

THE MINERAL INDUSTRY OF

CANADA

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For the most part, Canadian mining changed for the better in 1999 despite such concerns as the global competition for exploration funds and the continuing expenditure of exploration monies outside of the country by major Canadian mining companies. Mine output of base and precious metals increased compared with that of 1998; the decline in world metals prices from 1997 through yearend 1998 had led to a decrease in Canadian mine output of those metals that was partially compensated by greater production of industrial minerals and the structural mineral (building) materials.

Canada's economy strengthened significantly in the fourth quarter of 1998 and performed well all through 1999. Unemployment fell to a long-time low of 6.8% at the end of 1999 and the gross domestic product (GDP) for the year was \$638.95 billion,¹ which was up 5.3% from that of 1998, whose GDP, in turn, was up about 3% from that of 1997. Overall, Canada's economic picture for 1999 showed the country as a whole to have been doing well, but the mining industry was not keeping up.

The world overcapacity and oversupply in metals production which saw metals prices hit bottom in early 1999, resulted in many mine closures in Canada,² as well as the withdrawal of investment capital for new mines and mine expansions. Gradually, after the cutting of production, market metals prices began to climb in February and March. Prices for aluminum, copper, lead, nickel, and zinc began to redefine a justification for production. Prices for precious metals, especially gold, however, which remained in the doldrums, responded to an entirely different regimen of supply and demand that was influenced greatly by the actions of central banks in the European Union (EU), with consequences for gold mines throughout the world.

Overall exploration spending for Canada dropped to about \$337 million in 1999 from \$518 million in 1998, or about 35%. Although this decrease was fairly general in all the Provinces, it was particularly conspicuous in the Northwest Territories, Ontario, and Quebec, which together accounted for about 60% of exploration expenditures for the entire country. Canada's senior mining companies, however, continued to spend 80% of

their exploration monies outside of Canada and 20% in Canada, much to the chagrin of the geophysical companies, drilling contractors, helicopter companies, professional geologists and engineers, outfitters, and hotel services, all of which contribute to the country's economy.

According to predictions for the forthcoming year, metals exploration outlays would be flat or decline, and outlays in the search for diamond would increase by as much as 28%. 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 became a factor in world diamond markets for the first time.

A big newsmaker in the Canadian mining industry continued to be Inco Ltd.'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. Development has been delayed again as the result of a dispute with the Provincial Government of Newfoundland, which refused to revoke its demand that the ore smelting and refining be performed in that Province rather than elsewhere (Financial Times, 1998); since 1997, First Nation (aboriginal peoples) interests, environmental issues, and low nickel prices have caused delays. 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.

Financings of junior mining companies became more difficult to negotiate, and not only in Canada, as a result of the Bre-X Minerals Ltd. fraud in Kalimantan, Indonesia, in which drill-core samples from its Busang property were salted with gold in 1997. Various exchanges, particularly the Toronto Exchange, promulgated new requirements for the 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 foreign investment was welcomed, mining laws were coherent and reasonable, and profits could be repatriated.

Mineral exploration search criteria seem to have become increasingly subject to legal and sociological influences in much of Canada. Land use, which had never been given much attention in the past, has become an issue. First Nation rights were receiving long-awaited consideration. The antimining lobby in Canada was hardy enough that many of mining's supporters were urging that the industry be more vocal in defending its interests (Mining Journal, 1998b). Canada's Minister of Natural Resources stated that Federal and Provincial Governments were working on legislative reforms that should

¹Where necessary, values have been converted from Canadian dollars (CAN\$) to U.S. dollars at an average rate of CAN\$1.486=US\$1.00 for 1999. 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 Yearbook for 1998 and 1999, 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. Please note that 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.

afford an improved regulatory climate.

Government Policies and Programs

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, although 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 the research and information services that relate to the mining industry. The Federal Government had negotiated multiyear Mineral Development Agreements, which fund initiatives intended to strengthen the mining industry in each region, with Provincial Governments. Although new environmental assessment legislation was passed in 1992, the Federal 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 has prompted industry representatives to urge changes in the regulation and taxation of the mining industry.

In a far-reaching revision of territorial jurisdictions, the Government of Canada designated a huge piece of land carved out of the Northwest Territories as the newly created Nunavut Territory to exist as the self-governing homeland of the Inuit peoples, who are the aboriginal groups that predate the European discovery of the New World. The new Territory includes about one-fifth of the landmass of Canada and includes Baffin Island, Ellesmere Island, and the Queen Elizabeth Islands. Its southernmost boundary is the northern boundary of Manitoba, and the Territory's northernmost boundary extends slightly north of the northern coast of Greenland. Although Nunavut will depend on the Federal Government for 90% of its budget of almost \$400 million, a modest private sector included mining, retail sales, and transportation (Wall Street Journal, 1999a). Exploration for metals and petroleum has tended to move north in recent years into what is now Nunavut and has resulted in Baffin Island's Nanisivik lead-zinc mine, which was owned by Breakwater Resources Ltd., 750 kilometers (km) north of the Arctic Circle. The Inuit have been generally receptive to mining proposals as a way of bringing more business and employment into their region.

The Toronto Stock Exchange's Mining Standards Task Force recommended a number of regulatory changes designed to preserve Canada's preeminent position in world mining exploration, development, and financing. The task force's report aimed at setting new and higher standards for professional performance and standards for disclosure by exploration and mining companies. The report introduced the concept of the qualified person (QP), whereby the QP is responsible for scientific and technical matters, which included not only exploration, development, and mining matters, but also quality-control standards for analytical laboratories, requirements for technical reports, professional supervision,

corporate governance practices, regulatory oversight of the mining industry, and enforcement of securities laws. It also proposed higher disclosure standards for exploration results, and reporting of resource and reserve estimates, news releases, issues that affect land tenure, and reporting of production costs (Engineering & Mining Journal, 1999). The task force report was exhaustive and detailed and was possibly the only good thing to result from the Bre-X scandal in which so many investors lost heavily.

Environmental Issues

The Canadian Mining Association noted that for the first time, the 5-year-old Canadian Environmental Assessment Act (CEAA) for the first time put several Federal departments in a position to review mining activity, a purview previously limited to provincial jurisdiction. The CEAA includes many provisions that bring Federal agencies into the review process to evaluate impacts on area fisheries and navigable rivers, or where explosions or public works are involved. In that any mining operation is virtually certain to affect at least one of these considerations, the Federal Government is now involved in any significant mining project. Because of overlapping Federal jurisdictions, investors no longer have a clear idea of what they have to do to secure approval for their projects. Observers believed that if the CEAA resulted in difficulties for raising capital as investors grow wary of Canada's approval regime, people would invest their monies in other countries where regulations were more straightforward and transparent (Financial Times, 2000).

Further to an effort to define goals, approaches, and alternatives in the name of sustainable development, the Prospectors & Developers Association of Canada (PDAC), a private-sector organization, has issued a paper entitled "Total Landscape Management (TLM): An Integrated Approach to Conservation Protection and Resource Development." PDAC asserts 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 acknowledges that access to land and certainty of title are crucial to resource development, and that biological diversity, wilderness protection, and the preservation of unique and exceptional areas are fundamental to conservation objectives. TLM prescribes management of entire ecological landscapes by employing the overarching principal of conservation diversity; a system of "floating reserves" that is designed to accomplish protection in a constantly changing, dynamic landscape; adaptive management that allows the flexibility to accommodate new information, evolving ecosystems, and natural disturbances; and comanagement that ensures 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 differences among adversarial viewpoints by PDAC.

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 lays much of the blame on a sharp increase in emissions from five coal-fired plants operated by Ontario Hydro, which was the Provincial electricity monopoly. In the 3 years since 1996, sulfur dioxide (SO₂) emissions from the plants have increased by 68%, and nitrogen oxide (NO) emissions have increased 58%. SO₂ is a major contributor to acid rain. NO emissions are the principal source of ground-level ozone that produces visible smog. Ontario Hydro planned to reintroduce upgraded nuclear plants in 2000 (Financial Times, 1999).

After the Provincial Government ruled that processing of Voisey's Bay ore must take place in Newfoundland or Labrador rather than anywhere else, Inco announced plans for a smelter and refinery at Argentia, Newfoundland. Inco projected that 99% of SO₂ emissions would be captured and that the complex would produce less atmospheric SO₂ than any existing industry in Newfoundland.

Production

Overall value of Canadian mineral production in 1999 climbed by about 21% to \$36 billion, which was the highest value ever. A moderate decline in the value of metals produced was more than compensated by a sharp increase in the value of the output of fuels.

In the three nonfuels groups (metals, nonmetals, and structural materials), changes from 1998 were mixed. Production values of metals dropped by 6% to \$6.602 billion, and nonmetals gained 17% for a total of \$2.697 billion. Structural materials increased by 4% to a total of \$2.172 billion compared with 1998. The performance of the fuels group, which totaled \$24.512 billion, showed a 33% increase from that of 1998 primarily because of the dramatic reversal of world market prices for crude oil. Although natural gas production increased by 1.8% compared with that of 1998, the value of this output climbed by 26% to \$9.218 billion, and market prices escalated along with those of crude. Production of gas byproducts, however, declined by about 2.2%, but value reached \$1.580 billion, which was an increase of 33% compared with that of 1998. Petroleum crude output dropped by 4.6% compared with that of 1998, but value soared by 46% to \$12.716 billion because of the surge in world crude prices. Finally, the value of coal production decreased by about 16% to \$999 million in 1999, although output was down by only 4%, which reflected a sag in market prices. Geographically, the sources of mineral fuels production in 1998 (the latest information available) were Alberta, 78%; British Columbia, 9.3%; Saskatchewan, 8.8%; and all other Provinces and Territories, 2.5%.

In terms of value of production in 1999, the top nonfuel commodities were gold at \$1.44 billion; potash, \$1.20 billion; nickel, \$1.05 billion; zinc, \$1.03 billion; iron ore, \$956 million; copper, \$916 million; and diamond, \$400 million.

Market prices played a changing role in the mineral commodity values, particularly for iron ore, whose output tonnage decreased by 9.8% from that of 1998, but the value of this production dropped by 51%, which reflected market price weakness. In another example of the effect of the fall in market

pricing, cobalt production decreased by more than 10.9% and its production value decreased by more than 28%. The output of lead and silver was up modestly in both cases, but the value of production for each of these two commodities was down slightly from that of 1998. Of interest is the fact that these changes in output tonnages can be accompanied by declines of two to five times in value of production, thus illustrating the destructive effect of price deterioration in relation to mineral production during periods of overproduction and price weakness.

Ontario, which was the leading producer of nonfuel mineral commodities, accounted for 29.5% of the total value, followed by Quebec, 20.7%; Saskatchewan, 13.5%; British Columbia, 9.9%; Newfoundland, 5.6%; New Brunswick, 4.9%; Manitoba, 4.7%; and other Provinces and Territories, 11.2%. Although production of fuels tends to be concentrated in the western plains Provinces, the output of nonfuel mineral commodities is 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, which included fuels, totaled \$48.76 billion in 1999, which was an increase of 6.1% compared with that of 1998, and represented about one-quarter of all Canadian exports for that year.

In 1998, the latest year for which more detailed export information is available regarding total mineral and mineral-product exports, metals registered 51%; fuels, 37.3%; nonmetals, about 10.3%, and structural or building materials, about 1.4%. Value of exports of nonfuel minerals (but including coal) was \$30.5 billion, which represented 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 EU; and smelted and refined metals, which included 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, which included fuels, were valued at \$36.2 billion and amounted 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, which included 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 fewer 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 they sought 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, which included coal, were active (Southam Mining Publications Group, 1998, p. 497). Another 3,000 mines and quarries produced sand, gravel, and other construction materials. About 40 smelters and refineries as well as other processing plants in the cement, sodium chlorate, and sulfuric acid industries, were operating 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 (PC) was owned partly by Federal and partly by Provincial Governments but is now completely privatized. A large proportion of the total number of mining and petroleum companies is 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 and open pit mines, leaching operations, concentrators, smelters, and refineries, as well as drilling and production operations characteristic of the petroleum industry. Table 2 lists the structure of the mineral industry by sectors of the major mineral commodities.

Employment in the mining and mineral manufacturing industries has stabilized after a decline that began in 1989 when the number of jobs in those industries peaked at 422,000. Preliminary employment estimates for 1998 (the latest year for which data are available) by Statistics Canada indicated that total employment in mining and mineral manufacturing, which included coal, was about 367,000, or about the same as that of 1997. The total number of employees in coal, metal, and nonmetal mining, and quarrying was estimated by Statistics Canada to be 55,750, or down about 2,700 jobs compared with the 1997 level. Employment in ferrous and nonferrous smelting and refining was estimated to be 59,600, or up about 1,000 jobs compared with 1997. About 7,600 people were also employed in diamond drilling and other support services incidental to mining operations.

Commodity Review

Metals

Aluminum.—Production of primary aluminum was 2.389

million metric tons (Mt), which was an increase of less than 1.0% compared with that of 1998. 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 1998 were valued at \$4.81 billion.

After completing public hearings on the potential environmental impact of a 375,000-metric-ton-per-year (t/yr) smelter at Alma, Quebec, and filing the results with the Ministry of Environment early in 1998, Alcan planned to build the huge new smelter at a cost of more than \$1 billion. Because the new plant's capacity required 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 additional power that Alcan may 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 primary aluminum capacity from all of its plants to 1.9 million metric tons per year (Mt/yr) (Metal Bulletin Monthly, 1998).

Alcan decided to step up closure of the Isle-Maligne by December 1999 rather than in September 2000. This decision resulted in a decrease of 90,000 metric tons (t) of aluminum production during the ensuing 18 months. The accelerated closure was in response to low aluminum prices and rising world inventories of the primary metal. Isle-Maligne employees were to be transferred to the new Alma works without loss of any jobs, and customer supply was expected to be unaffected. Construction of the Alma project was about 40% completed at the end of 1999.

Cobalt.—Mine production of cobalt amounted to 5,324 t, which was a decrease of about 9% compared with that of 1998, and reflected decreased nickel production as producers of that metal encountered lower market prices. Rising demand for cobalt for alloys, catalysts, magnets and batteries, and even pigment, however, has focused new attention on cobalt resources in Canada, led by the Voisey's Bay discovery of at least 40,000 t contained within the nickel-copper deposit; further results were expected as exploration progressed.

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. Processing, which began early in 1998, never amounted 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.

Columbium (Niobium).—Niobec, which is the only operating columbium mine in North America, was jointly (50% each) owned by Cambior Inc. and Teck Corp. Situated near Chicoutimi, Quebec, the mine ranks as the world’s third largest producer. The equal partners have undertaken a study of the feasibility of increasing production by 40% in at least two steps. Included in the upgrade would be an expansion of the crushing and grinding circuit by 20% to 50%. Columbium is used primarily as an alloying agent in specialty steels.

Copper.—Mine output of copper dropped by about 13%, which reflected a reversal following the 6.3% increase of 1998. Weakness of world copper prices and the spectre of worldwide overcapacity, however, resulted in a 19.7% drop in value of 1999 copper production. Canada exported \$1.61 billion worth of copper during 1998 (the latest year for which data are available).

Production of primary refined copper decreased by about 4%. Copper production by solvent extraction-electrowinning (SX-EW) decreased by 100% (to zero) compared with that of 1998; this was probably the 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 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 in 1997, 1998, and early 1999 resulted in suspension or shutdown of some copper production. The first casualty was Highland Valley Copper (HVC), which was a high-throughput and high-cost producer; it went on indefinite suspension in May but reopened late in the year after protracted negotiation of a new labor contract. HVC mined copper at an average grade of 0.39% and processed about 45 Mt/yr to produce copper in concentrate at a cost of about \$0.68 per pound (about \$1.50 per kilogram). Operations at Boliden Ltd.’s Gibraltar copper mine in British Columbia were suspended, and the mine was placed on care and maintenance at the beginning of 1999; after 1997 about 33,000 t of copper was produced at a cost approaching \$0.91 per pound (about \$2.00 per kilogram) (Wall Street Journal, 1998).

Princeton Mining Corp.’s British Columbia Huckleberry project expected 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, which was the 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, of which Imperial owned 60%. By early 1999, Huckleberry could not meet all its long-term debt obligations,

so the company adopted a financial restructuring package that deferred all principal and interest payments through the rest of the year. As with Huckleberry, Imperial’s Mount Polley encountered difficulty carrying its long-term financing and had to adopt an economic relief plan brokered by the Canadian Job Protection Commission (Northern Miner, 1999b).

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. In late 1999, Northgate Exploration Ltd., which was a small company based in Vancouver, arranged to buy Kemess pending the negotiation of financial details of the transaction.

The potential copper production at Voisey’s Bay suggested that Canada, which ranked 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 output dropped to a little less than 158 t, which was down by 4.2% after the previous year’s decrease of about 3%. The value of 1999 gold production dropped by about 7.8%, which reflected low market prices. Predictions made in 1995 that output would reach 170 t by 1998 were then seen as somewhat pessimistic, but a record high of 171.4 t was actually achieved in 1997. Price weakness since then had been a deleterious influence on production throughout 1998 and 1999 and resulted in the suspension of some mines. Canada was the fourth largest gold producer after South Africa, the United States, and Australia. Canada exported \$2.3 billion worth of gold in various forms during 1998.

In 1998 about 42 primary gold mines in Canada accounted for 90.7% of the gold produced, with the remainder coming from base metal mines (7.2%) and placer operations (2.1%). In 1999, these figures changed to 92.2%, 6%, and 1.8% in the same order. After 13 closures and 3 new openings by yearend 1999, Canada had 33 gold mining operations. 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 1999 was predictable. The principal gold refiners are 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 had 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, 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. The company was forced into bankruptcy and liquidation of its assets. In early 1998, the entire project was purchased by Harmony Gold Mining Company Ltd. of South Africa, which began an immediate reevaluation of the mine and forecast an

output of about 1.3 t of gold in the first year of production. In mid-1999, Harmony decided to increase its extraction rate per day from 635 t to 900 t of ore, thus decreasing production costs from \$278 per ton to an estimated \$220 per ton (Northern Miner, 1999a).

Echo Bay Mines Ltd. put its Lupin gold mine in Nunavut on care and maintenance while it examined its options in the light of low market prices. After nearly 2 years of shutdown, Echo Bay decided to reopen the mine with \$12 million of new financing and commercial production targeted for April 2000.

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 above in the section on copper) helped deflate prospects for improvement in overall production in 1999. Northgate Exploration Ltd. opted for the acquisition of Kemess pending the arrangement of financing.

Gold still seemed to be the principal metal targeted for exploration virtually throughout Canada, and in terms of value of production, gold exceeded nickel (second) and zinc (third). With the threat of more gold mine closures, which depended upon market confidence, however, gold seemed to have lost at least some of its traditional luster. Compounding the problem had been 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 International Monetary Fund release much of its gold to the open market to pay for projects in Third World countries. In September, however, European central banks commitment to sell no more than 2,000 t of bullion during the ensuing 5 years caused a positive spike in market price that subsided in the succeeding months as market hedging resumed.

Iron Ore.—Output of iron ore dropped by about 9.8% compared with that of 1998 and had an even greater drop in the value of production (13.8%). 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), and Wabush Mines Ltd. The Algoma Ore Division (AOD) of The Algoma Steel Corp. Ltd. closed its mining operations. Data for 1995 (the latest year for which data are available) give 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, and the remainder 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.

After paying \$230 million in return for a 59.3% stake in IOC, North Ltd., which was 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 1999 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, such as Roche Bay in the Northwest Territories, the Peace River area of Alberta, and Ungava Bay and Schefferville in Quebec.

Pig iron production decreased to 8.78 Mt from 8.94 Mt in 1998, or about 2%. The proportion of direct-reduced iron to pig iron produced was about 10%, thus confirming the ratio of 10% forecast 3 years before. Crude steel production was about 16.3 Mt compared with 15.9 Mt in 1998, both of which exceeded the old peak of 15.46 Mt in 1989.

Lead and Zinc.—Canada was tied with Australia as the world's second largest mine producer of zinc at more than 1.0 Mt of zinc and was the fifth largest producer of lead at 161,193 t of lead in concentrate. After showing a sharp decrease of 28% in 1997 compared with that of 1996, lead production fell back by about 15% compared with the 1.6% gain in 1998. Zinc mine output showed a loss of about 1% in 1998 that increased to a 5% drop in 1999. Weak market prices continued to take their toll well into 1999.

In December 1998, Boliden Ltd. suspended production at its Myra Falls operation on Vancouver Island for rehabilitation of ground-control conditions after problems with rock falls and ore dilution. About four-fifths of the labor force remained on duty during the suspension and devoted attention to rebolting 1,340 meters (m) of drifts in tighter patterns and to clearing backfill work that had lagged behind schedule. The company expected to bring the mine back to full production of 110,000 t/yr of zinc by the third quarter of 1999 (Northern Miner, 1999e).

Anvil Range Mining Corp.'s Faro lead-zinc mine, which was 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 runup that culminated in August 1997, the mine was reopened in October, just in time for the steep drop in zinc prices. The reopening, which had a depressing effect on already soft lead prices, was somewhat self-defeating for Anvil Range so far as the economics of lead were concerned. In January 1998, the mine was placed on care and maintenance and, finally, shut down. In January 1999, Anvil Range was delisted from the Toronto Stock Exchange.

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%, thus resulting in significant savings in shipping and treatment costs. Despite the zinc price slump, the operation generated a profit of \$12.4 million in 1997, which 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 will be driven from the 140-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 at a grade of 10.8% zinc (Northern Miner, 1998b).

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, which was estimated to include 1.2 Mt at a grade of about 16% zinc, but development work failed to confirm this resource (Northern Miner, 1998b). The mine was closed in 1999.

After closing its operations in the Matagami district of northern Quebec with the exhaustion of the Isle Dieu and 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. Armed with local experience from two closed mines, Noranda pressed exploration in the Matagami district for further discoveries of copper-zinc deposits.

After suspending operations at about the same time as the Faro Mine and for the same reasons in late 1996, 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 to reduce the size of stopes in some sectors, thus 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.—Noranda Inc., which was Canada's largest mining company, was pursuing an unusual venture—a \$733 million plant to turn asbestos waste, which is cheap and plentiful, into magnesium metal, whose market price averaged just less than \$2,500 per ton in 1999. The processing of asbestos commonly leaves tailings that are very rich in magnesium silicate. After successfully competing a 250-t/yr pilot operation, Noranda 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%, and Societe Generale de Financement du Quebec, 20%) will be the operator. By using a hydrochloric-acid continuous-leaching process, the resulting magnesium chloride will be electrolyzed to yield magnesium metal (Canadian Mining Journal, 1999).

Nickel.—Mine output sagged by about 10.5% from that of 1998 with a corresponding drop of 10.8% in value of production, which presumably reflected the bottoming-out of nickel prices in world markets in the early part of 1999. Nonetheless, nickel was the second most valuable metal (after gold) produced in Canada during the year. An attempt to offset sagging market prices by boosting production the previous year was not effective as a financial tactic because of the magnitude of the slump in prices, which resulted in a drop in value of 1998 output that exceeded 20%. As with other base metals, these low prices engendered a ferocity of financial problems in keeping

certain high-cost mines alive. Falconbridge Ltd. continued development of its Raglan nickel-copper property in northern Quebec and had targeted April 1998 for first commercial production and the following July for full production. 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, but low market prices for nickel may have complicated the schedule. Raglan concentrates were to be shipped from Deception Bay, 100 km north of the mine, to Quebec City and continue by rail to Falconbridge's Sudbury smelter in Ontario.

Predictably, the world's biggest newsmaker in nickel continued to be Inco's nickel-copper-cobalt project at Voisey's Bay, 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. In 1997, Inco had announced 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 of these issues, Inco announced in late 1997 that the 1-year delay had stretched to at least 18 months, which began after receipt of environmental and other permits (Mining Journal, 1997). 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 Argentina, 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, which included the Shebandowan, the McCreedy West, the Levack, and the Little Stobie mines. Shareholders' dividends were slashed, Standard & 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 Argentina, it would be more economical to ship concentrates all the way to Ontario to the company's existing smelter and refinery complex. 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 Argentina 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.

By the end of 1998, Inco and the Government of Newfoundland stood by their positions in a stalemate that probably could only be resolved with further negotiation after 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 Government of Newfoundland and Labrador, and the Labrador Inuit Association. No agreement, however, seemed to have been achieved in benefits negotiations with the Innu Nation. Nickel price improvements in 1999 may have removed one

obstacle to successful negotiations with the Government of Newfoundland, but new low-cost lateritic nickel operations in Australia might influence any equation for settlement.

About 120 km northeast of the town of Matagami in the Lac Rocher area of northern Quebec, area by Nuinsco Resources Inc. found strong nickel/copper mineralization, which caused a staking rush into the region that included activity by junior and major mining companies.

Platinum-Group Metals.—Mine production of platinum-group metals (PGM) dropped by about 10% compared with that of 1998; this closely reflected the decreased 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 being decommissioned.

As an approximation based on past experience, Inco's ratio of PGM produced worked out to about 12:7.6:1 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; it traded at more than \$4,000 per ounce in recent years. Beginning in 1995, however, rhodium prices dipped to levels only slightly higher than those of gold but have recovered into the vicinity of \$2,000.

Silver.—Canada ranked fifth in world silver production after Mexico, Peru, the United States, and Australia. Canadian silver production has been largely a coproduct of base metal and gold mining and, therefore, 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 that involve supply, demand, and pricing for other major mineral commodities. Production of silver in concentrate increased by about 2.9% compared with that of 1998, probably in concert with the increase in lead output, but the value of this production dropped by about 1.5% with a decline in silver prices. Silver production increased significantly starting 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 alone has been projected to be 28% of the total for the entire country.

Titanium.—Output of titanium rose to 950,000 t, which was an increase of about 12% since 1997. QIT-Fer et Titane of Canada invested \$260 million in the construction of a plant at Sorel, Quebec, to produce an upgraded slag, called UDS, that contain 95% titanium dioxide (TiO₂) compared with its previous Sorel slag that contained 80% TiO₂ (Industrial Minerals, 1996). The company aimed for extraction of 3 Mt/yr of ore.

Uranium.—After the previous upward trend in production of uranium oxide (U₃O₈) ended in 1998 with a decrease of 8% compared with that of 1997, the 1999 output dropped by

another 28%. Weakness of demand caused this precipitous drop, but uranium prices march to a different drummer, so to speak, and did not turn around in 1999 as did the base metals. 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 longer 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 Cigar Lake, the Cluff Lake, the Key Lake, and the Rabbit Lake districts of Saskatchewan.

Industrial Minerals

Asbestos.—Canadian asbestos production increased by about 3% compared with that of 1998; this was a slight reversal in a Canadian downtrend since at least 1992. Owing to human health concerns, world production has declined since the early 1980's. After Russia, Canada was the second largest producer of asbestos, which includes the minerals chrysotile, crocidolite, and amosite in that order of importance. China's asbestos production (almost exclusively short fibers for asbestos cement), which was rapidly gaining on that of Canada and meeting demand in Asian markets, could eventually threaten Russia's leading position. Mounting concern regarding chrysotile substitutes were expected to benefit the chrysotile industry in the near to medium term. Marginal gains were expected in Latin American consumption of Canadian chrysotile; Asia, which was already a significant market taking more than 50% of exports, was seen as expanding the demand for longer Canadian fibers. Asbestos cement product demand was fairly steady 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. (now Cassiar Mines and Metals Inc.), which aimed for a startup in July 1998 with production of 1,000 metric tons per month. Financing did not come easily, however, and the target date for the beginning of production was put back to late 1999. The company also contemplated the recovery of magnesium from asbestos mine tailings. Otherwise, by far the greatest proportion of Canadian asbestos production was in Quebec in the region that includes Thetford Mines and the town of Asbestos. Principal operators were LAB Chrysotile and JM Asbestos Inc. The production of metallic magnesium from asbestos mine waste materials should improve the economics of the asbestos industry and create better overall labor expectations, particularly in Quebec where decreased production has taken its toll.

Cement.—Production of cement increased by about 4% from that of 1998 with an increase in value of production of about 6%, which reflected continued strengthening of the export market in the midst of prices that had declined somewhat since 1978 (valued in 1986 dollars). Weakening of the Canadian dollar versus the U.S. dollar since the beginning of the 1990's 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. Canada has usually been 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 the dumping of cement by Mexican producers essentially removed them as competitors and left the field to Canada as the principal foreign source. For the immediate future, 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, which is the largest cement market, will play the key role in determining a balance between domestic and U.S. consumption.

Diamond.—Canada's first commercial production of diamond by BHP/Dia Met Joint Venture (Dia Met) began in October 1998 with project construction, which included such extensive support facilities as arctic living quarters and a powerplant; these were essentially completed. In 1998, output of the mining complex, newly named Ekati, was 300,000 carats, which jumped to 2.5 million carats in 1999 as operations gained in efficiency.

Company officials reported that the quality of diamond recovered to date from the five kimberlite pipes at their Lac de Gras property, which is 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 (Fox, Koala, Leslie, Misery, and Panda) and would be mined during a 30-year period. The centralized processing plant, which is 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, as well as high-intensity magnetic separation, X-ray concentration, and sorting. The construction phase work force reached 1,000 at its peak; after that, about 650 workers were to be employed during production. Future output was projected to be 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 eventually in association with the project. As early as May, BHP Diamonds Inc., which was the majority interest holder in Ekati, noted that it would channel a portion of its production through the DeBeers' Central Selling Organization (CSO). In July, DeBeers Consolidated Mines Ltd. completed a sales contract to take 35% of Ekati's run-of-mine production for a period of 3 years.

The Rio Tinto plc (60%) and Aber Resources Ltd. (40%) joint venture, which is called Diavik Diamond Mines Inc., proceeded with plans for a 2-Mt/yr operation that would begin 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. Throughout much of the year, the Diavik project awaited a decision by the Canadian Minister of the Environment to permit development. Following a favorable decision in November, the Diavik project then had

to contend with the Canadian Department of Indian Affairs and Northern Development's decision not to issue an interim land-use permit for activities that could lead to development and operations. At yearend, Diavik prepared to suspend all work activities and to repatriate all workers not essential to care and maintenance. Frustration levels at this predicament were not only high at Diavik, but discernible throughout other parts of the Canadian mining industry.

More than 500 companies, off and on, 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. DiaMet supported the establishment of a diamond valuation facility in a community in the Northwest Territories to be used for training, basic sorting, and valuation for Government royalty purposes. This could lead to more skilled and detailed sorting that would afford 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. By using artisans brought over from Belgium, the First Canadian Diamond Cutting Works in Montreal 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 1998 (the latest data available) amounted to about 127,000 t, much of this evidently from stockpiles. The greatest proportion of shipments were to the United States followed by the EU. 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 seemed marginal.

Gypsum and Anhydrite.—Production of gypsum and anhydrite increased about 6% compared with that of 1998 and reinstated an overall climb since 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 has been mostly by Canadian subsidiaries of United States and British companies, such as USG Corp. and National Gypsum Co., and 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, which discourages 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 tends 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.

Potash.—Potash production, which decreased by about 9.5% compared with that of 1997, totaled 8.33 Mt of K₂O equivalent; most came from mines in Saskatchewan, but about 5% came from New Brunswick. Canada led the world in potash production and had probably the largest reserve base of the material. Value of production increased by about 1.6% compared with that of 1998; this reflected higher market prices. Most Canadian potash was shipped to the United States (about 57%), Asia (about 25%), Latin America (about 10%), and Oceania and Western Europe (about 8%). Exports to the United States have risen steadily to satisfy agricultural needs, but lower prices for grains during 1999 and decreased production in Canada and the United States diminished the requirement for fertilizers. Exports to Asia, which climbed owing to an increase in shipments to China, accounted for about one-third of all seaborne 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 early summer 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. Potacan was jointly owned by Enterprise Minière et Chimique of France and Kali und Salz AG of Germany. Although IMC Kalium, which was owned by IMC Global Inc., had been studying the feasibility of converting the flooded mine to solution mining, PCS stepped in and arranged to purchase all the outstanding shares of Potacan. The Cloverhill Mine experienced minor brine inflows all through 1999, but these were controlled sufficiently so as not to affect mining operations.

Sulfur.—Production of all forms of sulfur increased compared with output in 1999. Sulfur from smelter gases climbed by 1.6% to 846,000 t with an accompanying increase in value of about 13.8%. Output of elemental sulfur from natural gas, crude oil, and byproducts increased by about 4.6% to 8.79 Mt with an increase in value of 30% compared with that of 1998. Most or all smelter-gas sulfur is converted to sulfuric acid. No Canadian production is derived from Frasch mining.

With a projected 17% 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 5 years to more or less match the stringent sulfur standards of California. The move would add about 1 cent 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 will be 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 72.472 Mt but was still declining from the record high of about 78.9 Mt in 1997 and down about 4% from the output of 1998. The total value of production was \$999 million, which was sharply lower (about 16%) than that of 1997 owing mainly to price declines and only slightly to a progressively lower conversion rate for the Canadian dollar. In April, industry spokesmen noted that price slumps in hard coking coal for Japanese steel mill consumption were going to contribute to the worst export year in a decade for Canadian coal and that companies were going to have to be cutting, chopping, and bargaining on all fronts to keep mines open and operating. At the same time, increased diversification and expansion into foreign markets was called for as a means to survival. Coal exports in 1998 amounted to 34.1 Mt; of that 16.7 Mt went to Japan; 6.1 Mt, the Republic of Korea; 1.3 Mt, Brazil; and Taiwan and the United Kingdom, 1.1 Mt each (Northern Miner, 1999c). Although Canada accounted for only about 2% of the world's coal production, it exported almost one-half of its production, thus making it the world's fourth largest exporter after Australia, the United States, and South Africa. Imports of coal into Canada during 1997 were about 13.9 Mt. The United States furnished more than 8 Mt of this coal, and Colombia furnished the remainder.

Luscar Coal Income Fund, which is Canada's largest coal producer, intended opening the Cheviot Mine in Alberta as a replacement for the nearly depleted Luscar Mine 30 km north of Cheviot and 50 km south of the town of Hinton, all in the foothills of the Rockies. A consortium of environmental groups led by the Sierra Legal Defense Fund has vigorously opposed the Cheviot opening and won a preliminary ruling that Luscar's environmental assessment was incomplete. The previously approved Cheviot project was overturned, and the Sierra Club faction urged that the region shift from dependence on mining to other sources of income, such as tourism (Northern Miner, 1999d).

In eastern Canada, domestic supplies of coal generally have to be augmented by imports, mostly thermal coal from the United States, which put 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.

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 about 210 billion cubic meters (Gm³) from 204 Gm³ in 1998. Production of marketed gas was 162 Gm³ compared with 173 Gm³ in 1998; marketed gas is gross production minus reinjected gas, shrinkage, and producer consumption (plant use).

About 89.4 Gm³ (about 3.16 trillion cubic feet) of natural gas, or roughly 10% of the U.S. supply, was exported to the United States in 1998. Gas exports to the United States were expected to increase to about 100 Gm³ by 2006, in anticipation of 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), which was a net decrease of 1.8% from the preceding year.

Spurred by increasing U.S. demand, exploration for new discoveries of natural gas continued the expansion that began at least two decades ago primarily in Alberta and Saskatchewan. Chevron Canada Resources Inc., which was a unit of Chevron Corp., had one of the largest natural gas strikes in recent history near Fort Laird, Northwest Territories, where projections by the company showed "between 400 billion and 600 billion cubic feet of gas in place in more than 1,200 feet of pay zone." Chevron Canada expected to put the first well in production in May 2000 (Wall Street Journal, 1999b).

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.—After production of crude oil reached a record high of 807.6 million barrels (Mbbbl) in 1998, output dropped by almost 14% to 698.5 Mbbbl in 1999, as high-cost wells were shut in during late 1998 to early 1999. Contrariwise, the value of this decreased production climbed by a startling 46%, which reflected the worldwide effect on market pricing of the coordinated decrease in production by the exporting states in the Organization of Petroleum Exporting Countries later in 1999. Value of the crude produced amounted to \$12.715 billion, which was up from \$8.760 billion in 1998. Canada exported 482 Mbbbl of crude to the United States in 1998.

After selling 30% of the integrated oil company PC, the Government continued with privatization by offering much of the other 70% with the aim of reducing its share to perhaps 20%. During 1999, PC relinquished conventional crude production in Western Canada in shifting its interest toward oil sands, natural gas, and offshore projects. PC was lauded as a model for state-owned oil company privatization and appeared to be expanding its revenues in 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 development began in mid-1999, with first production possible in 2000. After Terra Nova, the White Rose field, also in the Jeanne d'Arc basin, was eyed for development.

The Hibernia field, which is beneath 75 m of water, was earlier thought by its operators to contain perhaps 615 Mbbbl of light waxy oil. The field was being developed in a \$6.5 billion project by PC and a consortium of companies that included Mobil Oil Canada Ltd., Chevron Canada Resources, and Murphy Oil Company Ltd., with large subsidies from the 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 in early 1998, uses new and unique technical design features to resist damage by icebergs. Mobil Oil Canada, which owned 33% of the project, predicted that output will increase to 180,000 bbl/d, and upped its reserve estimate for the Hibernia field to 750 Mbbbl out of about 3 billion barrels (Gbbl) 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 Mbbbl in 1998, which was about 27% of Canada's total production that year. Technological development and increased operating efficiencies have steadily reduced production costs by Suncor Inc. and Syncrude Canada Ltd., which were the two major operators, at their sites in Alberta and northern Saskatchewan, respectively. Suncor's operating costs at the Suncor oil sands plant in Alberta dropped to below \$12 per barrel in 1995 from \$15 per barrel in 1992, and were 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, the Peace River, and other bitumen and heavy oil deposits in Alberta amount to 2.5 trillion barrels of oil in place, which is about 40% of the world's known bitumen. As of 1996, the 300 Gbbl considered recoverable exceeded the 265-Gbbl reserves of Saudi Arabia, but the latter could be extracted for less than \$1 per barrel. The Province of Alberta lowered its royalty on oil sand crude late in 1995 and stipulated that it be 1% on all production until companies pay off capital costs and earn a return that matches 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, 1999. Data are shown in terms of metal contained in ore for the base and precious metals or recoverable quantities of other mineral commodities, which included 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 the simplest terms, the arithmetic result of additions to reserves, deletions

from reserves, and production. A complication in Canada is that a large number of mines produce more than one metal, 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 t to less than 17,000 t during the same period.

From 1998 to 1999, reserves of the leading base and precious metals decreased significantly. The only exception was nickel, which increased by 11%. Other metals declined—copper, 7%; gold, 6%; lead, 21%; molybdenum, 19%; silver, 6%; and zinc, 4%. As a point of history, 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 and were influenced mostly by mineralization of the Precambrian shield, the Rockies (Cordillera), and the Coast Ranges. Several provinces dominated the reserves position in terms of proven and probable minable reserves of major metals. From east to west, New Brunswick had 76% of the lead reserves, 35% of the zinc, and 25% of the silver; Quebec had 26% of the zinc, 20% of the gold, 18% of the silver, 10% of the nickel, and 9% of the copper; Ontario had 72% of the nickel, about 51% of the gold, 50% of the copper, 22% of the silver, and 18% of the zinc; Manitoba had 18% of the nickel, 6% of the zinc, and 4% each of copper and gold; and British Columbia had 100% of the molybdenum and about 35% of the copper, 32% of the silver, and 19% of the gold. Discoveries yet to be made will alter the relation between overall reserves.

Infrastructure

With a total land area of about 9,221,000 square kilometers, which is slightly larger than the United States, Canada has networks of highly developed infrastructure, as well as vast areas of trackless wilderness. The country had 912,200 km of roads that comprised 246,400 km of paved highway (including 16,600 km of expressways) and 665,800 km of gravel or other loose-surface roads. Bulldozed temporary roads have been established for mining exploration in many remote places, but these deteriorate readily where not maintained.

A total of 67,773 km of standard-gauge railroads included two main systems, the Canadian National and the Canadian Pacific. The country also had about 3,000 km of inland waterways, which included the St. Lawrence Seaway, which is one of the busiest in the world and leads into the Great Lakes and marks the boundary with the United States in many places. Principal ports were Halifax, Montreal, Quebec, St. John (New Brunswick), St. John's (Newfoundland), and Toronto in the east and Vancouver on the west coast. Canada's merchant marine comprised about 109 ships of 1,000 or more gross registered tons.

The country had 1,393 airports. Among these, 515 had

permanent-surface runways—16 had runways longer than 3,047 m, 16 had runways from 2,438 to 3,047 m long, and 154 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 550 net terawatt hours, which was significantly less than capacity, was produced in 1996 (the last year for which complete data are available). More than 63% of Canada's electricity was generated by hydroelectric plants; about 16%, 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 and the remaining 3% was produced mainly by nuclear facilities. In contrast, about 61% of Ontario's electric power was derived from nuclear plants, and 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 that border the United States had transmission links to the neighboring systems. The surge in Canadian electricity exports to the United States in late 1993 and early 1994 was largely 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, which was 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 of 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 that linked 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 represents the greatest length for any Province.

Outlook

After having been buffeted by economic and environmental factors in 1999, Canada's mineral industry faced some immediate problems in the midst of longer term promise. Canada's dollar weakened slightly once more against the U.S.

dollar; presumably this helped exports but discouraged imports of certain necessary commodities, specialized equipment, and ad hoc professional expertise. Increased exports boded well for credit markets, but equity markets, especially for junior mining companies, still suffered in the wake of the Bre-X scandal. Although Canadian Provincial and Federal Securities Commissions developed new rules to govern public offerings, junior mining companies found themselves subjected to virtually paranoid scrutiny, and not without reason. Demand for base metals in world markets strengthened after prices had been soft at a critical time for many companies, whether starting up or expanding, and relief was slow in coming. Low prices are jeopardizing gold, which is one of Canada's mainstay metals, enough to cause (or threaten) sizable bankruptcies. A price is being paid by Canada, as well as some of the other major mining countries, for uncertainties in the formation of the EU banking system (particularly its large-scale gold selling), which could further complicate the recovery from what began as the Asian effect in 1997.

On the plus side, the Canadian petroleum industry continues to grow. Exploration is reaching new levels of activity, and Canada is 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. After Hibernia will come Terra Nova and White Rose fields, and these are in only one basin (the Jeanne d'Arc) with others to be tested. 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 makes an impressive case for more exploration in Canada, no matter how attractive the situations in Asia, Australia, and Latin America. Furthermore, new prospects are being 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 that concerns 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.

Despite declining reserves, 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 should 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 and frustrating, particularly the rapidly growing issue of the streamlining of regulatory actions. Other problems are international in nature and may lie beyond Canada's direct industrial or market influence. Although 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, Canada's greatest long-term asset may be, presumptively, the achievement of a popular consensus in support of sustainable development that respects the interests of mining companies, First Nation peoples, and the preservation of the environment.

References Cited

- Canadian Mining Journal, 1999, It's magnesium, it's magnificent, it's Magnola: Canadian Mining Journal, v. 120, no. 4, April, p. 15.
- Engineering & Mining Journal, 1999, Mining standards task force recommends improvements to Canadian Regulatory System: Engineering & Mining Journal, v. 200, no. 3, p. ww-9.
- 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.
- 2000, Canadian miners hit tough environmental conditions: Financial Times [London], February 28, p. 26.
- Industrial Minerals, 1996, New upgraded Ti-slag plant for QIT: Industrial Minerals, no. 342, March, p. 9.
- Metal Bulletin Monthly, 1998, Alcan's Alma smelter takes shape: Metal Bulletin Monthly [London], no. 336, December, p. 66.
- Mining Journal, 1997, Voisey's Bay to take 18 months: Mining Journal, v. 329, no. 8459, December 12, p. 487.
- 1998a, An integrated approach: Mining Journal, v. 331, no. 8497, September 11, p. 202.
- 1998b, Positive stance at the PDAC: Mining Journal, v. 330, no. 8473, March 20, p. 227.
- Northern Miner 1998a, Inmet suspends drilling at Winston Lake: Northern Miner, v. 84, no. 42, December 14, p. 1.
- 1998b, HBM&S launches program at Chisel North zinc deposit: Northern Miner, v. 84, no. 26, August 17, p. 1.
- 1999a, Bissett mine expansion to go ahead: Northern Miner, v. 85, no. 28, September 6, p. 1.
- 1999b, British Columbia copper mines face tough times: Northern Miner, v. 85, no. 15, June 7, p. 1.
- 1999c, Coal production costs to come under scrutiny: Northern Miner, v. 85, no. 7, April 12, p. 11.
- 1999d, Luscar prepares for Cheviot duel: Northern Miner, v. 85, no. 30, September 20, p. 1.
- 1999e, Myra Falls mine back on stream: Northern Miner, v. 85, no. 6, March 29, p. 3.
- Petroleum Economist, 1998, Canada—Sulphur cuts hurt refiners, help humans: Petroleum Economist, v. 65, no. 11, November, p. 36.
- Southern Mining Publications Group, 1998, Mines and projects summary—Producing mines, Canadian Mines Handbook 1998-99: Southern Mining Publications Group, August, p. 496-529.
- Wall Street Journal, 1998, Canadian copper mine to close down: Wall Street Journal, March 13, p. A10
- 1999a, Canada creates vast homeland for Inuit: Wall Street Journal, March 19, p. A17.
- 1999b, Gas deposit could rank among Canada's largest: Wall Street Journal, May 12, 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
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Statistics Canada
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Ottawa, Ontario K1A 0T6
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The Mining Association of Canada
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Provincial Sources

Ministry of Energy, Mines, and Petroleum Resources
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Petroleum Plaza, North Tower, 9945 108 St.
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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 Law.
Corporate annual reports of individual mining companies.

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

(Metric tons unless otherwise specified)

Commodity	1995	1996	1997	1998	1999
METALS					
Aluminum:					
Alumina, gross weight	1,064	1,060	1,165	1,229	1,233
Primary, metal	2,171,992	2,283,210	2,327,188	2,374,118	2,389,835
Antimony 3/	684	1,773	630	428 r/	566
Arsenic trioxide e/	250	250	250	250	250
Bismuth 3/	187	150	196 r/	219 r/	311
Cadmium:					
Mine output, Cd content 3/	1,942	1,771	1,471	1,361 r/	1,390
Metal, refined	2,349	2,433	2,260	2,090 r/	2,091
Calcium	W	W	W	W	W
Cobalt:					
Mine output, Co content 3/	5,339	5,714	5,709	5,861 r/	5,324
Metal:					
Shipments 4/	2,016	2,150	2,168	2,262 r/	2,015
Refined, including oxide	3,269	3,601	3,792	4,415 r/	4,187
Columbium and tantalum:					
Pyrochlore concentrate:					
Gross weight	5,230	5,160	5,090	5,110	5,240
Cb content	2,350	2,320	2,290	2,300	2,360
Tantalite concentrate:					
Gross weight	130	220	196	228 r/	208
Ta content	33	55	49	57 r/	52
Cb content	7	11	10	11 r/	10
Copper:					
Mine output, Cu content 3/	723,693	685,926	659,500	703,245	614,210
Electrowon	2,600	2,500	2,700	1,800	--
Total	726,293	688,426	662,200	705,045	614,210
Metal:					
Smelter:					
Primary, blister	522,761	529,349	529,525	553,133	542,439
Secondary and scrap	90,929	83,344	96,957	71,338	66,782
Total	613,690	612,693	626,482	624,471	609,221
Refined:					
Primary	479,100	477,500	464,000	489,941	468,300
Secondary	93,500	81,700	99,300	72,635	71,300
Total	572,600	559,200	563,300	562,576	539,600
Gold, mine output	152,032	166,378	171,376	165,599 r/	159,038
Iron and steel:					
Ore and concentrate:					
Gross weight	38,560	34,400	37,277	37,808 r/	34,487
Fe content	24,561	21,911	24,914	24,082 r/	21,967
Metal:					
Pig iron	8,464	8,638	8,679	8,937 r/	8,783
Direct reduced iron	1,010	1,420	1,391	1,240	920
Ferroalloys, electric arc furnace: e/					
Ferrosilicon	56	56	56	56	56
Silicon metal	22	26 r/	30 r/	30 r/	30
Ferrovandium	1	1	1	1	1
Total	79	83 r/	87 r/	87 r/	87
Crude steel	14,415	14,735	15,554	15,930 r/	16,300
Lead:					
Mine output, Pb content	210,826	257,253	186,234	189,752 r/	161,193
Metal, refined:					
Primary	178,019	192,877	139,736	129,750 r/	145,889
Secondary	103,372	117,914	131,659	135,737 r/	117,023
Total	281,391	310,791	271,395	265,487 r/	262,912
Lithium, spodumene e/	21,000	22,000	22,500	22,500	22,500
Magnesium metal, primary e/	41,900	54,000	57,700	77,109	80,000 e/
Molybdenum, mine output, Mo content	9,522	8,097	8,223	8,469 r/	5,930
Nickel:					
Mine output, Ni content 3/	181,820	192,649	190,529	208,302 r/	186,177
Refined 5/	125,311	130,136	131,639	146,755 r/	124,260

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

Commodity		1995	1996	1997	1998	1999
METALS--Continued						
Platinum-group metals, mine output	kilograms	16,068	14,668	12,459	16,408 r/	14,750
Selenium, refined 6/	do.	561,000	694,000	592,000	398,000 r/	438,000
Silver						
Mine output, Ag content	do.	1,284,757	1,308,758	1,223,983	1,195,943 r/	1,231,302
Refined	do.	1,040,866	1,402,983	1,322,779	1,579,030	1,657,130
Tellurium, refined 6/	do.	102,000	59,000	59,000	62,000 r/	67,000
Titanium Sorel slag e/ 7/		815,000	825,000	850,000	950,000	950,000
Uranium oxide (U ₃ O ₈)		12,337	13,784	14,174	12,896 r/	9,343
Zinc:						
Mine output, Zn content		1,121,174	1,222,388	1,076,385	1,061,645 r/	1,008,860
Metal, refined, primary		720,346	716,467	703,798	745,131 r/	780,832
INDUSTRIAL MINERALS						
Asbestos		524,000	506,000	455,000	302,000 r/	311,000
Barite		67,000	58,000	77,000	90,000	126,000
Cement, hydraulic 8/	thousand tons	10,440	11,587	11,736	12,124 r/	12,604
Clay and clay products 9/	value, thousands	\$69,698 r/	\$80,834 r/	\$105,269 r/	\$91,579 r/	\$111,525
Diamond	carats	--	--	--	300,006 r/	2,500,000
Diatomite e/		10,000	10,000	10,000	10,000	10,000
Gemstones, amethyst and jade		459	294	394	136 r/	175
Gypsum and anhydrite	thousand tons	8,055	8,202	9,117	8,967 r/	9,471
Lime 8/	do.	2,398	2,402	2,477	2,514	2,585
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		618,000	606,000	647,000	636,000 r/	650,000
Nitrogen, content of ammonia		3,773,000	3,839,600	4,081,000	3,899,900	4,134,900
Potash, K ₂ O equivalent	thousand tons	9,066	8,120	8,989	9,201 r/	8,329
Pyrite and pyrrhotite, gross weight e/		5,000	5,000	5,000	5,000	5,000
Salt	thousand tons	10,875	12,248	13,534	13,296 r/	12,481
Sand and gravel	do.	228,163	213,831	225,419	229,780 r/	222,572
Silica (quartz) 10/	do.	1,689	1,558	1,896	1,905 r/	1,994
Sodium compounds, n.e.s.:						
Sodium carbonate (soda ash) e/	do.	300	300	300	300	300
Sodium sulfate, natural 11/	do.	315	323	326	320 r/	305
Stone 12/	do.	120,660	92,449	120,953	129,057 r/	123,361
Sulfur, byproduct:						
Metallurgy	do.	886	789	801	836 r/	846
Petroleum	do.	8,150	8,329	8,280	8,404 r/	8,792
Total	do.	9,036	9,118	9,081	9,240 r/	9,638
Talc, soapstone, pyrophyllite	do.	108	77	73	71 r/	77
MINERAL FUELS AND RELATED MATERIALS						
Carbon black e/		165,000	165,000	165,000	165,000	165,000
Coal:						
Bituminous and subbituminous	thousand tons	64,176	65,006	67,034	63,596	60,813
Lignite	do.	10,740	10,854	11,653	11,790	11,659
Total	do.	74,916	75,860	78,687	75,386	72,472
Coke, high-temperature	do.	3,283	3,357	3,370	3,142	3,307
Gas, natural:						
Gross	million cubic meters	192,530	198,107	199,422	204,022	209,970
Marketed	do.	148,204	153,578	156,842	173,359	162,247
Natural gas liquids:						
Pentanes plus	thousand 42-gallon barrels	56,450	61,832	67,439	68,370	67,735
Condensate	do.	2,323	1,944	2,735	2,827	2,930
Total	do.	58,773	63,776	70,174	71,197	70,665
Peat		877,000	901,000	100,100	1,132 r/	1,306

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

Commodity		1995	1996	1997	1998	1999
MINERAL FUELS AND RELATED MATERIALS--Continued						
Petroleum:						
Crude 13/	thousand 42-gallon barrels	662,110	739,814	770,275	807,612	698,444
Refinery products:						
Propane; butane; naphtha; LPG 14/	do.	13,745	26,454	15,265	14,990	12,700 e/
Gasoline:						
Aviation	do.	846	789	726	933	790 e/
Other	do.	243,455	245,618	254,386	256,372	218,000 e/
Petrochemical feedstocks	do.	33,554	33,137	33,746	33,530	28,500 e/
Jet fuel	do.	29,315	32,048	33,935	34,953	29,700 e/
Kerosene	do.	5,470	18,446	3,106	1,995	1,700 e/
Distillate fuel oil, diesel and light	do.	183,597	184,738	201,737	196,511	167,000 e/
Lubricants including grease	do.	5,807	6,344	8,478	7,884	6,700 e/
Residual fuel oil, heavy	do.	41,352	41,999	47,477	50,736	43,100 e/
Asphalt	do.	20,048	19,586	24,938	26,007	22,100 e/
Petroleum coke	do.	6,961	7,416	7,122	7,207	6,200 e/
Unspecified	do.	24,271	21,144	25,114	26,489	22,500 e/
Refinery fuel and losses 15/	do.	37,583	25,172	24,491	25,601	21,800 e/
Total	do.	646,004	662,891	680,521	683,208	581,000 e/

e/ Estimated. r/ Revised. W Withheld to avoid disclosing proprietary data. -- Zero.

1/ Estimated data have been rounded to no more than three significant digits; may not add to totals shown.

2/ Table includes data available through July 15, 2000.

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 that 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 has been upgraded to 95% 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.	Aluminerie de Becancour Inc. (Pechiney Corp., 25%; Quebec Government, 24.95%)	Smelter, Beacancour, 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 Luralco 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. Marys 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).
Do.	Cardinal River Coals Ltd. (Luscar Ltd. 50%; Consol of Canada Ltd. 50%). Operated by Cardinal River Coals Ltd.	Metallurgical bituminous coal, mined near Hinton, Alberta.	3,000.
Do.	Genessee Coal Mine (Operated by Fording Coal Ltd, owned by Edmonton Power	Sub-bituminous thermal coal; near Warburg, Alberta.	3,600.
Do.	Phalen Colliery; operated by Cape Breton Development Corp.; (Government of Canada).	New Waterford, Nova Scotia.	2,200.
Do.	Quintette mine. Quintette Coal Ltd. (Teck Corp 45%). Operated by Teck Corp.	Tumbler Ridge, British Columbia, SW of Dawson Creek.	6,200.

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	Cassiar Mining Corp. (Princeton Mining Corp., 100%)	Similcom 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.	
Do.	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.	Princeton Mining Corp.	Similco mine, Princeton, British Columbia (suspended)	450 (kilograms 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.	do.	Dome mine, South Porcupine, Ontario	9.8 (tons 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).	

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
Iron and steel--Continued:	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, Kimberly, British Columbia	3,600 (ore).
Do.	do.	Polaris mine, Cornwallis Island, Northwest 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.	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, Ungava, Quebec	21 contained metal).
Do.	do.	Smelter, Falconbridge, Ontario	45 (rated capacity).
Do.	Inco Ltd.	Sudbury, Ontario, district mines: Frood, Stobie, Creighton, Copper Cliff North and South, Garson-Ofsets, 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, northern Alberta; Chauvin, Sibbald, North Pembina, Alberta
Crude	million 42-gallon barrels	do.	do.
Do.	do.	Gulf Canada Corp. (Olympia & York Developments, 80%; Gulf, 20%)	Fenn-Big Valley, Swan Hills, Goose River, Peerless, and Sene, Alberta
Do.	do.	Home Oil Co. Ltd. (Interhome Energy Inc., 100%)	Red Earth, Garrington, Cherhill, Medicine River, and Swan Hills, Alberta
Gas	billion cubic meters	do.	do.
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
Gas	million cubic meters	do.	do.
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
Gas	billion cubic meters	do.	do.
Crude	million 42-gallon barrels	Norcen Energy Resources Ltd. (Hollinger Inc., 59%; Hees International, 41%)	Pembina, Bodo, Majorville, Alberta
Do.	do.	Oakwood Petroleums Ltd. (Sceptre Resources Ltd., 100%)	Grantham, Hays Ronalane, Peace River, Normandville, Randell, Alberta, and Grizzly Valley, British Columbia

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	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.
Crude	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.
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 (tons).
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.		do.	Rabbit Lake, Saskatchewan	5,445 (oxide).

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
Zinc	Breakwater Resources Ltd.	Nanisivik mine, Baffin Island, Northwest Territories	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.	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, British 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).

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

TABLE 3
CANADA: RESERVES OF MAJOR MINERALS IN 1999

(Thousand metric tons unless otherwise specified) 1/

Commodity	Reserves
Asbestos, fiber	35,700 e/
Coal, all types	6,220,000 e/
Copper	8,400
Gold	1,415 2/
	metric tons
Gypsum	482,000 e/
Iron ore	1,261,000 e/
Lead	1,845
Molybdenum	121
Natural gas	1,810 e/
	billion cubic meters
Nickel	5,700
Petroleum crude	4,930 e/
	million barrels
Potash, K ₂ O equivalent	13,990 e/
	million tons
Salt	264,000 e/
	thousand short tons
Silver	15,738
	metric tons
Sodium sulfate	81,300 e/
	thousand short tons
Sulfur	130,000 e/
Uranium	416 3/
Zinc	10,200

e/ Estimated.

1/ 1998 and 1999 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 of U, or less.