

THE MINERAL INDUSTRY OF

CANADA

By David B. Doan

Lower metals prices during 1997 triggered a decline in Canadian mine output of base metals that was compensated for by increased production of industrial minerals and so-called structural mineral materials. Overall value of production increased slightly in Canadian dollars compared with that of 1996, but showed little difference in terms of U.S. dollars.¹ Thus, the 1996 figure for total value of mineral production, \$36.4 billion, was succeeded by a lesser value for 1997, or \$36.0 billion, although the equivalent Canadian value had climbed slightly at about 0.3%. Canada's economy as a whole fostered an increase of about 3.8% in gross domestic product (GDP), unemployment dropped significantly, and inflation remained low at 1.6% (Financial Times, 1998, p. 1). During the year, however, prices declined for copper, lead, and nickel and remained soft for zinc. Moreover, gold prices weakened as the central banks of several nations lowered their inventories by selling in world markets. In Canada, as in some other parts of the world, various mines went on suspension, or in some cases closed, pending improvements in economic incentive to mine base and precious metals.² After spreading to most of Canada, exploration for diamond continued with less public excitement than previously but with an increasing number of "finds." One of the biggest news-makers in the Canadian mining industry continued to be the huge nickel-copper-cobalt deposit at Voiseys Bay on the Labrador coast, where drilling results confirmed an unusually large, high-grade ore body that was open east and west, as well as downward. First Nation (aboriginal peoples) interests, environmental issues, and low nickel prices created problems and delays that threatened development of this ore body. Although a large number of Canadian mining companies have been exploring in other countries, such discoveries as Voisey's Bay reaffirmed that there is much still to be found in Canada. Overall outlay for 1997 exploration costs in Canada amounted to about \$578 million, down somewhat from the \$693 million spent in 1996, and reflecting lower markets prices for metals.

The Bre-X Minerals Ltd. fraud in Kalimantan, Indonesia, in which drill-core samples from its Busang property were salted with gold, became a world-class scandal that involved the loss of

hundreds of millions of dollars in connection with the collapse of Bre-X share prices from more than \$200 to \$0.08 on the Toronto Exchange. Financing of junior mining companies became more difficult to negotiate, and not only in Canada. Various exchanges, particularly the Toronto Exchange, reviewed and tightened their requirements for public offerings.

Environmental concerns continued to interact with mineral exploration and development activity throughout Canada, leading some companies to look elsewhere for projects. Central America and South America proved attractive, as companies saw that foreign investment was welcomed, mining laws were coherent and reasonable, and profits could be repatriated.

Various observers have commented that nongeologic criteria have become increasingly important in considering exploration in Canada. Land use, never given much attention in the past, is an issue today. After years of neglect, First Nation rights are now receiving much consideration. The antimining lobby in Canada is hardy enough that many of mining's supporters are urging that the industry be more vocal in defending its interests (Mining Journal, 1998, p. 227). Canada's Minister of Natural Resources stated that Federal and Provincial Governments are working on reform of the present regulations that should afford an improved regulatory climate for mineral exploration throughout Canada.

Government Policies and Programs

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

¹Where necessary, values have been converted from Canadian dollars (CAN\$) to U.S. dollars at an average rate of CAN\$1.385=US\$1.00 for 1997. All values in this report, unless otherwise specified, are expressed in U.S. dollars.

²For more detailed information on the mineral production in Canada, see the Canadian Minerals Yearbooks for 1996 and 1997, 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.

Canada reacted to the Helms-Burton legislation (essentially sanctioning those doing business with, or in, Cuba) passed by the U.S. Congress in 1996 by drafting legislation to allow Canadians to countersue in Canadian courts for damages incurred in U.S. courts under Helms-Burton. The U.S. Department of State announcement that it would be ready to revoke the visas of persons deemed to have violated the provisions of the act was poorly received in Canada. The most likely target was Sherritt International, a Canadian company investing in the development of Cuban nickel mining operations (Mining Journal, 1996, p. 481).

In Ottawa the Supreme Court of Canada handed down a unanimous landmark decision that a case brought in 1987 on behalf of about 6,500 indigenous peoples in British Columbia concerning rights to 58,000 square kilometers (km²) resource-rich lands should be retried. This decision, which appeared to establish the principle that the native Indian rights were not extinguished by European settlement in Canada, had far-reaching implications for much of Canada (Mining Journal, 1997a, p. 1).

The Government of Quebec has taken a step toward changing to a map-based system of pre-surveyed claims with the aim of replacing the use of stakes to establish claim corners. This would remove a varying degree of uncertainty in the exact position of claim boundaries and simplify the burden of claiming and assessment work.

Environmental Issues

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

In a concerted effort to devise national policy fundamentals aimed at forestalling the kinds of shutdown actions represented by the multibillion-dollar Windy Craggy cobalt-copper-gold-silver-zinc mine development in British Columbia, Natural Resources Canada issued a wide-ranging statement of policy goals linking environmental considerations with minerals, metals, markets, labor, investment, and taxation (Natural Resources Canada, 1996b, p. 1-25). This paper addresses life-cycle management, safe use, health and the environment, reclamation, recycling of minerals and metals, the role of science and technology, and First Nation concerns, aiming to establish the equilibrium between interests necessary for sustainability. A typical example of the need for such an approach was demonstrated when the Labrador Inuit Association received an appeal by indigenous protest groups at Voisey's Bay who were objecting to the development of the huge nickel-copper-cobalt ore body until an environmental assessment and an impact benefits study could be agreed upon with Inco Ltd. The negotiations were complicated by longstanding, overlapping land claims by Inuit (formerly Eskimos) and Innu (formerly the Neskaupi Indians). By the end of the year, a number of key disputes were resolved, with the result that the Inuit were to receive 25% of Newfoundland's tax revenues from mining, oil and gas, and quarry developments in

the region and, specifically, 3% of the Provincial royalties from the Voisey's Bay project. At yearend, the Innu had not reached a resolution of their concerns on land claims and impact benefits, but the entire Voisey's Bay project was delayed for at least a year, to the satisfaction of the Inuit and Innu. Environmental assessments were not ready for submittal until close to the end of the year.

Meanwhile, 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 sulfur-dioxide (SO₂) emissions would be captured and that the complex would produce less atmospheric SO₂ than any existing industry in Newfoundland. This did not satisfy environmental activists, who launched a campaign against the smelter per the Canadian Environmental Assessment Act; this action could stall any project for years (Engineering and Mining Journal, 1997b, p. ww-13).

Production

Total value of production of all mineral commodities, including mineral fuels, was \$35.998 billion, up only slightly from that of 1996, which, in turn, was 13% more than that of 1995. The growth in value of production was stalled essentially by uncertainty in connection with lower metals prices and the unpredictability of price recovery in the midst of serious financial problems in Asia.

In the three nonfuels groups (metals, nonmetals, and structural materials), changes from the previous year were mixed. Production values of metals dropped \$196 million to \$8,252 million while nonmetals gained \$104 million for a total of \$2,096 million. Structural materials increased by \$110 million, compared with 1996, to a total of \$2,018 million in 1997. The performance of these three groups was aided slightly by an increase of \$119 million in the value of mineral fuels produced, amounting to \$23,632 million. Value of natural gas production climbed almost 16% to \$7.301 billion; part of this was represented by higher market prices. The value of natural gas byproducts, however, declined about 1.8% to \$1,843 billion. Petroleum crude output increased 4% versus 1996, but value dropped by almost 5% to \$13,094 billion because of the sag in world crude prices. Finally, the value of coal production increased by about 3.5% to \$1.394 billion in 1997, a new record. Geographically, the sources of mineral fuels production were Alberta, 79.1% of the total; Saskatchewan, 10.3%; British Columbia, 8.1%; and all other Provinces and Territories, 2.5%.

In terms of value of production in 1997, the top nonfuel commodities were gold at \$1.8 billion; by copper, \$1.49 billion; zinc, \$1.36 billion; nickel, \$1.28 billion; potash, \$1.06 billion, and iron ore, \$1.03 billion.

Market prices played a role in the mineral commodity values, particularly for gold, whose value decreased by \$217 million despite a small increase in production tonnage. Value and tonnage of copper output remained about the same in 1997 as in 1996, but values were significantly lower than those of 1995 because of sharp price reductions in 1996. Value of nickel production also dropped by about 7.5% in 1997 owing mainly to

lower nickel prices. One exception was the 1997 value of zinc production, up by 15.4% even though production volume declined by 12.5%, thanks this time to increased market prices.

Ontario was the leading producer of nonfuel mineral commodities, accounting for 31.8% of the total value, followed by Quebec, 19.3%; Saskatchewan, 11.9%; British Columbia, 11.5%; Manitoba, 6.0%; Newfoundland, 5.7%; New Brunswick, 5.4%; and other Provinces and Territories, 8.4%. 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, including fuels, totaled \$51.50 billion in 1997, an increase of more than 5% compared with that of 1996, and represented about 26% of all Canadian exports for that year. Of total mineral and mineral-product exports, metals registered 47.6%; fuels, 41.6%; nonmetals, about 9.6%, and building materials, about 1.2%. Value of exports of nonfuel minerals (but including coal) was \$32 billion, representing an increase of 1.3% compared with that of 1995. Included in these exports were crude minerals, smelted and refined products, and semifabricated and fabricated products. Prominent among the crude minerals exported were iron ore, potash, and sulfur to the United States; copper concentrates to Japan; iron ore and zinc concentrates to the European Union (EU); smelted and refined metals, including aluminum, copper, gold, iron and steel, nickel, silver, and zinc to the United States; aluminum and gold to Japan; and copper and nickel to the EU. Coal exports went mostly to Japan.

Mineral and mineral-product imports, including fuels, were valued at \$36.1 billion, amounting to more than 18% of the value of all imports. In terms of net trade, the mineral (including fuels) surplus was valued at \$21.3 billion. Total trade between the United States and Canada exceeded that of any other two countries in the world. Exports to the United States from Canada were a record \$159.1 billion in 1996 according to the latest information available.

Structure of the Mineral Industry

The Canadian mineral industry comprised about 3,000 domestic and perhaps 150 foreign companies. 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. Roughly 300 mine sites, including coal, were active. Another 3,000 mines and quarries produced sand, gravel, and other construction materials. At least 40 smelters and refineries were operating, plus other processing plants in the cement, sodium chlorate, and sulfuric acid industries. Foreign companies were subject to the same taxes as domestic companies, but repatriation of earnings was unimpeded.

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

Overall, the mineral industry in Canada consisted of underground mines, open pits, leaching operations, concentrators, smelters, and refineries, as well as drilling and production operations characteristic of the petroleum industry. Table 2 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 1997 by Statistics Canada indicated that total employment in mining and mineral manufacturing, including coal, was about 368,000, up 5% from that of 1996. The total number of employees in metal, nonmetal, and coal mining, and quarrying was estimated by Statistics Canada to be 64,000, up about 5,000 jobs compared with the 1996 level. Employment in nonferrous smelting and refining was estimated to be 59,000, about the same as that of 1996. About 8,900 people were also employed in diamond drilling and other support services incidental to mining operations.

Commodity Review

Metals

Aluminum.—Production of primary aluminum was 2.327 million metric tons (Mt), an increase of about 2.0% compared with that of 1996. This put Canada third, after the United States and Russia, in the world in volume of production and second, after Russia, in volume of exports. Primary aluminum exports during the year were 1.88 Mt valued at \$3.25 billion.

After postponing an investment of \$729 million to double its smelter's capacity at Sept-Iles, Quebec, Aluminerie Alouette Inc. began what was to have been a 3-year shift from carbon potlines to graphitized cathodes, costing about \$72 million. This was projected to increase the smelter's capacity from 218,000 metric tons per year (t/yr) to 229,000 by boosting the current from the original 300,000 amperes to 315,000. Elsewhere in Quebec, Aluminerie Lauralco Inc. finished a \$12 million overhaul of its smelter's 264 pots at its potline refurbishing center at Deschambault, where it produces 215,000 t/yr.

After having to take a \$420 million write-down of its Kemano hydroelectric power project near Kitimat, British Columbia, when the Provincial Government decided to cancel the half-built project, Alcan negotiated an agreement to add 225,000 t/yr to the

existing 272,000-t/yr Kitimat smelter, where Alcan restarted 22,000 t/yr of existing capacity that had been idle since 1994.

In Quebec, Alcan completed public hearings on the potential environmental impact of a 375,000-t/yr smelter at Alma and filed the results with the Ministry of Environment late in the year. 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 smelters in Quebec, Alcan's hydroelectric power system stood ready to accommodate Hydro-Quebec's requirements when feasible.

Antimony.—A drop in the output of antimony to 776 metric tons (t), representing a decrease of 56% compared with that of 1996, was attributable, at least in part, to declining prices in conjunction with increasing supplies. In mid-1996, Roycefield Resources Ltd. announced that they planned to open one of the largest antimony mines outside China. According to the company, their Beaver Brook deposit, near Gander, Newfoundland, has reserves of 59,000 t, which could put it in position to provide 5% of the world's antimony supply. This \$15 million project will produce high-purity antimony trioxide (Sb_2O_3) for use as a fire retardant for the plastics and vinyl industries. Because the deposit is open in all directions, its full extent may not be known until further exploration is completed. Gold is also present in one zone, showing 8.8 grams per metric ton (g/t) over a 1.1 meter (m) intercept, which could enhance revenues (Metal Bulletin Monthly, 1997, p. 49).

Cobalt.—Production of refined cobalt reached 3,738 t, an increase of nearly 4% compared with that of 1996. Rising demand for cobalt for alloys, catalysts, magnets and batteries, and even pigment, its oldest use, has focused new attention on cobalt resources in Canada, led by the Voisey's Bay discovery of at least 40,000 t, with further results expected as exploration progresses.

Cobatec Inc., which operates a cobalt-nickel solvent extraction plant in North Cobalt, Ontario, has negotiated a long-term supply agreement with the Cuban Government to process cobalt-nickel sulfate precipitates from Cuba. During the first 3-year period of the agreement, recovery is expected to average more than 1 million pounds per year (445 t/yr) of cobalt and 2.5 million pounds per year (1,134 t/yr) of nickel. Processing was scheduled to begin at the end of the year. This production was to be from the new \$15 million facility established by Ego Resources Inc., now named Cobatec (Engineering and Mining Journal, 1997a, p. 108).

The company 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, demonstrating that resource development can coexist with environmental responsibility.

Copper.—Mine output of copper dropped 4.5%, reflecting a further decrease following the 5.5% decline of 1996. Weakness of world copper prices was the prime influence of these contractions

in output. Production of primary refined copper, however, increased slightly. Copper production by solvent extraction-electrowinning (SX-EW) increased by about 8% compared with that of 1996. After firming to a temporary peak in 1995, the softening of copper prices into 1996 and 1997 resulted in suspension or shutdown of some copper production.

Princeton Mining Corp. pursued its Huckleberry project on schedule, expecting production of 37,000 t/yr of contained copper after startup in November, 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. Late in 1996, Princeton suspended production at its Similco mine in British Columbia, pending exploration results on-site and the hoped-for improvement of copper prices after their collapse in conjunction with Sumitomo's copper-trading scandal in Japan. The mine has been on care and maintenance during the year.

Near Flin Flon, Manitoba, Hudson Bay Mining and Smelting Co. Ltd. reported that it had encountered new reserves close to its present mining operations. Combined with some innovative cost-cutting measures, exploitation of the new deposits could extend mine life significantly beyond the previously scheduled closure date of 2004. The new resource is projected to be about 13.3 Mt grading 3.3% copper and 5.8% zinc, plus precious metals comprising 2.7 g/t gold and 37.7 g/t silver.

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

Falconbridge Ltd. was forced to suspend operations for 4 days at its Kidd Creek mine because of movement in the pit's east wall. Part of the infrastructure in the upper mine was damaged and scheduled for redevelopment. A further consequence was that the Kidd Creek smelter was scheduled to close down for 2 weeks in March, owing to production problems at the mine caused by the movement. In December, Falconbridge prepared to initiate production at the very end of the year at its \$360 million Raglan mine on the Ungava Peninsula of northern Quebec. This nickel-copper mine will produce 5,200 t/yr of copper.

Although the SX-EW technique for copper production leads to significant cost savings, all byproduct credits are lost in the process as a result of the year's low market prices for copper. The revenue flow is thus completely dependent on the price of copper. By normally conferring a so-called risk-reduction advantage as byproduct prices help buoy the revenue stream, Canada's many polymetallic copper deposits lose this benefit during SX-EW operations.

Overshadowing all potential copper production in Canada, the Voisey's Bay discovery, still being evaluated, suggested that Canada, ranking third after Chile and the United States, will continue to be a major world copper producer. Expectations were that Voisey's Bay might yield 99,000 t/yr of contained copper, but, in terms of a variety of administrative concerns, the mine was a long way from production.

Gold.—Continuing the gold production surge that started in 1995, output climbed to about 169 t, up 2.6% after the 9%

increase in 1996. Predictions made in 1995 that output would reach 170 t by 1998 were seen as somewhat pessimistic, although price weakness late in the year may have adverse consequences in 1998. Canada was the fourth largest gold producer after South Africa, the United States, and Australia.

The pace of exploration for gold seemed to increase steadily, along with various innovations in the chemistry and physics of search techniques supporting the effort in Canada and by Canadian companies in other countries. Canadian companies also pioneered in the enhancement of recovery techniques in the ongoing effort to improve leach processing.

At the beginning of the year, about 50 primary gold mines in Canada accounted for 89.5% of the gold produced, with the remainder coming from base metal mines (8.4%) and placer operations (2.1%). Total employment in primary gold mines totaled 9,406 in 1996 (the latest year for which data are available). Employment figures have been improving since 1993, when the steady decline from the 1988 peak of 12,600 was halted. Principal gold refiners are Noranda Inc. in southern Quebec; the Royal Canadian Mint at Ottawa, Ontario; Johnson Mathey Ltd. near Mississauga, Ontario; and Imperial Smelting and Refining, near Toronto.

After finishing its reevaluation of the venerable San Antonio mine at Bissett, Manitoba, which has previously produced more than 1 million ounces (31 t), according to mining records held by various former owners, Rea Gold Corporation prepared for full production with a first pour in 1997. Rea carried out an intensive sampling program after pumping out all the levels of the 5,500-foot-deep mine. Reserves are projected as being 3.5 Mt grading 9 g/t, or about 30 t of gold, with a projected output of 3 t/yr. Rea, however, was financially over-extended at other mines outside Canada, as well as in their San Antonio startup, at about the time gold prices confirmed a serious downward trend. San Antonio was closed at the end of the year, and the company was forced into bankruptcy and liquidation of its assets.

Raymo Processing Ltd., a subsidiary of Electra Mining Consolidated of Vancouver, recovered gold from mine tailings on the old Rambler property near Baie Verte, Newfoundland. Extraction is by indoor vat leaching, a technique developed by NovaGold Resources Inc. of Halifax. Recovery has exceeded 80%, with 85% as an eventual goal (Canadian Mining Journal, 1996).

Viceroy Resource Corporation opened its open-pit gold mine in Yukon Territory at a capital cost of about \$44 million. Scheduled to produce 85,000 ounces per year (2,600 kg/yr) during a 7.5-year mine life, the project is notable for its successful heap leaching during the winter months. With temperatures that reached -43.5° C, the operation demonstrated that cold weather need not be a factor in planning this type of recovery. The company took several precautions, such as covering the ore under leach with a 4-m-thick insulating frost cover layer; insulating and heat-tracing solution pipes; heating of outgoing barren cyanide process solutions using waste heat from diesel-powered generators, and the use of a waste-oil fired heat exchanger. Metallurgical analysis indicated a recovery of 78% in 120 days.

Gold seemed to be the principal targeted metal for exploration virtually throughout Canada. In terms of value of production, gold led the list, exceeding copper (second) and zinc (third).

Iron Ore.—Production of iron ore climbed to 37.3 Mt compared with 34.4 Mt in 1996 for an increase of more than 8%. This category comprised concentrates, pellets, and sinter from hematite and siderite ores. Major iron-ore-producing companies included Quebec Cartier Mining (QCM), Iron Ore Company of Canada (IOC), Wabush Mines, and the Algoma Ore Division (AOD) of The Algoma Steel Corp. Ltd.

Although data are not available for 1997, the latest year for which data are available, 1995, gives an approximation of the proportions of pellets and sinter versus concentrates. QCM produced 16.1 Mt of ore in 1995, of which 8.3 Mt was used for pelletization and the remainder, sinter feed. Shipments exceeded production so that stocks were drawn down to meet demand. IOC produced 15.9 Mt of ore, of which 10.8 Mt went to pelletization; the remainder went to concentrates that were not used for pellets. Wabush Mines turned out 5.3 Mt of iron-ore pellets. AOD produced 975,000 t of sinter at its complex in Wawa, Ontario.

Changes in 1997 included output of a record 8.9 Mt of pellets by QCM and an announcement by AOD that the Wawa operation would be closed. Cleveland Cliffs Inc. increased its ownership of Wabush Mines to 22.8% by purchasing Inland Steel's 15.1% share.

Exploration and development continued in various parts of Canada, including Roche Bay in the Northwest Territories, the Peace River area of Alberta, and Ungava Bay and Schefferville in Quebec.

Pig iron production increased slightly to 8.68 Mt from 8.64 Mt in 1996, a change of less than 1%. The proportion of direct-reduced iron to pig iron produced was 16%, thus increasing the ratio of 10% forecast 2 years before. Crude steel production was about 15.5 Mt compared with an estimated 14.5 Mt in 1996, making it the highest in 5 years and roughly equal to the peak of 15.5 Mt in 1989.

Lead and Zinc.—Canada was the world's second largest mine producer of zinc and the fifth largest producer of lead with totals of 1,088,968 t of zinc and 186,180 t of lead in concentrate, respectively. Lead production, in particular, was down sharply, showing a decrease of 28% compared with that of 1996. Zinc showed a parallel loss of almost 13%. The notable decrease in production of both commodities resulted primarily from market price fundamentals, which saw lead prices working their way downward from \$0.36 per pound to \$0.24 per pound throughout the year. Zinc prices, however, worked upward sharply to a peak of \$0.75 per pound in August followed by an equally sharp drop to \$0.50 per pound at the end of the year. Hence both commodities sustained price declines of 33% during the year.

Anvil Range Mining Corp's. Faro lead-zinc mine, one of the world's largest, had reached its capacity of 150,000 t/yr of zinc and 98,000 t/yr of lead in concentrate in August 1996. It was then put on hiatus (processing only stockpiled material) in December 1996 because of the then low zinc prices. In March, the entire operation went on standby, dewatered and ventilated but with no production. After the zinc price run-up culminating in August, the mine was reopened in October, just in time for the steep drop in zinc prices. The reopening had a depressing effect on already soft lead prices, thus being somewhat self-defeating for Anvil Range so far as the economics of lead were concerned. At

the end of the year it was rumored that the Faro mine might close again.

At the end of the year, Noranda closed its operation in the Matagami district of northern Quebec after the exhaustion of the Isle Dieu and Norita East zinc-copper mines, thus losing a source of 50,000 t/yr of zinc concentrate. The company continued development of its Bell Allard zinc-copper project, also in the Matagami district. After 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 is expected to have a capacity of 80,000 t/yr of zinc and 5,000 t/yr of copper.

After suspending operations at about the same time as the Faro mine, and for the same reasons, in late 1966, Cambior resumed operations in July at its Gonzague Langlois (formerly Grevet) zinc-copper mine near Label-sur-Quevillon, Quebec.

Cominco Ltd. shut down its superannuated 100,000 t/yr lead smelter at Trail, British Columbia, to coincide with the opening of its new Kivcet lead smelter and slag-fuming furnace also at Trail. The new smelter required modifications to its external power supply and experienced some difficulties with the oxygen fuel supply, necessitating a 5-week shutdown near the end of the year.

Nickel.—Mine output fell slightly to 190,529 t of contained nickel, a decrease of just more than 1.1% compared with that of 1996, which was up about 6% from that of 1995. As with certain other base metals, the market did little or nothing to encourage nickel production. Prices remained weak throughout most of the year.

Falconbridge Ltd. pressed development of its Raglan nickel-copper property in northern Quebec sufficiently to begin production ahead of schedule in December. Reserves at this property now stand at 20.6 Mt grading 3.17% nickel and 0.88% copper. The \$360 million operation is scheduled to produce about 20,800 t/yr of nickel in concentrate and about 5,200 t/yr of copper in concentrate by mid-1998. Raglan concentrates will be shipped from Deception Bay, 100 kilometers (km) north of the mine, to Quebec City and continue by rail to Falconbridge's Sudbury smelter in Ontario.

Inco and Falconbridge experienced labor difficulties during the year. At Sudbury, Inco was struck for 26 days until employees accepted a new labor package comprising improvements to wages, vacation bonuses, pensions, and contracting out. In August, Falconbridge was struck for 23 days until employees agreed to a wage increase with pension improvements and enhanced health benefits. Cost reductions, however, were the objective for most nickel producers, and Inco planned to close higher-cost mines and to reduce its labor force by about 7%. Capital expenditures were cut wherever possible in the light of static nickel prices and demand.

Probably the biggest newsmaker in nickel continued to be Inco's nickel-copper-cobalt project at Voisey's Bay, where exploration drilling continued. In February, the company announced the discovery of a new mineralized zone below and nearly contiguous with the deposit's western extension. The new zone plunges eastward toward the original, or ovoid, discovery zone and shows nickel values grading from 1.2% to 2.8%.

Although this is a lower grade for nickel than that of the ovoid zone, the copper and cobalt grades are higher than in the ovoid and eastern deeps zones (Northern Miner, 1997, p. 1). As exploration progressed other developmental problems (See Environmental Issues) came to the fore. As a result, Inco announced in September that the entire project would be delayed for at least 1 year as First Nation claims and environmental challenges arose that required adjudication before development could proceed. After settlement of some, but not all, of these issues, Inco announced in December that the 1-year delay had stretched to at least 18 months after receipt environmental and other permits (Mining Journal, 1997b, p. 487). Current plans propose mining 15,000 metric tons per day (t/d) from an open pit, forming a concentrate, and shipping to a smelter-refinery complex at Argentia, where refinery output would be 122,500 t/yr. Total capital costs would exceed \$1 billion. This operation will clearly affect the economics of nickel production and marketing for some time to come.

Platinum-Group Metals.—Mine production of platinum-group metals (PGM) decreased by almost 7% compared with that of 1996. Production 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 Co. Ltd.'s and Outokumpo Mines Ltd.'s Namew Lake mine near Flin Flon, which is now 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, having traded at \$4,000 per ounce at one point in the past decade. Beginning in 1995, however, rhodium prices dipped to levels only slightly higher than those of gold.

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

Silver.—Production of silver in concentrate declined nearly 7% compared with that of 1996. This was a reflection of the overall decline in base metal production during the year. Although gold production was up slightly, the decrease in production of copper, lead, and zinc was more than enough to counter the gold output trend.

Canadian silver production has been largely a coproduct of base metal and gold mining, subject to whatever mining incentive applies to the major product, whether gold, copper, or lead-zinc. Accordingly, silver output suffers when mines close or go on suspension for reasons involving supply, demand, and pricing for other major mineral commodities. Production increased significantly in 1995 when Prime Resources Group Inc.'s Eskay Creek gold mine in British Columbia came on-stream as the largest producer of silver in Canada; output of silver from this mine is expected to be 340 t/yr.

Canada ranked fifth in world silver production after Mexico, Peru, the United States, and the Commonwealth of Independent States, formerly part of the Soviet Union.

Titanium.—Output of titanium is estimated to have risen to 850,000 t, an increase of about 3%, since 1996. QIT-Fer et Titane (QIT) of Canada scheduled an investment of \$260 million in construction of a plant at Sorel, Quebec, to produce an upgraded slag, called UDS, containing 95% titanium dioxide (TiO₂) compared with its present Sorelslag containing 80% TiO₂ (Industrial Minerals, 1996, p. 9).

Uranium.—The upward trend in production of uranium oxide (U₃O₈) continued, with an increase of about 2% compared with that of 1996. 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 world demand and rising spot- and open-market prices. As older mines were shut down in the Elliot Lake district of Ontario, newer ones were being developed and mined in the Rabbit Lake, Key Lake, Cluff Lake, and Cigar Lake districts of Saskatchewan.

Industrial Minerals

Asbestos.—Canadian asbestos production dropped almost 12% compared with that of 1996, continuing a decrease that involved an earlier drop in output of between 2% and 3% from 1994 to 1995, and 8% from 1995 to 1996. After Russia, Canada was the second largest producer of asbestos. Increasing concern regarding chrysotile substitutes were expected to benefit the chrysotile industry over the near to medium term. Marginal gains were expected in Latin American consumption of Canadian chrysotile; but Asia, already a significant market taking about 58% of exports, was seen as expanding the demand for Canadian fibers. Asbestos-cement product demand was consistent as many users continued to favor this combination over substitute fibers and steel.

LAB Chrysotile, Inc. closed its mine near Black Lake, Quebec, less than 1 ½ years after its opening in July 1996. Grades were less than expected, and the company decided not to commit further investment, although the mine is on care and maintenance. Instead, LAB invested \$29 million in its Lac D'Amiante du Quebec chrysotile asbestos mine to extend the mine life by 10 years.

Cement.—Production of cement increased about 1.4% from that of 1996, reflecting continued strengthening of the export market in the midst of prices that have been declining since 1978 (valued in 1986 dollars). Weakening of the Canadian dollar versus the U.S. dollar since the beginning of the 1990's, especially in early 1995, has made Canadian cement prices attractive to U.S. consumers across the border at a time when domestic consumption withered in the face of diminishing residential and nonresidential construction, although there were signs that consumption was improving near the end of the year. 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 dumping of cement by Mexican producers essentially removed them as competitors, leaving the field to Canada as the principal foreign source. For the immediate future, certainly, the success of Canadian cement producers will be based significantly on exports to the United States and, hence, upon the prospects for U.S. economic growth. Canadian growth and construction, particularly in Ontario, the largest cement market, will play the key role in determining a balance between domestic and U.S. consumption.

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

Diamond.—Canada's first commercial production of diamond by BHP/Dia Met joint venture was expected to begin in 1998, as mine construction progressed, including extensive support facilities, such as arctic living quarters and a powerplant.

More than 500 companies have been exploring for diamond, especially in the Northwest Territories, but also in Alberta, British Columbia, Labrador, Manitoba, Ontario, Quebec, and Saskatchewan. The field seemed to be narrowing somewhat as various kimberlite pipes proved disappointing upon testing. The leading contenders in the area were the BHP/Dia-Met and the Aber Resources/Diavik projects. BHP's Diamond Division reported that the quality of diamond recovered to date from five kimberlite pipes at their Lac de Gras property, about 300 km northeast of Yellowknife, compared favorably with the best pipes in other parts of the world. The company confirmed that at current prices for rough diamond, the project to develop the pipes was economically feasible. Capital investment was to be in excess of \$360 million, but observers expected that at least \$4 billion would be spent in association with the project over a period of time.

During 1996, BHP/Dia-Met noted grades and values for their deposits. The five pipes were located under lakes bearing the same names (Panda, Koala, Misery, Fox, and Leslie) and would be mined during a 30-year period. Current results on the pipes were as follows: Panda, 0.95 carat per ton (kt/t) at \$130 per carat, resulting in an ore value of \$124 per metric ton; Koala, containing 0.95 kt/t, at an average of \$122 per carat resulting in an ore value of \$116 per ton; Misery, containing 4.19 kt/t at \$26 per carat with an ore value of \$109 per ton; Fox, containing 0.27 kt/t at \$122 per carat with an ore value of \$34 per ton; and Leslie, having 0.33 kt/t at a value of \$89 per carat for an ore value of \$29 per ton. In early 1997, the company noted that the Leslie pipe would be replaced in initial operations by the Sable pipe, whose contained-diamond value was rated at \$63 per ton versus the Leslie's lower value (Mining Journal, 1997a, p. 130). The planned centralized processing plant, which was to be located southwest of the Koala pit, would receive 9,000 t/d of ore during the first 9 years of operation and 18,000 t/d thereafter. The cutoff grade would be 0.01 carat. Processing was expected to involve mainly crushing, scrubbing, and dense-media separation, plus high-intensity magnetic separation, X-ray concentration, and sorting. The construction phase work force was projected to reach

1,000 at its peak; after that, about 650 workers would be employed during production.

Also in the Lac de Gras area, Diavik moved ahead with sampling of three of its pipes, but had not announced mining commitments at yearend. The A-145 South pipe yielded analyses of 4.54 kt/t providing a value of \$255 per ton. The nearby A-154 North pipe showed 2.19 kt/t with a value of \$77.31 per ton. Finally, the A-418 pipe graded 4.02 kt/t providing a value of \$258 per ton (Northern Miner, 1996, p. 1). Diavik is owned by Rio Tinto (60%) of the United Kingdom and by Aber Resources of Vancouver (40%).

Graphite.—Shipments of graphite, estimated to be about 44,000 t, were thought to have remained flat compared with those of 1996. 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 near Kearney, Ontario. 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 dominant position of Strategic Exploration now, the probabilities of success for other new graphite mines were clearly marginal.

Gypsum and Anhydrite.—Production of gypsum and anhydrite increased nearly 45% compared with that of 1996, continuing its overall climb from 1992. Production thus far in the 1990's, however, has not equaled the 1989 output of more than 12 Mt prior to Canada's economic recession and accompanying sag in domestic construction.

Production has been mostly by Canadian subsidiaries of United States and British companies such as USG Corp. and National Gypsum Co., governed by demand for wallboard in all building categories by consumers in the United States and Canada. Nova Scotia and Newfoundland produced the bulk of Canadian gypsum, with lesser amounts from Ontario, British Columbia, and Manitoba, in about that order of commodity value. Although gypsum occurs widely in Canada and the world, the high unit weight, low unit cost, and vulnerability to damage of wallboard combine to give gypsum products a relatively high place value, discouraging long-distance transportation. Instead, gypsum industries tend to develop in localities that serve developing construction requirements. As with the cement industry, gypsum production in Canada and the United States 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. About twice as hard and heavier than gypsum, anhydrite is produced in Nova Scotia by Fundy Gypsum Co. Ltd. at Wentworth and Little Narrows Gypsum Co. Ltd. at Little Narrows.

A gypsum discovery in Newfoundland, located on Exempt

Mineral Land about 2 km from the coast, was described as flat-lying and 93% pure; the Government of Newfoundland invited proposals for its exploration and development. About 17 Mt of reserves are indicated from preliminary drilling.

Tusket Mining Inc. proposed opening a gypsum mine in the Murchyville-Elderbank area of Halifax County, Nova Scotia. With projected reserves of more than 400 Mt, the Murchyville deposit is the first significant gypsum discovery in Nova Scotia since the 1970's (Nova Scotia Department of Mineral Resources, 1996).

Potash.—Potash production climbed by more than 14% compared with that of 1996, totaling 9.30 Mt of K₂O equivalent, mostly from mines in Saskatchewan, but with about 8% of it coming from New Brunswick. Most Canadian potash was shipped to the United States (almost 60%), Asia (about 26%), and Latin America (about 8%), with the remainder going to Oceania and Western Europe. Exports to the United States have risen steadily to satisfy agricultural needs. Exports to Asia increased by 20%, compared with 1996, owing to a conspicuous increase in shipments to China, which accounted for about one-third of all offshore exports of potash from Canada.

The Potash Company of Canada Ltd. (Potacan) had to shut down its Cloverhill underground mine, near Sussex, New Brunswick, unexpectedly when it experienced water inflow in June. Despite continuous efforts to salvage the operation for the remainder of the summer, the mine flooded in the fall and was evidently beyond saving. The mine had been producing since 1985.

Potacan is jointly owned by Enterprise Miniere et Chimique of France and Kali und Salz AG of Germany. Potacan's assets were thought to be under consideration for purchase by the Canadian company, Potash Corporation of Saskatchewan. IMC Global concluded its exploration work at the Millstream deposit near Sussex.

IMC Kalium began a structural consolidation at the Esterhazy mines in Saskatchewan to reduce water inflows that have been a problem for at least 10 years. At Alsask, the Potassium Sulfate Co. commissioned a 25,000-t/yr potassium sulfate plant.

Sulfur.—Production of all forms of sulfur is estimated to have remained about the same as in 1996, representing output from sour natural gas, petroleum refineries, tar sands, and smelters. Elemental sulfur, obtained from petroleum crude refining, natural gas scrubbing, and oilsand recovery, accounted for an estimated 9.37 Mt. Smelter gases yielded 801,000 t, most (or all) of which is converted and produced as 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 a 38% slice of world trade in sulfur.

Exports to the United States, however, remained soft because some Canadian producers withheld product from U.S. markets rather than cope with possible antidumping penalties after new antidumping levies were made by the U.S. Department of Commerce (DOC) on shipments received in 1994 and 1995. By this decision, the DOC established that the cost of sulfur

production should be determined at the point where sulfur is separated from hydrogen rather than at the well head or the point at which raw material reaches the processing plant.

As background, in July 1995, the DOC released preliminary results of its antidumping administrative review of sulfur sales from December 1991 to November 1992 by Canada to the United States, as requested by Pennzoil Sulfur Co., a former U.S. Frasch producer. The DOC set a preliminary dumping margin of 5.66% for three active exporters, a 28.9% rate for nonrespondents, and a 5.56% rate for other exporters who were not listed in petitions or who received revocation. Final determination was anticipated in 1996 but, instead, a new antidumping margin of 7.17% was imposed on the three leading exporters by the DOC's International Trade Administration (Green Markets, 1996, p. 1).

Mineral Fuels

Coal.—Coal production reached another record high of 78.7 Mt, surpassing the previous high of 75.9 Mt in 1996. The total value of production was \$1.39 billion, about 2.8% lower than that of 1996, owing partly price declines and partly to a progressively lower conversion rate for the Canadian dollar. Overall, production was up in the western Provinces of Alberta, British Columbia, and Saskatchewan and down in the eastern Provinces of New Brunswick and Nova Scotia. Domestic coal consumption in 1995 (the latest information available) was about 53 Mt, with 47 Mt for the generation of electricity, 4 Mt for steelmaking, and 2 Mt for other industrial uses.

In eastern Canada, domestic supplies of coal generally have to be augmented by imports, mostly thermal coal from the United States, putting Canada in the unusual position of being a major exporter and a major importer of coal. This paradox reflects transportation costs between mines and consumers and is one more example of the natural integration of U.S. and Canadian interests in mineral commodities; others include cement and gypsum. Also in eastern Canada, 5 years after the notorious Westray mine explosion in Pictou County, Nova Scotia, in which 26 coal miners were killed, a Nova Scotia court judge released his final report on the investigation into the tragedy, criticizing politicians, managers, and bureaucrats for negligence and incompetence (U.S. Embassy, Ottawa, Canada, 1997b).

Although Canada accounts for only about 2% of the world's coal production, it exports almost one-half of its production, making it the world's fourth largest exporter after Australia, the United States, and South Africa. During 1997, Canada shipped 36.6 Mt of coal to at least 20 countries; much of it went to Brazil and the Pacific Rim countries. Traditionally, more than 80% of Canadian coal exports has been coking coal, sold mostly to Japan; about 70% of Canadian thermal coal was exported to Japan and the Republic of Korea. Imports of coal into Canada during 1997 were about 13.9 Mt. Normally, the United States furnishes more than 8 Mt of this coal, and Colombia furnishes the remainder.

Natural Gas.—Canada ranked third in the world, after Russia and the United States, in output of natural gas. Increasingly, the production of natural gas has played a major role in the mineral economy of Canada and has had a palpable effect on the GDP. Gross output increased to 199 billion cubic meters (Gm³) from

198 Gm³ in 1996. Production of marketable gas was 156 Gm³; marketable gas is gross production minus reinjected gas, shrinkage, and producer consumption (plant use).

About 81.8 Gm³ (2.89 trillion cubic feet) of natural gas was exported to the United States, which was roughly 10% of the U.S. supply. Gas exports to the United States were expected to increase to about 100 Gm³ by 2006, anticipating the increasing inability of U.S. domestic production to meet demand. At the beginning of 1997, Canada's natural gas reserves were projected to be about 1.9 trillion m³ (68.1 trillion cubic feet), a net increase of 27% from the preceding year (Petroleum Economist, 1998, p. 94).

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

Petroleum Crude.—Production of crude reached a record high of 770 million barrels (Mbbbl), 4% higher than that of 1996 and 37% higher than that of 1991. Canada exported 437 Mbbbl of crude to the United States in 1996.

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

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

The Athabasca oil sands north of Fort McMurray, Alberta, played an increasingly important role in Canadian oil production. In 1995, output in the form of a light sweet crude was 25% of the total for the year. Technological development and increased operating efficiencies have steadily reduced production costs by the two major operators, Suncor Inc. and Syncrude Canada Ltd., at their sites in Alberta and northern Saskatchewan, respectively. Suncor's operating costs at the Suncor oil sands plant in Alberta dropped from \$15 per barrel in 1992 to below \$12 per barrel in 1995 and may drop to a projected \$9 per barrel in 1997. Hence, the crude from the Athabasca sands has sold for \$6 or \$7 more than the cost of production. Canada's National Energy Board

predicted that the oil sands could contribute 50% of national production by 2010.

The Athabasca, Peace River, and other bitumen and heavy oil deposits in Alberta amount to 2.5 trillion barrels of oil in place, which is about 40% of the world's known bitumen. The 300 billion barrels presently considered recoverable exceeds the 265-billion-barrel reserves of Saudi Arabia, but the latter can be extracted for less than \$1 per barrel. The Province of Alberta lowered its royalty on oil sand crude late in 1995, stipulating that it be 1% on all production until companies pay off capital costs and earn a return that 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 commodities on or about December 31, 1997. Data are shown in terms of metal contained in ore for the base and precious metals, or recoverable quantities of other mineral commodities including industrial minerals and mineral fuels. These mineral reserves represent "proven" and "probable" categories and exclude quantities reported as "possible." Reserves were defined as being well-delineated and economically minable ore from mines committed to production.

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

Other than for gold, reserves of major metals fell steadily from 1977 to 1997. During this period, gold reserves trebled from about 500 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 one-third from about 31,000 to less than 20,000 t during the same period.

From 1977 to 1995, reserves of the leading base metals decreased conspicuously. The decline was led by molybdenum, which fell 60%. Other base metals also declined—lead, 57%; zinc, 46%; copper, 44%; and nickel, 31%. In each case, the downtrend was not monotonic, but varied positively as well as negatively. From 1980 to 1982, the absolute high values showed a clustering at a time when successful exploration had increased rapidly and extraction had not kept pace.

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

Infrastructure

With a total land area of about 9,221,000 km², slightly larger than the United States, Canada has networks of highly developed infrastructure, as well as vast areas of trackless wilderness. The country had 1.021 million kilometers (km) of roads, comprising 358,371 km of paved highway and 662,629 km of gravel or other loose surface roads. Bulldozed temporary roads have been established for mining exploration in many remote places, but these deteriorate quickly where not maintained.

A total of 70,176 km of railroads included two main systems, the Canadian National and the Canadian Pacific. The country also had about 3,000 km of inland waterways, including the St. Lawrence Seaway, one of the busiest in the world, leading into the Great Lakes and marking the boundary with the United States in many places. Principal ports were Halifax, Montreal, Quebec, St. John (New Brunswick), St. John's (Newfoundland), Toronto and, on the west coast, Vancouver. Canada's merchant marine comprised about 75 ships of 1,000 or more gross registered tons.

The country had 1,139 airports. Among these, 816 had permanent-surface runways—17 had runways longer than 3,047 m, 15 had runways from 2,438 to 3,047 m long, and 138 had runways from 1,524 to 2,437 m in length. Civil aviation included about 636 major transport aircraft, with Air Canada as the major carrier.

Canada generated electrical power from coal, natural gas, and nuclear fuels, as well as massive hydroelectric facilities. Total capacity was roughly 114 gigawatts. About 535 net terawatt hours, significantly less than capacity, was produced in 1995, the last year for which complete data are available. More than 62% of Canada's electricity was generated by hydroelectric plants; about 17%, nuclear reactors; 15%, coal; and 6%, oil and gas. Quebec and Ontario produced the most electricity, 154 and 141 megawatt hours, respectively. Nearly 97% of Quebec's electricity came from hydroelectric plants, with the remaining 3% produced mainly by nuclear facilities. In contrast, about 61% of Ontario's electric power was derived from nuclear plants, with the remainder from hydroelectric and coal-fired plants. The majority of Canada's electricity exports originated in the eastern Provinces of New Brunswick, Ontario, and Quebec, and were sold to consumers in New England and New York. The western Provinces of British Columbia and Manitoba also exported large amounts of electricity, mainly to California, Minnesota, Oregon, and Washington. Except for Alberta, all Canadian Provinces bordering the United States had transmission links to the neighboring systems. Canadian electricity exports to the United States surged in late 1993 and early 1994, largely the result of favorable hydrological conditions. In November 1994, Quebec announced cancellation of the controversial \$10 billion Great Whale hydroelectric power project. Under discussion since the mid-1970's, Great Whale was dealt a severe setback when New York's Power Authority, a major Hydro-Quebec customer, announced cancellation of a \$5 billion power contract, citing environmental concerns and decreased power needs.

An extensive system of pipelines connected oil-producing (mostly western Canada) and oil-consuming (mostly central and eastern Canada and the United States) areas. 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 owns 13,600 km of mainline gas pipelines in Canada, as well as 56 compressor stations, linking western Canadian gas producers with consumers in eastern Canada and the United States. Total Canadian pipeline network included about 25,000 km for crude oil and refined products and 75,000 km for transmission of natural gas. Alberta's network represents the greatest length for any Province.

Outlook

After having been influenced by several economic factors in 1997, Canada's mineral industry faced near-term problems in the midst of longer term promise. Canada's dollar weakened against the U.S. dollar, presumably helping exports but discouraging imports of certain necessary commodities, specialized equipment, and *ad hoc* professional expertise. Increased exports boded well for credit markets, but equity markets suffered in the wake of the Bre-X scandal. Junior mining companies found themselves subjected to virtually paranoid scrutiny, and not without reason.

Demand for base metals in world markets was weakened, at least in part, by Asian economic problems; prices were soft at a critical time for many companies, whether starting up or expanding, and relief was not in sight. Low prices jeopardized two of Canada's mainstay metals, gold and nickel, enough to cause (or threaten) sizable bankruptcies. A price was being paid by Canada, as well as some other major mining countries, for uncertainties in the formation of the EU banking system (particularly its large-scale gold selling) to further complicate the Asian effect.

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

The huge nickel-copper-cobalt discovery at Voisey's Bay made an impressive case for more exploration in Canada, no matter how attractive the situation in Latin America, or in Asia or Australia. Furthermore, new prospects were found for gold in many parts of Canada, even though current market pricing promises little encouragement for the near future.

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

Canada is well positioned in terms of its mineral-resource base and its access to markets in the United States and the rest of the

world. Its mineral industry is primarily export oriented with as much as 90% of the production of some commodities going to foreign purchasers. The United States 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. Many of them are international in nature and may lie beyond Canada's direct industrial or market influence.

No country can escape the realities of growing international competition, especially from mineral-rich developing countries that have liberalized economic and political systems to attract foreign investment. But Canada's greatest long-term asset may be its achievement of a popular consensus in support of sustainable development.

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Natural Resources Canada
 580 Booth Street
 Ottawa, Ontario K1A 0E4
 Canada
 Minerals and Metals Sector
 Earth Sciences Sector

Canada Centre for Mineral and Energy Technology
(CANMET)

Geological Survey of Canada
601 Booth Street
Ottawa, Ontario K1A 0E4
Canada

Statistics Canada

Tunney's Pasture
Ottawa, Ontario K1A 0T6
Canada

Indian and Northern Affairs Canada

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

Environment Canada

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

Provincial Sources

Ministry of Energy, Mines, and Petroleum Resources

Parliament Buildings
Victoria, British Columbia V8V 1X4
Canada

Department of Energy

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

Department of Energy and Mines

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

Administration of Mining Lands

Toronto-Dominion Bank Building
1914 Hamilton Street
Regina, Saskatchewan S4P 4V4
Canada

Department of Energy and Mines

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

Ministry of Northern Development and Mines

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

Mines and Minerals Division:

Mineral Development and Lands Branch
Ontario Geological Survey
Southern Ontario Region
Northeastern Region
Northwestern Region

Ministere des Ressources Naturelles

5700, 4e Avenue Ouest, 3e Etage

Charlesbourg (Quebec) G1H 6R1
Canada

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

Mines and Minerals Division:

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

Department of Mines and Energy

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

Department of Energy and Forestry

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

Newfoundland Department of Mines and Energy

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

The Mining Association of Canada

1105-350 Sparks Street
Ottawa, Ontario K1R 7S8
Canada

Northwest Territories Chamber of Mines

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

Yukon Chamber of Mines

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

British Columbia and Yukon Chamber of Mines

840 West Hastings Street
Vancouver, British Columbia V6C 1C8
Canada

Chamber of Mines of Eastern British Columbia

215 Hall Street
Nelson, British Columbia V1L 5X4
Canada

Mining Association of British Columbia

P.O. Box 12540, 860, 1066 West Hastings Street
Vancouver, British Columbia V6E 3X1
Canada

Alberta Chamber of Resources

1410 Oxford Tower, 10235 101 Street
Edmonton, Alberta T5J 3G1
Canada

Saskatchewan Mining Association Inc.

1740 Avord Tower
Regina, Saskatchewan S4P 0R7
Canada

The Mining Association of Manitoba

700-305 Broadway
Winnipeg, Manitoba R3C 3J7
Canada

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

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

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

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

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

Major Publications

Canadian Geoscience Council, annual report.
Canadian Institute of Mining and Metallurgy, Bulletin, 10
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Canadian Mineral Analysts, monthly.
Canadian Mining Journal, Canada's Top Mining Companies, 6
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TABLE 1
CANADA: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity	1993	1994	1995	1996	1997 p/
METALS					
Aluminum:					
Alumina, gross weight	1,182	1,170	1,064	1,060 r/	1,165
Primary, metal	2,308,868	2,250,000	2,171,992	2,283,210 r/	2,327,188
Antimony 3/	673	643	684	1,773 r/	776
Arsenic trioxide e/	250	250	250	250	250
Bismuth 3/	144	129	187	150 r/	183
Cadmium:					
Mine output, Cd content 3/	1,340	1,500	1,942	1,771 r/	1,519
Metal, refined	1,944	2,173	2,349	2,433 r/	2,384
Calcium	W	W	W	W	W
Cobalt:					
Mine output, Co content 3/	5,108	4,265	5,339	5,714 r/	5,700
Metal:					
Shipments 4/	2,150	1,846	2,016	2,150 r/	2,157
Refined, including oxide	2,695	2,950	3,269	3,601 r/	3,738
Columbium and tantalum:					
Pyrochlore concentrate:					
Gross weight	5,320	5,130	5,230	5,160	5,090
Cb content	2,393	2,310	2,353	2,320	2,290
Tantalite concentrate:					
Gross weight	102	144	130	220 r/	216
Ta content	25	36	33	55 r/	54
Cb content	5	7	7	11 r/	11
Copper:					
Mine output, Cu content 3/	729,891 r/	614,476 r/	723,693 r/	685,926 r/	654,700
Electrowon	2,700	2,300	2,600	2,500	2,700
Total	732,591 r/	616,776 r/	726,293 r/	688,426 r/	657,400
Metal:					
Smelter:					
Primary, blister	518,301	515,088	522,761	529,349	529,524
Secondary and scrap	44,059	45,445	90,929	83,344	96,957
Total	562,360	560,533	613,690	612,693	626,481
Refined:					
Primary	561,580	549,869	479,100	477,500	463,355
Secondary	41,600	45,000	93,500	81,700	96,957
Total	603,180	594,869	572,600	559,200	560,312
Gold, mine output	152,929	146,428	152,032	166,378 r/	168,061
Iron and steel:					
Ore and concentrate:					
Gross weight	31,830	37,703	38,560	34,400 r/	37,284
Fe content	19,990	24,235	24,561	21,911 r/	23,748
Metal:					
Pig iron	8,633	8,106	8,464	8,638	8,679
Direct reduced iron	758	770	1,010	1,420 r/	1,391
Ferroalloys, electric arc furnace: e/					
Ferrosilicon	55	55	56	56	56 e/
Silicon metal	20	20	22	22	22 e/
Ferrovandium	2	2	1	1	1 e/
Total	77	77	79	79	79 e/
Crude steel	14,387	13,897	14,415	14,500 e/	15,554
Lead:					
Mine output, Pb content	182,234	167,584	210,826	257,253 r/	186,180
Metal, refined:					
Primary	147,907	153,035	178,019	192,877 r/	160,772
Secondary	69,107	98,605	103,372	117,914 r/	109,235
Total	217,014	251,640	281,391	310,791 r/	270,007
Lithium, spodumene e/	18,900	20,000	21,000	22,000	22,500
Magnesium metal, primary e/	23,000	28,900	41,900	54,000	57,700
Molybdenum, mine output, Mo content	9,699	9,188	9,522	8,097 r/	7,612

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

Commodity	1993	1994	1995	1996	1997 p/
METALS -- Continued					
Nickel:					
Mine output, Ni content 3/ kilograms	188,080	149,886	181,820	192,649 r/	190,529
Refined 5/	123,139	105,144	125,311 r/	130,136 r/	131,639
Platinum-group metals, mine output	12,441	14,313	16,068	14,668 r/	13,694
Selenium, refined 6/ do.	500,000 e/	566,000	561,000	694,000 r/	509,000
Silver:					
Mine output, Ag content kilograms	895,837	767,842	1,284,757	1,308,758 r/	1,222,367
Refined do.	1,011,956	915,128	1,040,866	1,402,983 r/	1,322,793
Tellurium, refined 6/ do.	24,000	42,000	102,000	59,000 r/	40,000
Tin, metal, smelter, secondary e/	-- r/	-- r/	--	--	--
Titanium Sorel slag 7/	653,000	764,000	815,000	825,000 e/	850,000 e/
Uranium oxide (U ₃ O ₈)	10,795	11,372	12,337	13,784 r/	14,042
Zinc:					
Mine output, Zn content	1,004,367	1,010,712	1,121,174	1,222,388 r/	1,088,968
Metal, refined, primary	659,881	690,965	720,346	716,467 r/	699,816
INDUSTRIAL MINERALS					
Asbestos	522,967	531,000	524,000	506,000 r/	447,000
Barite	59,000	55,000	67,000	58,000 r/	103,000
Cement, hydraulic 8/ thousand tons	9,390	10,584	10,440	11,587 r/	11,736
Clay and clay products 9/ value, thousands	\$120,000 e/	\$120,000 e/	\$95,675	\$110,218 r/	\$151,655
Diatomite e/	10,000	10,000	10,000	10,000	10,000
Gemstones, amethyst and jade	3,680	1,212	459	294 r/	381
Gypsum and anhydrite thousand tons	7,880	8,500	8,055	8,202 r/	8,503
Lime 8/ do.	2,380	2,390	2,398	2,402 r/	2,447
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	550,000	602,000	618,000 r/	606,000 r/	628,000
Nitrogen, content of ammonia	3,410,000	3,474,000	3,773,000	3,839,600	3,979,800
Potash, K ₂ O equivalent thousand tons	6,841	8,517	9,066	8,120 r/	9,301
Pyrite and pyrrhotite, gross weight e/	5,000	5,000	5,000	5,000	5,000
Salt thousand tons	10,900	11,700	10,875	12,248 r/	13,264
Sand and gravel do.	237,000	247,148	228,163	213,831 r/	214,302
Silica (quartz) 10/ do.	1,600 e/	1,600 e/	1,689	1,558 r/	1,591
Sodium compounds, n.e.s.:					
Sodium carbonate (soda ash) e/ do.	305	300	300	300	300
Sodium sulfate, natural 11/ do.	320	317	315	323	307
Stone 12/ do.	106,000	110,411	120,660	92,449 r/	94,230
Sulfur, elemental byproduct:					
Metallurgy do.	900	870	886	789 r/	801
Natural gas do.	6,600	7,000	7,100	8,329 r/	8,280
Petroleum e/ do.	340	350	380	400	410
Tar sands do.	590	630	670	670 r/	680 e/
Total do.	8,430	8,850	9,036	10,188 r/	10,171 e/
Talc, soapstone, pyrophyllite do.	108	130	108	77 r/	76
MINERAL FUELS AND RELATED MATERIALS					
Carbon black e/	161,000	160,000	165,000	165,000	165,000
Coal:					
Bituminous and subbituminous thousand tons	59,000	62,700	64,176	65,006	67,034
Lignite do.	10,000	10,100	10,740	10,854	11,653
Total do.	69,000	72,800	74,916	75,860	78,687
Coke, high-temperature do.	3,657	3,684	3,283	3,357	3,370
Gas, natural:					
Gross million cubic meters	171,000	183,000	192,530	198,107	199,422
Marketed do.	129,000	139,000	148,204	153,578 r/	156,842
Natural gas liquids:					
Pentanes plus thousand 42-gallon barrels	50,500	55,900	56,450	61,832	67,439
Condensate do.	1,430	1,730	2,323	1,944 r/	2,735
Total do.	51,930	57,630	58,773	63,776	70,174
Peat	801,000	914,000	877,000	901,000 r/	849,000

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

Commodity	1993	1994	1995	1996	1997 p/	
MINERAL FUELS AND RELATED MATERIALS						
Continued						
Petroleum:						
Crude 13/	thousand 42-gallon barrels	610,000	636,000	662,110	739,814 r/	770,275
Refinery products:						
Propane; butane; naphtha; LPG 14/	do.	15,800	14,900	13,745	26,454	15,265
Gasoline:						
Aviation	do.	824	835	846	789	726
Other	do.	234,000	239,000	243,455	245,618	254,386
Petrochemical feedstocks	do.	29,400	28,200	33,554	33,137	33,746
Jet fuel	do.	26,600	26,800	29,315	32,048	33,935
Kerosene	do.	3,670	2,690	5,470	18,446	3,106
Distillate fuel oil, diesel and light	do.	178,000	186,000	183,597	184,738	201,737
Lubricants including grease	do.	5,360	6,250	5,807	6,344	8,478
Residual fuel oil, heavy	do.	48,500	44,200	41,352	41,999	47,477
Asphalt	do.	17,800	20,400	20,048	19,586	24,938
Petroleum coke	do.	7,220	6,660	6,961	7,416	7,122
Unspecified	do.	28,900	28,100	24,271	21,144	25,114
Refinery fuel and losses 15/	do.	24,800	25,100	37,583	25,172	24,491
Total	do.	620,874	629,135	646,004	662,891	680,521

e/ Estimated. r/ Revised. p/ Preliminary

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

2/ Table includes data available through July 1998.

3/ Metal content of concentrates produced.

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

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

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

7/ Refined Sorel slag contains 80% titanium dioxide.

8/ Producers' shipments and quantities used by producers.

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

10/ Producers' shipments of quartz.

11/ Excludes byproduct production from chemical plants.

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

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

14/ Liquefied petroleum gas.

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

TABLE 2
CANADA: STRUCTURE OF THE MINERAL INDUSTRY IN 1997

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Aluminum	Alcan Aluminum Ltd.	Smelter, Laterriere, Quebec	204.
Do.	do.	Smelter, Isle-Maligne, Quebec	73.
Do.	do.	Smelter, Beauharnois, Quebec	48.
Do.	do.	Smelter, Shawinigan, Quebec	84.
Do.	do.	Smelter, Grande-Baie, Quebec	180.
Do.	do.	Smelter, Arvida, Quebec	232.
Do.	do.	Smelter, Kitimat, British Columbia	272.
Do.	Aluminiere de Becancour Inc. (Pechiney Corp., 25%; Quebec Government, 24.95%)	Smelter, 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.	Asbestos Corp. Ltd. (Mazarin Mining Exploration Inc.)	British Canadian Mine, Black Lake, Quebec	70 (fiber).
Do.	Bell Operations (Mines D'Amiante Bell)	Theftord Mines, Quebec	70 (fiber).
Do.	JM Asbestos Inc.	Jeffrey Mines, Asbestos, Quebec	250 (fiber).
Do.	Teranov Mining Corp. (Black Hill Minerals Ltd., 50%; Cliff Resources, 50%)	Baie Verte, Newfoundland	20 (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.	do.	Beauport, Quebec	611 (wet-process).
Do.	ESSROC Canada Inc.	Picton, Ontario	1,124 (dry-process).
Do.	North Star Cement Ltd.	Corner Brook, Newfoundland	152 (dry-process).
Do.	Ciment Quebec Inc.	St. Basile, Quebec	1,074 (wet and dry).
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%; seven 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).

See footnote at end of the table.

TABLE 2--Continued
CANADA: STRUCTURE OF THE MINERAL INDUSTRY IN 1997

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Copper	Broken Hill Proprietary Co. Ltd. (BHP Holdings Inc., 100%)	Island Copper Mine, Port Hardy, British Columbia	16,200.
Do.	Cassiar Mining Corp. (Princeton Mining Corp., 100%)	Similco Mine, Princeton, British Columbia	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	13,070.
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.	Sudbury and Shebandowan, Ontario Thompson District, Manitoba	20,250 (mine).
Do.	do.	Smelter, Sudbury, Ontario	500.
Do.	do.	Refinery, Sudbury, Ontario	170.
Do.	Noranda Inc.	Bell Copper Mine, Babine Lake, British Columbia	5,550 (mine).
Do.	do.	Smelter Horne, Noranda, Quebec	770.
Do.	Huckleberry Mines Ltd. (Princeton Mining Corp., 60%; Japanese consortium, 40%).	SE of Houston, British Columbia	33,000 (Cu contained).
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	450 (kilograms metal).
Do.	Echo Bay Mines Ltd.	Lupin Mine, Contwoyo Lake; Northwest Territories	612.
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	945 (ore).
Do.	do.	Hope Brook Mine, Conneau Bay, Newfoundland	1,090 (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	400 (ore).
Do.	do.	Detour Lake Mine, Northeast Ontario	900 (ore).
Do.	do.	Dome Mine, South Porcupine, Ontario	1,300 (ore).
Do.	do.	Sigma Mine, Val d'Or, Quebec	500 (ore).
Do.	do.	Kiena Mine, Val d'Or, Quebec	500 (ore).
Do.	Teck-Corona Corp. (Teck Corp., 100%)	David Bell Mine, Hemlo, Ontario	456 (ore).
Graphite	Strategic Exploration Inc.	Kearney Lake, Ontario	Withheld.
Gypsum	Domtar Inc.	Flat Bay, 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, 6.95%; North Ltd. 59.31%; Mitsubishi 21.77%; other, 11.97%).	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).

See footnote at end of the table.

TABLE 2--Continued
CANADA: STRUCTURE OF THE MINERAL INDUSTRY IN 1997

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Iron and steel--Continued:			
Do.	Stelco, Inc.	Hamilton, Ontario	2,733 (pig iron), 7,990 (crude steel), 560 (sinter).
	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, North- west Territories	1,000 (ore).
Do.	Conwest Exploration Co. 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.	Scotia Limestone Ltd.	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%)	East, Fraser, Lockerby, Onaping, Strathcona, and Craig in Sudbury	30 (metal contained).
Do.	do.	Smelter, Falconbridge	45 (rated capacity).
Do.	Inco Ltd.	Sudbury, Ontario, district mines: Froot, Stobie, Little Stobie, Creighton, Copper Cliff North and South, Garson-Offsets, Levack, McCreedy East and West, Coleman, Crean Hill, Murray, and Totten in Sudbury area, Ontario; also Shebandowan Mine in western 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, Pipe, Birchtree Mines in Manitoba	62 (metal contained).
Do.	do.	Smelter, Thompson, Manitoba	82 (metal contained).
Do.	Sherritt International Ltd.	Refinery, Fort Saskatchewan, Alberta	24 (metal contained).
Petroleum: 1/			
Gas	million cubic meters	BP Canada Inc. (The British Petroleum Co. PLC London, 100%)	Noel Area, North Alberta; Chauvin, Sibbald, North Pembina, Alberta
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.

See footnote at end of the table.

TABLE 2--Continued
CANADA: STRUCTURE OF THE MINERAL INDUSTRY IN 1997

(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	Norcen Energy Resources Ltd. (Hollinger Inc., 59%; Hees International, 41%)	Pembina, Bodo, Majorville, Alberta	12.1.
Do.	do.	Oakwood Petroleum Ltd. (Sceptre Resources Ltd., 100%)	Grantham, Hays Ronalane, Peace River, Normandville, Randell, Alberta, and Grizzly Valley, British Columbia	24.6.
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.
Do.	thousand 42-gallon barrels	Texaco Canada Petroleum Inc. (Texaco Inc., United States, 78%; others, 22%)	Eaglesham, Virgo, Alberta, and Desan, British Columbia	158.
Gas	million cubic meters	do.	do.	67.3.
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	3,400 (KCl).
Do.		do.	Rocanville, southeast Saskatchewan	1,750 (KCl).
Do.		International Minerals & Chemical Corp. (Canada) Ltd. (IMC Fertilizer Corp., 100%)	Esterhazy, southeast Saskatchewan	1,814 (KCl).
Do.		Kalium Chemicals (Kalium Canada Ltd.)	Potash Mine, Moose Jaw, Saskatchewan	2,040 (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	227.
Do.		Equity Silver Mines Ltd. (Placer Dome Inc., 58.8%)	Houston, British Columbia	2,970 (Ag-Au-Cu concentrate).
Do.		Faro Mine (Anvil Range Mining Corp. 100%)	Yukon Territory	4,745 (Pb-Zn-Ag-Au mill feed).
Do.		LAC Minerals Ltd.	Macassa Mine, Ontario	165 (mill feed).
Do.		do.	Bousquet Mine, Quebec	580 (mill feed).
Do.		Similco Mines Ltd.	Princeton, British Columbia	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).

See footnote at end of the table.

TABLE 2--Continued
CANADA: STRUCTURE OF THE MINERAL INDUSTRY IN 1997

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Principal SO ₂ and H ₂ SO ₄ --Continued:			
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	Stanleigh Mine (Rio Algom Ltd. 100%)	Elliot Lake, Ontario	815 (metal).
Do.	Cameco Corp. (Province of Saskatchewan, 61.5%; Government of Canada, 38.5%)	Key Lake, Saskatchewan	4,976 (metal).
Zinc	Brunswick Mining and Smelting Corp. Ltd. (Noranda Inc., 63.3%)	Bathurst, New Brunswick	232 (Zn in concentrate).
Do.	Falconbridge Ltd. (Noranda Inc., 50%; Trelleborg AB, 50%)	Timmins Operations, Ontario	212 (Pb-Zn contained).
Do.	do.	Smelter, Timmins, Ontario	133 (slab zinc).
Do.	Hudson Bay Mining and Smelting Co., Ltd. (Minorco, 100%)	Snow Lake concentrator, Manitoba	1,125 (Pb-Zn ore).
Do.	do.	Flin Flon Mine and smelter, Manitoba	85 (slab zinc).
Do.	Cominco Ltd. (Teck Corp, 36.34%)	Sullivan Mine, Kimberley, Brit. Columbia)	70 (Pb-Zn contained).
Do.	do.	Smelter, Trail, British Columbia	300 (slab zinc).
Do.	Anvil Range Mining Corp. (100%)	Faro Mine, Yukon Territory	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 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 1997

(Thousand metric tons unless otherwise specified) 1/

Commodity	Reserves
Abestos, fiber	38,000 e/
Coal, all types	6,364,000 e/
Copper	9,700
Gold	1,724 2/
Gypsum	500,000 e/
Iron ore	1,304,000 e/
Lead	3,477
Molybdenum	144
Natural gas	1,900 e/
Nickel	5,600
Petroleum crude	3,650 e/
Potash, K ₂ O equivalent	14,200 e/
Salt	315,000 e/ 3/
Silver	19,000
Sodium sulfate	91,000 e/ 3/
Sulfur	150,000 e/
Uranium	430 4/
Zinc	13,700

e/ Estimated.

1/ 1996 and 1997 "Canadian Minerals Yearbook," Natural Resources Canada, unless noted.

2/ Excludes metal in placer deposits.

3/ Data in thousand short tons.

4/ Recoverable at prices of \$100 per kilogram of U, or less.