737	196,511
Lubricants including grease do.	6,250	5,807	6,344	8,478	7,884
Residual fuel oil, heavy do.	44,200	41,352	41,999	47,477	50,736
Asphalt do.	20,400	20,048	19,586	24,938	26,007
Petroleum coke do.	6,660	6,961	7,416	7,122	7,207
Unspecified do.	28,100	24,271	21,144	25,114	26,489
Refinery fuel and losses 15/ do.	25,100	37,583	25,172	24,491	25,601
Total do.	629,135	646,004	662,891	680,521	683,208

e/ Estimated. p/ Preliminary. r/ Revised. W Withheld to avoid disclosing company proprietary data.

1/ Data previously published for 1993 and 1994 were rounded by the U.S. Bureau of Mines to three significant digits. With very few exceptions, data in the present table have been unrounded to their original state.

2/ Table includes data available through July 15, 1999.

3/ Metal content of concentrates produced.

4/ Cobalt content of all products derived from Canadian ores, including cobalt oxide shipped to the United Kingdom for further processing and nickel-copper-cobalt matte shipped to Norway for refining.

5/ Nickel contained in products of smelters and refineries in forms which are ready for use by consumers. Natural Resources Canada has revised all refined nickel figures to conform with International Nickel Study Group guidelines.

6/ From all sources, including imports and secondary sources. Excludes intermediate products exported for refining.

7/ Refined Sorel slag contains 80% titanium dioxide.

8/ Producers' shipments and quantities used by producers.

9/ Includes bentonite products from common clay, fire, stoneware clay, and other clays. Values are in current Canadian dollars.

10/ Producers' shipments of quartz.

11/ Excludes byproduct production from chemical plants.

12/ Crushed, building, ornamental, paving, and similar stone.

13/ Including synthetic crude (from oil shale and/or tar sands).

14/ Liquefied petroleum gas.

15/ Refinery fuel represents total reported production of still gas, including a small amount sold.

TABLE 2
CANADA: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Aluminum	Alcan Aluminum Ltd.	Smelter, Laterriere, Quebec	204.
Do.	do.	Smelter, Isle-Maligne, Quebec	73.
Do.	do.	Smelter, Beauharnois, Quebec	48.
Do.	do.	Smelter, Shawinigan, Quebec	84.
Do.	do.	Smelter, Grande-Baie, Quebec	180.
Do.	do.	Smelter, Arvida, Quebec	232.
Do.	do.	Smelter, Kitimat, British Columbia	272.
Do.	Aluminiere de Becancour Inc. (Pechiney Corp., 25%; Quebec Government, 24.95%)	Smelter, Becancour, Quebec	360.
Do.	Canadian Reynolds Metals Co. Ltd. (Reynolds Metals Co., 100%)	Smelter, Baie-Comeau, Quebec	400.
Do.	Aluminerie Alouette Inc. (Vereinigte Aluminium-Werke AG, Germany, 20%; Hoogovens Groep BP, Netherlands, 20%; Metall Aktiengesellschaft, Austria, 20%; SGF, Alunor, 20%; Marubeni, Italy, 16.3%; Kobe Steel, Japan, 3.7%)	Smelter, Sept-Iles, Quebec	218
Do.	Aluminerie Lauralco Inc. (Alumax Inc. of the U.S.)	Deschambault, Quebec	215.
Asbestos	Lac d'Amiante du Quebec, Ltee (LAQ) (Jean Dupere, President of LAB Chrysotile, Inc.; Connell Bros. Co. Ltd.)	Black Lake, Quebec	160 (fiber).
Do.	Bell Operations (Mines D'Amiante Bell)	Thetford Mines, Quebec	70 (fiber).
Do.	JM Asbestos Inc.	Jeffrey Mines, Asbestos, Quebec	250 (fiber).
Cement	Lafarge Canada Inc.	Bath, Ontario	1,045 (dry-process).
Do.	do.	Exshaw, Alberta	1,029 (dry-process).
Do.	do.	Kamloops, British Columbia	194 (dry-process).
Do.	do.	Richmond, British Columbia	474 (wet-process).
Do.	do.	St. Constant, Quebec	991 (dry-process).
Do.	do.	Brookfield, Nova Scotia	527 (dry-process).
Do.	St. Lawrence Cement Inc. (Independent Cement Inc.)	Joliette, Quebec	991 (dry-process).
Do.	do.	Mississauga, Ontario	1,876 (wet and dry).
Do.	ESSROC Canada Inc.	St. Basile, Quebec	1,124 (dry-process).
Do.	North Star Cement Ltd.	Corner Brook, Newfoundland	152 (dry-process).
Do.	Federal White Cement Ltd.	Woodstock, Ontario	170 (dry-process).
Do.	St. Mary's Cement Corp.	Bowmanville, Ontario	1,550 (dry-process).
Do.	do.	St. Marys, Ontario	645 (dry-process).
Do.	Inland Cement Ltd. (S.A. Cimenteries CBR)	Edmonton, Alberta	726 (dry-process).
Do.	Tilbury Cement Ltd. (S.A. Cimenteries CBR)	Delta, British Columbia	1,040 (dry-process).
Coal	Quinsam Coal Corp. (Hillsborough Resources Ltd., 63%; Marubeni Corp., 33%; remainder unknown, 4%)	Quinsam Coal mine, Campbell River, British Columbia	14,400 (open pit and underground).
Do.	Cape Breton Development Corp. (Government of Canada, 100%)	Sydney, Nova Scotia	22,000 (longwall).
Do.	Luscar, Ltd.	Obed Mountain Mine, Hinton, Alberta	3,500.
Do.	Gregg River Resources Ltd. (Gregg River Coal, 60%; 7 Japanese Co.'s, 40%)	Gregg River Mine, Hinton, Alberta	3,960 (open pit).
Do.	Manalta Coal Ltd. (Transalta Utilities Corp.)	Highvale Mine, Seba Beach, Alberta	11,610 (open pit).
Do.	Smoky River Coal Ltd. (Smoky River Holdings Ltd., 100%)	Grande Cache, Alberta	3,600 (open pit and underground).
Copper	Cassiar Mining Corp. (Princeton Mining Corp., 100%)	Similco Mine, Princeton, British Columbia (suspended, 1996)	9,000.
Do.	Falconbridge Ltd. (Noranda Inc. 50%; Trelleborg AB, 50%)	Sudbury operations, Sudbury, Ontario Strathcona and Timmins operations, Timmins, Ontario	4,250. 4,860.
Do.	do.	Smelter, Timmins, Ontario	440.
Do.	Gibraltar Mines Ltd.	McLease Lake, British Columbia	29.
Do.	Highland Valley Copper (Cominco, 50%; Rio Alom Ltd., 33.6%; Teck Corp., 13.9%; Highmont Mining Co., 2.5%)	Logan Lake, British Columbia	4,500.

See footnote at end of the table.

TABLE 2--Continued
CANADA: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Copper--Continued		Inco Ltd.	Thompson District, Manitoba	Variable (polymetallic).
Do.		do.	Smelter, Sudbury, Ontario	500.
Do.		do.	Refinery, Sudbury, Ontario	170.
Do.		Noranda Inc.	Smelter, Thompson, Manitoba	686 (projected).
Do.		do.	Mines Gaspé, Murdochville, Quebec	4,000 (ore).
Do.		do.	Horne Smelter, Noranda, Quebec	770.
Do.		Huckleberry Mines Ltd. (Princeton Mining Corp., 60%; Japanese consortium, 40%).	SE of Houston, British Columbia	33,000 (Cu contained).
Diamond	carats	DiaMet Minerals Ltd. (BHP Diamonds Inc., 51%; DiaMet Minerals Ltd., 29%; Charles Fipke and Stuart Blossom, 20%)	Ekati Mine, Lac de Gras region, Northwest Territories	1,350,000.
Gold		Barrick Gold Corp.	Holt-McDermott Mine, Harker Twp., Ontario	405 (ore).
Do.		do.	Bosquet Mines 1 and 2, NW Quebec	954 (ore).
Do.		do.	Macassa Mine, Teck Twp. N. Ontario	473 (ore).
Do.	kilograms	Princeton Mining Corp.	Similco Mine, Princeton, British Columbia (suspended)	450 (metal).
Do.		Echo Bay Mines Ltd.	Lupin Mine, Contwoyo Lake; Northwest Territories (suspended)	612 (ore).
Do.		Royal Oak Mines Inc.	Giant Mine, Yellowknife, Northwest Territories	407 (ore).
Do.		do.	Giant mill--tailings, Yellowknife, Northwest Territories	3,265 (ore).
Do.		do.	Pamour, Ontario	1,460 (ore).
Do.		Hemlo Gold Mines Inc. (Noranda Inc., 44.1%)	Golden Giant Mine, Hemlo, Ontario	1,080 (ore).
Do.		Placer Dome Inc.	Campbell Mine, Red Lake, Ontario	584 (ore).
Do.		do.	Detour Lake Mine, Northeast Ontario	1,278 (ore).
Do.	tons	do.	Dome Mine, South Porcupine, Ontario	9.8 (metal).
Do.		do.	Sigma Mine, Val d'Or, Quebec	730 (ore).
Do.		do.	Kiena Mine, Val d'Or, Quebec	
Do.		Teck-Corona Corp. (Teck Corp., 100%)	David Bell Mine, Hemlo, Ontario	456 (ore).
Graphite		Strategic Exploration Inc.	Kearney Lake, Ontario	W.
Gypsum		Atlantic Gypsum Resources Inc.	Fischell Brook, St. George's, Newfoundland	1,300.
Do.		Georgia-Pacific Corp.	River Denys, Sugar Camp, Nova Scotia	1,460.
Do.		Little Narrows Gypsum Co. Ltd. (USG Corp., 100%)	Little Narrows, Nova Scotia	1,640.
Do.		National Gypsum (Canada) Ltd. (Aancor Holdings Corp., 100%)	Milford, Nova Scotia	3,300.
Do.		Westroc Industries Ltd.	Windermere, British Columbia	1,170.
Iron and steel		Iron Ore Co. of Canada (Dofasco, 6.9%; North Ltd. 56.1%; Mitsubishi 25%; other, 12%).	Carol Lake, Labrador	8,800 (concentrate), 10,300 (pellets).
Do.		Quebec Cartier Mining Co. (Dofasco Inc., 50%)	Mount Wright, Quebec	16,950 (concentrate), 7,500 (acid pellets).
Do.		The Algoma Steel Corp. Ltd. (Dofasco Inc., 100%)	Sault Ste. Marie, Ontario	2,478 (pig iron), 3,135 (crude steel), 657 (sinter).
Do.		Dofasco Inc.	Hamilton, Ontario	3,642 (pig iron), 4,500 (crude steel).
Do.		Stelco, Inc.	do.	2,733 (pig iron), 7,990 (crude steel), 560 (sinter).
Do.		Wabush Mines Ltd. (Inland Steel Co., 15.1%; Acme Steel, 15.1%; Stelco Inc., 37.9%; Dofasco Inc., 24.2%; Cliffs Mining Co., 7.7%).	Wabush, Labrador, and Pointe Noire, Quebec	6,200 (concentrate).
Lead		Brunswick Mining and Smelting Corp. Ltd. (Noranda Inc., 63.3%)	No. 12 mine, Bathurst and smelter in Belledune, New Brunswick	72 (Pb contained).
Do.		Hudson Bay Mining and Smelting Co., Ltd. (Minorco, 100%)	Flin Flon and Snow Lake, Manitoba	60 (Pb-Zn contained).
Do.		Cominco Ltd. (Teck Corp. 36.34%)	Trail, British Columbia	95 (refined lead).
Do.		do.	Sullivan Mine, Kimberley, British Columbia	3,600 (ore).

See footnote at end of the table.

TABLE 2--Continued
CANADA: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Copper--Continued:		Cominco Ltd. (Teck Corp. 36.34%)	Polaris Mine, Cornwallis Island, North-west Territories	1,000 (ore).
Do.		Breakwater Resources Ltd.	Nanisivik Mine, Baffin Island, Northwest Territories	785 (ore).
Do.		Anvil Range Mining Corp.	Faro Mine, Yukon Territory	184 (Pb-Zn contained).
Limestone		Lafarge Canada Inc.	Steep Rock, Manitoba	906 (quarry).
Do.		Atlantic Industrial Minerals Inc.	Iris Cove, Sydney, Nova Scotia	720.
Do.		Inland Cement Ltd. (CBR Materials Corp.)	Cadomin, Alberta	2,160.
Do.			do.	2,160 (quarry).
Do.		Havelock Co. (Kickenson Mines Co., 100%)	Havelock, New Brunswick	864 (limestone).
Do.		Continental Lime Ltd.	Faulkner, Manitoba	1,440 (crushed stone).
Molybdenum		Huckleberry Mines Ltd. (Princeton Mines Corp., 60%; Japanese consortium, 40%)	SE of Houston, British Columbia	635 (Mo contained).
Nickel		Falconbridge Ltd. (Noranda Inc., 46.4%; underwriting syndicate, 28.3%)	Fraser, Lockerby, Onaping, and Strathcona, Sudbury district, Ontario	30 (metal contained).
Do.		do.	Raglan Mine, Ungave, Quebec	21 contained metal).
Do.		do.	Smelter, Falconbridge	45 (rated capacity).
Do.		Inco Ltd.	Sudbury, Ontario, district mines: Frood, Stobie, Creighton, Copper Cliff North and South, Garson-Offsets, McCreedy East and West, Coleman, Crean Hill, and Totten in Sudbury district, Ontario	106 (metal contained).
Do.		do.	Smelter, Sudbury, Ontario	110 (metal contained).
Do.		do.	Refinery, Sudbury, Ontario	57 (metal contained).
Do.		do.	Refinery, Port Colborne, Ontario	30 (metal contained).
Do.		do.	Thompson, Birchtree Mines in Manitoba	62 (metal contained).
Do.		do.	Smelter, Thompson, Manitoba	82 (metal contained).
Do.		Sherritt International Ltd.	Refinery, Fort Saskatchewan, Alberta	24 (metal contained).
Petroleum: 1/				
Gas	million cubic meters	BP Canada Inc. (The British Petroleum Co. PLC London, 100%)	Noel Area, North Alberta; Chauvin, Sibbald, North Pembina, Alberta	47.
Crude	million 42-gallon barrels	do.	do.	12.
Do.	do.	Gulf Canada Corp. (Olympia & York Developments, 80%; Gulf, 20%)	Fenn-Big Valley, Swan Hills, Goose River, Peerless, and Sene, Alberta	18.
Do.	do.	Home Oil Co. Ltd. (Interhome Energy Inc., 100%)	Red Earth, Garrington, Cherhill, Medicine River, and Swan Hills, Alberta	11.5.
Gas	billion cubic meters	do.	do.	1.8.
Crude	thousand 42-gallon barrels	Imperial Oil Ltd. (Exxon Corp., USA, 70%; others, 30%)	Judy Creek, Cold Lake, Alberta, Mackenzie Delta, Beaufort Sea, Yukon and Northwest Territories	670.
Gas	million cubic meters	do.	do.	36.4.
Crude	million 42-gallon barrels	Mobil Oil Canada Ltd. (Mobil Corp., United States, 100%)	Hibernia, Grand Banks, Southeast of Newfoundland and Sable Island, Nova Scotia, and others in Alberta	26.1.
Gas	billion cubic meters	do.	do.	3.0.
Crude	million 42-gallon barrels	Norcen Energy Resources Ltd. (Hollinger Inc., 59%; Hees International, 41%)	Pembina, Bodo, Majorville, Alberta	12.1.
Do.	do.	Oakwood Petroleum Ltd. (Sceptre Resources Ltd., 100%)	Grantham, Hays Ronalane, Peace River, Normandville, Randell, Alberta, and Grizzly Valley, British Columbia	24.6.
Do.	million 42-gallon barrels	PanCanadian Petroleum Ltd. (Canadian Pacific Enterprises, 87%; others, 13%)	Rycroft, Wembley, Elk Point, Rio Bravo, Alberta	19.7.
Gas	billion cubic meters	do.	do.	3.53.
Crude	million 42-gallon barrels	Shell Canada Ltd. (Shell Investments, 79%; others, 21%)	Dimsdale, Little Smoky Lake, Sousa, Alberta, Midale, Benson, Saskatchewan	22.2.
Gas	billion cubic meters	do.	do.	6.53.
Crude	million 42-gallon barrels	Suncor Inc. (Sun Co. Inc., United States, 75%; Ontario Energy Resources, 25%)	Kidney, Zama Lake, Cosway, Albersun Prevo, and Medicine River, Alberta, and Leitchville, Unwin, Saskatchewan	4.1.
Do.	thousand 42-gallon barrels	Texaco Canada Petroleum Inc. (Texaco Inc., United States, 78%; others, 22%)	Eaglesham, Virgo, Alberta, and Desan, British Columbia	158.
Gas	million cubic meters	do.	do.	67.3.

See footnote at end of the table.

TABLE 2--Continued
CANADA: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity	
Petroleum--Continued:				
Crude	million 42-gallon barrels	UNOCAL Canada Ltd. (UNOCAL Corp., United States, 100%)	Calgary, Alberta	14.7.
Potash (K ₂ O equivalent):	Potash Corp. of Saskatchewan Inc. (private, 37%; Provincial government, 63%)	Lanigan, near Lanigan, Saskatchewan	3,828 (KCl).	
Do.	do.	Rocanville, southeast Saskatchewan	2,295 (KCl).	
Do.	do.	Allan Division, Allan, Saskatchewan	5,256 (KCl).	
Do.	International Minerals & Chemical Corp. (Canada) Ltd. (IMC Fertilizer Corp., 100%)	Esterhazy, southeast Saskatchewan	951 (KCl).	
Do.	Agrium Products Inc.	Vanscoy, Saskatchewan	1,750 (KCl).	
Salt and brine operations	The Canadian Salt Co.	Pugwash, Nova Scotia	1,400 (rock salt and brine salt).	
Do.	do.	Iles-de-la-Madeleine, Quebec	1,625 (rock salt).	
Do.	do.	Ojibway, Ontario	2,600 (rock salt).	
Silver	Prime Resources Group Inc.	Eskay Creek Mine, British Columbia	340.	
Do.	Breakwater Resources Ltd.	Caribou Mine, Bathurst, New Brunswick	7.5.	
Do.	Faro Mine (Anvil Range Mining Corp. 100%)	Yukon Territory (on suspension)	4,745 (Pb-Zn-Ag-Au mill feed).	
Do.	Kinross Gold Corp.	Macassa Mine, Ontario	438 (mill feed).	
Do.	Barrick Gold Corp.	Bousquet Mine, Quebec	876 (mill feed).	
Do.	Similco Mines Ltd.	Princeton, British Columbia (on suspension)	8,250 (Ag-Au-Cu concentrate).	
Sodium chlorate production using salt	Dow Chemical Canada Inc. (The Dow Chemical Co. Michigan, United States, 100%)	Fort Saskatchewan, Alberta	524 (caustic soda).	
Do.	do.	Sarnia, Ontario	350 (caustic soda).	
Do.	General Chemical Canada Ltd.	Amherstburg, Ontario	363 (sodium carbonate).	
Sulfur:				
Petroleum refinery capacities	Consumer's Cooperative Refineries Ltd. (Federated Cooperatives Ltd., 100%)	Regina, Saskatchewan	54.	
Do.	Esso Petroleum Canada	Sarnia, Ontario	50.	
Do.	Sulconam Inc. (Petro Canada, 7.6%)	Montreal, Quebec	108.	
Main sulfur extraction plants (sour gas and oil sands)	Amoco Canada Petroleum Co., Ltd. (Amoco Corp. USA, 100%)	East Crossfield-Elkton, Alberta	650.	
Do.	Canadian Occidental Petroleum, Ltd.	East Calgary-Crossfield, Alberta	610.	
Do.	Chevron Canada Resources Ltd. (Chevron Corp. USA, 100%)	Kaybob South III, Alberta	1,281.	
Do.	Husky Oil Ltd.	Ram River, Ricinus, Alberta	1,646.	
Do.	Shell Canada Ltd.	Waterton, Alberta	1,120.	
Principal SO ₂ and H ₂ SO ₄ production capacities	Canadian Electro Zinc Ltd. (CEZ) (Noranda Inc., 90.17%)	Valleyfield, Quebec	430 (H ₂ SO ₄).	
Do.	Inco Ltd.	Copper Cliff, Ontario	950 (H ₂ SO ₄).	
Do.	Falconbridge Ltd. (Noranda Inc., 50%; Trelleborg AB, 50%)	Kidd Creek, Ontario	690 (H ₂ SO ₄).	
Do.	ESSO Chemical Canada (Imperial Oil, Ltd., 100%)	Redwater, Alberta	910 (H ₂ SO ₄).	
Uranium	Cogema Resources Inc.	Cluff Lake, Saskatchewan	1,815 (metal).	
Do.	Cameco Corp.	Key Lake, Saskatchewan	6,395 (oxide).	
Do.		Rabbit Lake, Saskatchewan	5,445 (oxide).	
Zinc	Breakwater Resources Ltd.	Nanisivik Mine, Baffin Island	53 (Zn contained).	
Do.	Brunswick Mining and Smelting Corp. Ltd. (Noranda Inc., 100%)	Bathurst, New Brunswick	232 (Zn in concentrate).	
Do.	Falconbridge Ltd. (Noranda Inc., 49.9%)	Timmins operations, Ontario	212 (Pb-Zn contained).	
Do.	do.	Smelter, Timmins, Ontario	133 (slab zinc).	
Do.	Hudson Bay Mining and Smelting Co., Ltd. (Minorco, 100%)	Snow Lake concentrator, Manitoba	1,125 (Pb-Zn ore).	
Do.	do.	Flin Flon Mine and smelter, Manitoba	85 (slab zinc).	
Do.	Cominco Ltd. (Teck Corp, 36.34%)	Sullivan Mine, Kimberley, Brit. Columbia	70 (Pb-Zn contained).	
Do.	do.	Smelter, Trail, British Columbia	300 (slab zinc).	
Do.	Anvil Range Mining Corp. (100%)	Faro Mine, Yukon Territory (suspended)	184 (Pb-Zn contained).	

W Withheld to avoid disclosing company proprietary data.

1/ Projections of annual capacity involve matching decline curves against later discoveries and are generalized extrapolations only, based on data presented in Canadian Oil and Gas Handbook, 1991 and subsequent years. Ownership of various companies and proportionate participation in various leaseblocks and/or joint venture changes continually. The ownership proportions shown here must be considered to be illustrative only.

TABLE 3
CANADA: RESERVES OF MAJOR MINERALS IN 1998

(Thousand metric tons unless otherwise specified) 1/

Commodity	Reserves
Asbestos, fiber	36,000 e/
Coal, all types	6,290,000 e/
Copper	9,032
Gold	1,510 2/
	metric tons
Gypsum	492,000 e/
Iron ore	1,295,000 e/
Lead	2,344
Molybdenum	149
Natural gas	1,900 e/
	billion cubic meters
Nickel	5,122
Petroleum crude	3,650 e/
	million barrels
Potash, K ₂ O equivalent	14,000 e/
	million tons
Salt	305,000 e/
	thousand short tons
Silver	16,697
	metric tons
Sodium sulfate	90,000 e/
	thousand short tons
Sulfur	140,000 e/
Uranium	425 3/
Zinc	10,600

e/ Estimated.

1/ In 1997 and 1998 Canadian Minerals Yearbook, Natural Resources Canada, except for natural gas and petroleum crude.

2/ Excludes metal in placer deposits.

3/ Recoverable at prices of \$100 per kilogram or less of Uranium.