

THE MINERAL INDUSTRY OF

CANADA¹

By Alfredo C. Gurmendi

Canada, which was the second largest economy in the American continent with about 31 million people in 2001, had a gross domestic product (GDP) of \$699.5 billion,² or a purchasing power parity of \$774.7 billion. Canada's GDP growth was 4.3% compared with 4.1% in 2000, which was a record growth among the seven industrialized countries, or G-7 economies (Washington Times, 2001b; U.S. Central Intelligence Agency, 2001§³). Canada's economy strengthened significantly in the first quarter of 2001 and performed well during the year. Unemployment fell to a long-time low of 6.8% at the end of December 2000. Overall, Canada's economic picture for 2001 showed that the country as a whole was doing well; the minerals, metals, and energy sectors contributed 8.7% of its GDP. The mineral industry played an integral part in Canada's new technology-driven and knowledge-based economy (Steele, 2002a).

Despite a global slowdown in economic activity in 2001, the value of Canadian minerals production reached \$54.4 billion, which was almost the same level as that of 2000, or \$54.5 billion. This continuing high level was principally due to the substantial gains in the fuels sector, particularly natural gas exports. In 2001, mine output of base and precious metals and nonmetals decreased in value to \$11.6 billion compared with that of 2000. The value of metal output decreased by 6.8% to \$6.7 billion in 2001 from that of 2000 after declining for the past 3 years (Natural Resources Canada, 2002b).

Changing prices in world markets have affected mine openings and closings in Canada.⁴ The value of production for base metals and nonmetals remained close to 2000 levels despite weakening prices; the value of nickel, however, declined to \$1.2 billion in 2001 from \$1.5 billion in 2000. A significant drop in iron ore output and sharp price declines for copper and zinc also contributed to the decline in value of Canadian metals. Several metals increased in value—uranium, 42.8%; molybdenum, 22.8%; platinum-group metals (PGM), 18.9%; and lead, 12.2%; these partially offset the decrease of the metals value. Strong prices encouraged increases in PGM production, thus

¹Revised on March 16, 2004.

²Where necessary, values have been converted from Canadian dollars (CAN\$) to U.S. dollars at an average rate of CAN\$1.54=US\$1.00 for 2001. All values in this report, unless otherwise specified, are expressed in U.S. dollars.

³References that include a section twist (§) are found in the Internet References Cited section.

⁴More detailed information on the mineral production in Canada can be found in the Canadian Minerals Yearbooks for 1998 and 1999 prepared by the Mining Sector, Natural Resources Canada, Ottawa, Canada, which were used extensively as source material for this report. The U.S. Department of the Interior has arranged to have these Canadian publications placed in selected depository libraries of the 50 States and Puerto Rico. Please note that any datum of 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.

continuing the upward trend that started in 1998 and resulted in significant increases in value in 2001 (\$369.4 million) because of higher demand for use in autocatalysts. Prices for precious metals, especially gold, however, remained stable with a modest increase in production and a corresponding increase of 2.9% in its value of output. Gold led the metals group in 2001 in terms of value of production (\$1.4 billion) (Natural Resources Canada, 2002b).

Canada realized an overall increase of 1.7%, or \$4.9 billion value for nonmetals in 2001, which was the sixth consecutive year that value increased. Production values, which were impressive, increased by 35.5% for diamond, 27.9% for salt, 11.3% for clay products, and 4.3% for cement; these increases offset the declining values of other commodities in the nonmetals group. Potash was the leading nonmetal producer at \$1.04 billion.

In 2001, the value of mineral fuels production remained stable with a minor increase to \$42.9 billion from \$42.5 billion in 2000. Increases in the value of natural gas (21.5%) and coal (8.4%) offset the decreases in value of natural gas byproducts (17.3%) and crude oil (15%) (Natural Resources Canada, 2002a, b).

In 2001, overall exploration spending for Canada declined significantly to \$297.4 million compared with almost \$307.1 million in 2000, \$327.3 million in 1999, \$426 million in 1998, and \$598.1 million in 1997. Although this decrease was fairly characteristic of all the Provinces, it was particularly apparent in the Northwest Territories, Ontario, and Quebec, which together accounted for about 60% of exploration expenditures for the entire country. Despite the decline in global exploration levels, Canada's larger mining companies remained internationally active by continuing to spend 80% of their exploration budgets in other countries, particularly in South America, the Caribbean, and Eastern Europe, and 20% in Canada. Although a large number of Canadian mining companies have been exploring in other countries, such discoveries as Voisey's Bay and the Ekati diamond mines reaffirmed that there is much still to be found in Canada (Natural Resources Canada, 2001b, p. 37-38, 101-102).

According to predictions for the forthcoming year, spending for metals exploration would be flat or decline, and that for diamond exploration would increase by as much as 25%. After spreading to most of Canada, diamond exploration continued with some public excitement because of an increasing number of discoveries. The value of diamond production increased by 35.5% (\$550 million) as the Ekati diamond mine completed its third full year of operation in the Northwest Territories. For the first time, the mine became a factor in world diamond markets. In 2001, diamond was expected to be the most sought after mineral commodity in the country. Macroeconomics and the globalization of diamond demand have introduced

unprecedented levels of volatility into the diamond supply and rough and polished diamond pricing; this takes into consideration increased levels of diamond mining activity and the move to a more competitive open market for rough diamonds in particular (Natural Resources Canada, 2002b; Rapaport, 2002).

Voisey's Bay Nickel Co. (a subsidiary of Inco Limited and based in St. John's, Newfoundland) was established as a separate firm to finance and develop the huge and rich nickel, copper, and cobalt deposit on the Labrador Peninsula in eastern Canada. In early 2001, formal talks began between the Government of Newfoundland and Labrador and Inco on potential development of the project. Inco was developing a special hydrometallurgical process that could be used to treat the sulfide nickel ore found at Voisey's Bay. If the process was successful, then Inco would process the ore within the Province, thus fulfilling its key demand that the nickel ore be processed in Newfoundland before being shipped out of the Province. With the expected recovery in nickel demand by early 2002, questions remained about the timeframe in which the nickel price could recover to effect the supply/demand balance. Whether the timely development of Voisey's Bay and new nickel mines plus producers' destocking can provide sufficient supply to keep the nickel price in control remains to be seen (Metal Bulletin, 2000b; Natural Resources Canada, 2001a, p. 1.9-1.11; Rochon, 2002).

Although the number of junior exploration firms has declined considerably in recent years (to 379 firms in 2000 from 409 firms in 1999), junior spending remained an important component of total expenditures; definitions of junior and senior companies in Canada can be found at National Resources Canada (2002§) and from David Comba (Director, Issues Management Prospectors & Developers Association of Canada, written commun., November 7, 2002). In 2000, it amounted to \$96.8 million, or 31% of total spending compared with the \$211 million spent by senior companies. In 2001, junior company spending was \$108 million, or about 36% of the forecasted total of \$297 million. Globally, Canada remained one of the world's top mineral exploration targets by attracting the interest of the world's larger exploration and mining companies. Canadian companies were very active abroad as well (Natural Resources Canada, 2001b, p. 2-13).

Environmental concerns continued to interact with mineral exploration and development activity throughout Canada. Canadian mining firms were acquiring mineral properties in Latin America where Governments offered incentives to attract foreign investments, their mining laws are coherent and reasonable, up to 100% of ownership was allowed, and profits could be repatriated.

Mineral exploration search criteria seem to have become increasingly subject to legal and sociological influences in much of Canada. Land use, which had never been given much attention in the past, has become an issue. First Nation rights were receiving long-awaited consideration. Canada's Minister of Natural Resources stated that Federal and Provincial Governments were working on legislative reforms that should afford an improved regulatory climate.

Government Policies and Programs

Primary jurisdiction over mineral resources in Canada is exercised by the Provinces. Through their mining acts, the Provincial Governments regulate most aspects of exploration and mining. Exceptions have been the Yukon Territory, the Northwest Territories, and the Nunavut Territory, which, although still under the resource-management control of the Canadian Federal Government, were slowly accumulating more independent powers. For instance, the Devolution Transfer Agreement (DTA) was initiated by the Federal, Territorial, and First Nation negotiators in September 2001. The DTA is the transfer of the Federal Government's current responsibilities for managing most of Yukon's natural (mineral-energy) resources to the Government of Yukon; the move will be effective on April 1, 2003. In 2001, Yukon offered a refundable mineral exploration tax of 25% on exploration expenditures for eligible individuals and companies. The Federal Department of Indian Affairs and Northern Development (DIAND) and the Northwest Territories Government merged their geoscience programs and jointly managed the C.S. Lord Northern Geoscience Centre in Yellowknife. The Centre is supported by the DIAND, the Government of the Northwest Territories, and the Geological Survey of Canada.

In 1993, the largest Aboriginal land settlement took place in Canada, which resulted in the formation of the new Territory of Nunavut on April 1, 1999. Nunavut comprises the Franklin and the Keewatin districts of the Northwest Territories and has a landmass of 1,994,000 square kilometers (km^2) which includes Baffin Island, Ellesmere Island, and the Queen Elizabeth Islands. Its southernmost boundary is the northern boundary of Manitoba, and the northernmost boundary extends slightly north of the northern coast of Greenland. The land claim settlement allocated about 40,000 km^2 of Nunavut as "Inuit Owned Land" whereby surface rights are held by Regional Inuit Associations (RIAs), and subsurface rights are held by the Inuit people and administered by Nunavut Tunngavik Incorporated. An additional 320,000 km^2 is considered to be "Inuit Owned Land" whereby only surface rights are held by the Inuit and are administered by the RIAs, and subsurface rights are retained by the Crown and administered by the DIAND. In both cases, exploration and mining are allowed and subject to permitting through the respective RIAs. Although Nunavut depended on the Federal Government for 90% of its budget of almost \$400 million in 2001, it had a modest private sector that included mining, retail sales, and transportation. Exploration for metals and petroleum has tended to move north in recent years into what is now Nunavut and has resulted in Baffin Island's Nanisivik lead-zinc mine, which is located 750 kilometers (km) north of the Arctic Circle; it was owned by Breakwater Resources Ltd. The Inuit have been generally receptive to mining proposals as a way of bringing more business and employment into their region (Natural Resources Canada, 2001b, p. 96-105).

Federal and Provincial policies, though not entirely consistent among the Provinces, are generally stable and have traditionally favored the research and information services that relate to the

mining industry. The Federal Government negotiated multiyear Mineral Development Agreements, which fund initiatives intended to strengthen the mining industry in each region, with Provincial Governments. Although environmental assessment legislation was passed in 1992, the Federal Government has been deliberate in producing regulations to implement such laws. One subsequent measure was the tax deductibility for funds set aside for the cleanup of closed mine sites, thus complementing emerging Provincial reclamation requirements.

The Canadian Securities Administrators (CSA) have finalized the National Instrument 43-101, which pertains to the "Standards of Disclosure for Mineral Projects." This instrument, which was enacted into law in early 2001 will apply to all technical public disclosure on mineral projects and will require all technical disclosure to be based on the work of a qualified person (QP). This law will preserve Canada's preeminent position in world mining exploration, development, and financing. The QP is to be responsible for scientific and technical matters, which will include not only exploration, development, definitions of resources and reserves, and mining matters, but also quality-control standards for analytical laboratories, the form of technical reports, professional supervision, corporate governance practices, regulatory oversight of the mining industry, and enforcement of securities laws. This instrument was a result of the 1997 Bre-X scandal in which so many investors lost heavily because of the Bre-X Minerals Ltd. fraud in Kalimantan, Indonesia, in which drill-core samples from its Busang property were salted with gold (McCombe, 2001, p. 4).

In August 2000, a new set of definitions and guidelines was approved for reporting exploration information, mineral resources, and mineral reserves in Canada; they replaced the previous classification system contained in the Canadian Institute of Mining, Metallurgy and Petroleum Ad Hoc Committee report of February 1996. The standards are applicable to all minerals, which include metals, industrial minerals, diamond, and other gemstones, but will not apply to bitumen, natural gas, and oil (Canadian Mining Journal, 2000).

On October 19, 2000, the Canadian Federal Government introduced a 15% nonrefundable tax credit, which will be in effect until 2004. The credit is in addition to the existing 100% deduction of eligible exploration expenditures from the Federal portion of investors' income tax and is equivalent to a 136.7% exploration expense deduction. The two types of flow-through share investments are the "super" flow-through, or additional Federal tax credits, for "grassroots" exploration and the regular flow-through plus Provincial and Territorial harmonization initiatives. Both flow-through share investments will assist the sector in gaining new investment and stimulating minerals exploration activity in Canada. The Federal Government is laying a foundation for the sector by providing sound economic fundamentals, encouraging innovation and knowledge, and promoting sustainable development. Income tax benefits to individual investors for income tax purposes and marginal tax rate will vary depending on the taxpayer's residence. Quebec will offer the largest potential tax savings for flow-through share investments, followed by Ontario, Saskatchewan, and Yukon

Territory; this special tax savings feature will further enhance the benefit of flow-through shares for mining corporations. British Columbia has also introduced the Mining Exploration Tax Credit, which provides a 20% refundable credit of qualified expenses not funded by flow-through shares. This would make the Province's incentive program the most attractive one in Canada (Heakes, 2002; Schroeter, 2002; Steele, 2002b, p. 2).

Environmental Issues

The Canadian Mining Association noted that for the first time, the 5-year-old Canadian Environmental Assessment Act (CEAA) put several Federal departments in a position to review mining activity, a purview that had been limited to Provincial jurisdiction. The CEAA includes many provisions that bring Federal agencies into the review process to evaluate impacts on area fisheries and navigable rivers or where explosions or public works are involved. Because any mining operation could affect at least one of these considerations, the Federal Government is now involved in any significant mining project. Overlapping Federal jurisdictions have made it difficult for investors to know what they have to do to secure approval for their projects. Observers believed that if the CEAA created difficulties in raising capital, then investors could become wary of Canada's approval regime. They would invest their monies in other countries where regulations are more straightforward and transparent. In Canada, however, the Provincial and Territorial Governments continued to support and promote exploration and deposit appraisal activities in their respective jurisdictions via various initiatives, such as fiscal incentives, the resolution of land access issues, and the provision of state-of-the-art geoscientific data (Natural Resources Canada, 2001b, p. 7).

In a further effort to define goals, approaches, and alternatives in the name of sustainable development, the Prospectors and Developers Association of Canada (PDAC), which is a private sector organization, has issued a paper, "Total Landscape Management (TLM): An Integrated Approach to Conservation Protection and Resource Development." The PDAC asserts that TLM goes beyond the growing reliance on multiple-use exclusive areas to achieve conservation objectives; this multiple-use concept, however, has produced unsatisfactory results because the complex and changing needs of the landscape require a more comprehensive and integrated approach. The paper acknowledges that access to land and certainty of title are crucial to resource development and that biological diversity, wilderness protection, and the preservation of unique and exceptional areas are fundamental to conservation objectives. TLM prescribes management of entire ecological landscapes by employing the overarching principle of conservation diversity; a system of "floating reserves" designed to accomplish protection in a constantly changing, dynamic landscape; adaptive management that allows the flexibility to accommodate new information, evolving ecosystems, and natural disturbances; and comanagement that ensures the provision of local community input. Failure to understand local realities and to involve the community constructively creates the risk of costly delays or even termination of mineral exploration and development

projects owing to disruption, confrontation, and conflict over social, cultural, and environmental issues (Thomson, 2001, p. 4). Too comprehensive to detail here, this paper appears to be a carefully crafted and far-reaching attempt by the PDAC to rationalize and harmonize the differences among adversarial viewpoints.

Production

In 2001, the value of Canadian mineral production remained strong, which was principally attributed to very significant increases in the values of the output of natural gas (21.5%) and coal (8.4%) compared with those of 2000. Production values of metals decreased by 6.8% compared with those of 2000, and those of nonmetals, which includes structural materials, increased slightly to \$7.6 billion in 2001 from \$7.4 billion in 2000. The performance of the fuels group, which totaled about \$66 billion, showed a small 0.8% increase compared with \$65.4 billion in 2000 primarily because of the lower energy prices for crude oil and natural gas. The increase in value was led by natural gas, which climbed to \$33.8 billion compared with \$27.8 billion in 2000. Production of natural gas byproducts decreased by 17.3% with a value of \$4.7 billion compared with \$5.7 billion in 2000. Crude oil and equivalent output decreased by 15% with a value of \$25.9 billion compared with \$31.5 billion in 2000. Finally, the value of coal production increased by about 8.4% to \$1.5 billion in 2001 compared with \$1.3 billion in 2000 (Natural Resources Canada, 2002a, b).

In terms of value of production in 2001, the top nonfuel commodities were gold at \$1.4 billion; nickel, \$1.2 billion; copper, \$1.0 billion; potash, \$1.0 billion; zinc, \$910 million; cement, \$844 million; iron ore, \$780 million; sand and gravel, \$650 million; stone, \$584 million; diamond, \$520 million; uranium, \$455 million; PGM, \$390 million; and salt, \$260 million (Natural Resources Canada, 2002b).

Market prices played a changing role in the mineral commodity values. In 2001, the value of metals reached to \$6.6 billion, or 6.8% lower than that of 2000, but still 5.6% higher than that of 1999. In 2001, much of that decrease was due to the steep decline in the value of nickel production from \$2.4 billion in 2000 to \$1.2 billion; increases in value for uranium (42.8%), molybdenum (22.8%), PGM (18.9%), and lead (12.2%), however, partially offset the decrease in the value of metals. Strong prices encouraged increases in the production of PGM; this continued the upward trend that started in 1998. Gold remained stable with a modest increase in production and with an increase of 2.9% in value. Moderate declines in output led to a decreased value of production for copper (-9.7%), zinc (-9.7%), silver (-4.0%), potash (-3.8%), and sand and gravel (-1.9%). The value of output for most other metals remained at about the 2000 levels despite weakening prices (Natural Resources Canada, 2002a, b).

Changes in outputs can be accompanied by robust increases in their value, thus illustrating the compelling effect of market prices when higher demands for minerals are prevalent. Likewise, the destructive effect of price deterioration in relation to mineral production during periods of oversupply and price weakness will be harmful to mineral producers.

Ontario, which was the leading producer of nonfuel mineral commodities, accounted for 30.9% of the total value followed by Quebec, 19.6%; Saskatchewan, 12.9%; British Columbia, 10.8%; Manitoba and Northwest Territories, 5.1% each; Newfoundland, 4.7%; New Brunswick, 4.3%; Alberta, 3.1%; Nunavut, 1.8%; Nova Scotia, 1.3%; and Yukon Territory, 0.2% (total does not add to 100% because of rounding). Although the production of fuels tended to be concentrated in the western plains Provinces, the output of nonfuel mineral commodities was characterized by a much wider distribution throughout Canada (Natural Resources Canada, 2002a, b).

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 trade balance, as well as major support of the national standard of living. In 2001, minerals and metals exports earned \$44 billion, or 13% of all exports. Mineral and mineral product exports, which included fuels, totaled \$49 billion; this was an increase of 6.1% compared with that of 2000, and represented about one-quarter of all Canadian exports for that year (Goodale, 2001).

In 2000 (the latest year for which more-detailed trade information is available regarding total mineral and mineral product exports, imports, and trade balance), metals registered 51%; fuels, 37.3%; nonmetals, about 10.3%; and structural or building materials, about 1.4%. Value of exports of nonfuel minerals, which included coal, was \$33 billion; this represented an increase of 10.5% compared with that of 1999 (Natural Resources Canada, 2001a, p. 1.16).

Included in these exports were crude minerals and smelted and refined products. Prominent among the crude minerals exported were iron ore, potash, and sulfur to the United States; copper concentrates to Japan; and iron ore and zinc concentrates to the European Union (EU). Smelted and refined metals included aluminum, copper, gold, iron and steel, nickel, silver, and zinc to the United States; aluminum and gold to Japan; and copper and nickel to the EU. Coal exports went mostly to Japan.

Mineral and mineral product imports, which included fuels, were valued at \$44.7 billion, or more than 19% of the value of all imports. In terms of net trade, the mineral surplus, which included fuels, was valued at \$20.3 billion. Total trade between Canada and the United States exceeded that of any other two countries in the world. Exports of mineral commodities and mineral-related products, which included fuels, from Canada to the United States were \$49.1 billion in 2000 (Natural Resources Canada, 2001a, p. 1.8).

Structure of the Mineral Industry

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

companies, were relatively dormant while they sought sources of investment or finance. Companies whose corporate voting rights were at least 50% non-Canadian were considered to be foreign, although other distinctions could apply in some large companies. More than 200 mine sites, which included coal, were active (Giancola, 2002, p. 505-528). Another 3,000 mines and quarries produced sand, gravel, and other construction materials. About 40 smelters and refineries, as well as other processing plants, were operating in the cement, sodium chloride, and sulfuric acid industries. Foreign companies were subject to the same taxes as domestic companies, but repatriation of earnings was allowed.

Most of the Canadian mineral industry was privately owned with the notable exception of Government participation in potash and petroleum, but even these were in transition to private ownership. Some companies, such as Potash Corp. of Saskatchewan Inc. (PCS), which was based in Saskatoon, and Saskatchewan Oil & Gas Corp., had been owned, in part, by the Province of Saskatchewan. The Province of Alberta had owned part of Alberta Energy Co. Ltd. The proportion of Provincial Government ownership was changeable, but the trend was also toward privatization in 2003. Petro-Canada (PC), which was owned partly by Federal and partly by Provincial Governments, was completely privatized in 2001. 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 and open pit mines, leaching operations, concentrators, smelters, and refineries, as well as drilling and production operations characteristic of the petroleum industry. Table 2 lists the structure of the mineral industry, by sectors, of the major mineral commodities.

Employment in the mining and mineral manufacturing industries stabilized after a decline that began in 1989 when the number of jobs in those industries peaked at 422,000. Preliminary employment estimates for 2001 by Statistics Canada indicated that total employment in mining and mineral manufacturing, which included coal, was about 410,000. The total number of employees in coal, metal, and nonmetal mining and quarrying was estimated to be 55,750, or down about 2,700 jobs compared with the 2000 level. Employment in ferrous and nonferrous smelting and refining was estimated to be 59,600, or up about 1,000 jobs compared with the 2000 level (Natural Resources Canada, 2001a, p. 1.3). About 8,000 people were also employed in diamond drilling and other support services incidental to mining operations. The mining sector was considered to be a pillar of the Canadian economy and a way of life for Canadians (Goodale, 2001).

Commodity Review

Metals

Aluminum.—Production of primary aluminum was 2.6 million metric tons (Mt), which was an increase of 8.8% compared with that of 2000 (Natural Resources Canada, 2001a).

This put Canada fourth, after Russia, China, and the United States, in the world in volume of production and first, with Russia second, in volume of exports to the United States. The value of Canadian production increased to \$3.6 billion from \$3.1 billion in 1999, which reflects the increased metal price in 2000. Primary aluminum exports during 2000 were valued at \$3 billion (Wagner, 2001a, p. 8.3, 27; Plunkert, 2002).

In October 2000, Alcan Aluminum Ltd. and Alusuisse Lonza Group Ltd. merged into Alcan Inc. Alcan owned 54% of the total Canadian primary aluminum smelter capacity in 2001 with the completion and ramping up of the Alama smelter. The \$2.2 billion 375,000-metric-ton-per-year (t/yr) primary aluminum smelter, which started producing in October 2000, was increased to 400,000 t/yr in mid-2001. Alama's new capacity required 620 megawatts (MW) of power; 270 MW would come from Alcan's own grid, and 350 MW, from provincial utility Hydro-Quebec. The company had negotiated a projected 22-year power-exchange project with Hydro-Quebec. With Hydro-Quebec furnishing additional power that Alcan may need for modernization and expansion of its various smelters in Quebec, Alcan's hydroelectric power system stood ready to accommodate Hydro-Quebec's requirements when feasible. Alcan projected that it would require an average market price of \$1,400 per metric ton to meet its cost of capital. The new potlines would comprise 432 pots in two lines. This Alama facility would raise Alcan's overall primary aluminum capacity from all its plants to 1.9 million metric tons per year (Mt/yr) (Wagner, 2001a, p. 8.3).

Cobalt.—Mine production of cobalt amounted to 5,334 metric tons (t), which increased by about 0.7% compared with that of 2000, in spite of the steep decreased in the value of nickel. Rising demand for cobalt for alloys, catalysts, magnets and batteries, and even pigment, however, has focused new attention on cobalt resources in Canada led by the Voisey's Bay discovery of at least 40,000 t contained within the nickel-copper deposit; further results were expected as exploration progressed (Natural Resources Canada, 2002a, b).

Cobatec Inc., which operated a cobalt-nickel solvent extraction plant in North Cobalt, Ontario, had negotiated a long-term supply agreement with the Cuban Government to process cobalt-nickel sulfate precipitates from Cuba. Processing, which began early in 1998, never amounted to more than minimal output from this \$15 million facility established by Cobatec because of expectations to proceed with a number of new hydrometallurgical nickel-cobalt laterite plants, which would further depress cobalt prices in the open market. The higher prices of the mid-1990's would be rather difficult to sustain in the future, given the current market conditions and expectations (McCutcheon, 2001, p. 37.22). Thus, the company had developed a proprietary hydrometallurgical process for extracting cobalt from ore, tailings, or mine spoil that involves crushing, grinding, flotation, and solvent extraction; this cobalt is then further treated to produce simple salts, such as carbonates. Their process had been endorsed by the Ontario Government as being consistent with its "green" industries strategy, the purpose of which is demonstrate that resource development can coexist with environmental responsibility.

Columbium (Niobium).—Mine output increased to 3,180 t in 2001 from 2,280 t in 2000, or an increase of 39.5% (Natural Resources Canada, 2002a). Niobec, which was the only operating columbium mine in North America, was jointly owned (50% each) by Cambior Inc. and Teck Corp. Situated near Chicoutimi, Quebec, the mine ranked as the world's third largest producer. The equal partners have undertaken a study of the feasibility of increasing production by 40% in at least two steps. Included in the upgrade would be an expansion of the crushing and grinding circuit by 20% to 50%. Columbium is used primarily as an alloying agent in specialty steels.

Copper.—Mine output of copper decreased by 0.7% to 629,684 t in 2001 from 633,855 t in 2000, which reflected the sharp world copper price decline that resulted in a drop in value to \$987 million in 2001 from \$1.1 billion in 2000 (Natural Resources Canada, 2002a, b). Canada exported \$1.6 billion worth of copper during 2000 (Coulas, 2001, p. 21.11).

After firming to a peak in 1998, the softening of copper prices between 1998 and 2000 resulted in suspension or shutdown of some copper production. Mine outputs in 2000 and 2001 were low owing to the temporary closure of the Highland Valley Copper (HVC) and the Myra Falls Mines, as well as the permanent closure of the Mines Gaspé in October 1999, the strike at the Sudbury operations, and lower ore grades at Kidd Creek (table 2; Giancola, 2000, p. 442, 463). No new copper mines were scheduled to come onstream until 2003. HVC mined copper at an average grade of 0.39% and processed about 45 Mt/yr to produce copper in concentrate at a cost of about \$0.68 per pound (about \$1.50 per kilogram).

In October 2000, Cominco Engineering Services Ltd. signed a memorandum of understanding (MOU) with Taseko Mines Ltd. to begin a \$3 million feasibility study to construct a 35,000-t/yr copper refinery at the Gibralter Mine site near Williams Lake, British Columbia. The facility would use Cominco's hydrometallurgical technology to leach copper concentrates. In November 2000, London-based Billiton plc. acquired 100% control of Toronto-based Rio Algom Ltd. Algom's operations in Canada included a 33.6% interest in HVC, as well as 100% interest in the Cerro Colorado Mine of northern Chile, a 25% interest in the Alumbrera copper-gold mine in Argentina, and a 33.75% interest in the Antamina copper-zinc mine in Peru. Billiton owned 100% of Les Mines Selbaie, which is a copper-zinc mine in northwestern Quebec that will operate until June 2004 (Giancola, 2000, p. 67, Coulas, 2001, p. 21.3).

Princeton Mining Corp. expected production of 37,000 t/yr of contained copper, which would also yield 11,800 kilograms per year (kg/yr) of silver, 218 kg/yr of gold, and 670 t/yr of molybdenum at its British Columbia Huckleberry polymetallic ore body. The Huckleberry Mine's probable reserves were estimated to be 56.5 Mt of ore at a grade of 0.5% copper, 0.014% molybdenum, 0.06 gram per ton (g/t) gold, and 2.8 g/t silver. Princeton merged with Imperial Metals Corporation, which was the operator and 55% owner of the Mount Polley copper-gold mine near Williams Lake, British Columbia, to form a new company to be called Huckleberry Mines Ltd., of which Imperial owned 50% (Coulas, 2001, p. 21.3-21.7; Giancola, 2002, p. 192-193).

The potential copper production at Voisey's Bay suggested that Canada, which ranked fifth after Chile, the United States, Indonesia, and Australia, will continue to be a major world copper producer (Edelstein, 2002). Expectations were that Voisey's Bay might yield 99,000 t/yr of contained copper, but because of a variety of administrative concerns with the Newfoundland Provincial Government described above, the mine was a long way from production. Voisey's Bay's, nickel-copper-cobalt deposit in Labrador, proven reserves were estimated to be 31 Mt of ore at a grade of 2.88% of nickel, 1.69% of copper, and 0.14% of cobalt (Giancola, 2002, p. 195).

Gold.—Gold output increased to 159.7 t in 2001 from 156.2 t, which was up by 2.2% compared with that of 2000. The value of 2001 gold production increased by about 2.9% to \$1.4 billion from \$1.36 billion in 2000 (Natural Resources Canada, 2002a, b). Ontario produced 49%; Quebec, 21%; British Columbia, 15%; Manitoba, 4%; and Yukon Territory, the Northwest Territories, Saskatchewan, Newfoundland, Alberta, and New Brunswick, a total of 11%. Predictions made in 1995 that output would reach 170 t by 1998 were then seen as somewhat pessimistic, but a record high of 171.4 t was actually achieved in 1997. Although 3 mines opened, low gold prices and/or depletion were responsible for 13 mine closures, which had a deleterious effect on production from 1999 through 2001. By yearend, 33 mines were operating. Gold mines accounted for 88% of Canada's output, and 19 base-metal mines and numerous placers contributed with 10% and 2% of production, respectively. Canada was the fifth largest gold producer after South Africa, the United States, Australia, and China. Canada exported \$2 billion worth of gold in various forms during 2000. The principal gold refiners were Noranda Inc., which was Canada's largest mining company, in southern Quebec; the Royal Canadian Mint at Ottawa, Ontario; and Johnson Matthey Ltd. near Mississauga, Ontario (Keating, 2000, p. 23.1; Amey, 2002).

Echo Bay Mines Ltd. put its Lupin gold mine in Nunavut, which is located about 138 km south of the Arctic Circle, on care and maintenance while it examined its options in the light of low market prices during 2000. After nearly 2 years of shutdown, Echo Bay decided to reopen the mine with \$12 million of new financing and commercial production targeted in 2002.

Effective February 14, 2000, Northgate Exploration Ltd. acquired the Kemess gold mine from Royal Oak Mines Inc. at a cost of \$145 million. This royalty interest was purchased pursuant to the proposal that Royal Oak filed under the Bankruptcy and Insolvency Act of Canada in December 1999, which received Court approval on January 4, 2000. The Kemess Mine was forecasted to produce about 8.7 t/yr (280,000 ounces per year) of gold and 27,500 t/yr of copper. Kemess' proven and probable reserves were estimated to be 165 Mt of ore at a grade of 0.7 g/t gold and 0.23% copper (Lyons, 2000).

Although gold still seemed to be the principal metal targeted for exploration virtually throughout Canada, it yielded to nickel in terms of the value of production in 2001. With the threat of more gold mine closures, which depended on market confidence, gold seemed to have lost at least some of

its traditional luster. Compounding the problem had been the announced future sale of gold in the open market by the United Kingdom, the possibility of significant sales by the Swiss Government from its large holdings, and repeated suggestions that the International Monetary Fund would release much of its gold to the open market to pay for projects in Third World countries. In September, however, the European central banks' commitment to sell no more than 2,000 t of bullion during the ensuing 4 years caused a positive spike in the market price that subsided in the succeeding months as market hedging resumed (Keating, 2000, p. 23.1; Natural Resources Canada, 2001b, p. 1).

Iron Ore.—Output of iron ore decreased by about 20.1% compared with that of 2000, and the value of production decreased by 18.9% (Natural Resources Canada, 2002b). This category comprised concentrates, pellets, and sinter from hematite and siderite ores. Major iron ore producing companies included Iron Ore Co. of Canada (IOC), Quebec Cartier Mining Co. (QCM), and Wabush Mines Ltd. The Algoma Ore Division (AOD) of the Algoma Steel Inc. closed its mining operations because it was not economical (Giancola, 2000, p. 463; Perron, 2001). Data for 2000 (the latest year for which data are available) give an approximation of the proportions of pellets and sinter versus concentrates. QCM produced 16.1 Mt of ore, of which 8.3 Mt was used for pelletization and the remainder, sinter feed. Shipments exceeded production so that stocks were drawn down to meet demand. IOC produced 15.9 Mt of ore, of which 10.8 Mt went to pelletization, and the remainder to concentrates that were not used for pellets. Wabush Mines turned out 5.3 Mt of iron ore pellets. AOD produced 975,000 t of sinter at its complex in Wawa, Ontario (Perron, 2001).

After paying \$235 million in return for a 56.1% stake in IOC, North Ltd., which was a diversified Australian resources group, decided to reactivate IOC's dormant (since 1982) Sept-Iles pellet plant, which had port facilities on the Gulf of St. Lawrence in Quebec. The anticipated expansion in 2002 will increase IOC's capacity for production of high-quality pellets to 15.5 Mt/yr from the 2000 capacity of 11 Mt/yr. A redesigned plant at Sept-Iles was expected to reduce IOC's average production costs by \$5 per ton. Exploration continued in various parts of Canada, such as Roche Bay in the Northwest Territories, the Peace River area of Alberta, and Ungava Bay and Schefferville in Quebec (Perron, 2001).

Pig iron production decreased to 8.8 Mt from 8.9 Mt in 2000, or about 2%. The proportion of direct-reduced iron to pig iron produced was about 10%, thus confirming the ratio of 10% forecast 3 years before. Crude steel production was about 16.3 Mt compared with 15.9 Mt in 2000; the old peak was 15.5 Mt in 1989 (Perron, 2001).

Lead and Zinc.—Canada was the world's third largest mine producer of zinc at 1.07 Mt of zinc and was tied with Mexico as the world's sixth largest producer of lead at 157,127 t of lead in concentrate. Zinc mine output showed an increase of 6.8% in 2001 compared with that of 2000, and lead production increased by 5.6% compared with that of 2000 (Chevalier, 2001, p. 62.1- 62.18; Natural Resources Canada, 2002a, b; Plachy,

2002; Smith, 2002). Zinc markets recovered somewhat in 2000 despite continued poor demand in Japan, slow growth in Europe, and increased mine production worldwide. New mine capacity in Australia, Ireland, and Peru; expansions in Chile, Peru, and the United States; increased exports from China; and weak market prices continued to take their toll despite a continued decline in stock levels (Chevalier, 2001, p. 62.18).

Boliden Ltd. restarted operations at its Myra Falls Mine in Strathcona Provincial Park, British Columbia, in 2000, after a 3-month suspension for rehabilitation of ground-control conditions after problems with rock falls and ore dilution. About four-fifths of the labor force remained on duty during the suspension and devoted attention to rebolting 1,340 meters (m) of drifts in tighter patterns and to clearing backfill work that had lagged behind schedule. The company carried out a \$9.8 million rehabilitation and additional development, which was expected to result in lower operating costs and more-efficient and controlled mining of the Battle and the Gap zones of the mine and to bring it back to its full production of 110,000 t/yr of zinc (Chevalier, 2001, p. 62.1).

Breakwater Resources Ltd. (BRL) established milling improvements at its Nanisivik zinc mine on Baffin Island, New Brunswick, in the form of a regrind circuit that improved the zinc concentrate grade from 55.5% to 57.5% and increased recovery by 0.5% to 96.5%, thus resulting in significant savings in shipping and treatment costs. BRL's Caribou zinc mine remained on care and maintenance; reopening depends on better metal prices (Chevalier, 2001, p. 62.4).

Hudson Bay Mining and Smelting Co. Ltd. (a wholly owned subsidiary of Anglo American plc.) began an underground development program at its Chisel North zinc deposit at Chisel Lake, Manitoba, which is not far from Snow Lake. A decline will be driven from the 140-m level of the main deposit to the north deposit for drilling and bulk sampling to confirm the surface-drill indicated resource of 2.4 Mt at a grade of 10.8% zinc. The \$21 million capital investment was part of Hudson Bay's \$260 million investment in the "777 deposit," which contains some 14.5 Mt of proven and probable zinc reserves, and included the refurbishment of the Snow Lake concentrator. Snow Lakes' concentrates will be trucked 200 kilometers (km) southwest to the Flin Flon smelter. The "777 deposit" was expected to enter into production in 2003. The construction of a \$65 million electrolytic tankhouse also continued (Chevalier, 2001, p. 62.1-62.4).

In 2000, Inmet Mining Corporation permanently closed operations at the Winston Lake zinc mine on the north shore of Lake Superior in Ontario after studies showed that it was not economic considering the low zinc prices. Although the small high-grade mine had been nearing the projected end of its mine life, Inmet sought to extend it another 4 years by developing the lower Pick Lake zone, which was estimated to include 1.2 Mt at a grade of about 16% zinc, but development work failed to confirm this resource (Chevalier, 2001, p. 62.3).

After closing its operations in the Matagami district of northern Quebec with the exhaustion of the Isle Dieu and Norita East zinc-copper mines, Noranda completed development of the \$119 million Bell Allard zinc-copper mine, also in the Matagami district. The project started underground operations in January

2000, which would counter the exhaustion of Isle Dieu and Norita East. The Bell Allard Mine was expected to have a capacity of 80,000 t/yr of zinc and 5,000 t/yr of copper. Armed with local experience from two closed mines, Noranda pressed exploration in the Matagami district for further discoveries of copper-zinc deposits (Giancola, 2000, p. 279).

Agnico Eagle Mines Limited will spend \$104 million to complete the expansion of its LaRonde zinc mine in northwestern Quebec, which was expected to produce 52,000 t/yr of zinc in concentrates in the near future. In northwestern Quebec, Noranda reported a finding of new sources of feed for its milling and smelting operations in the Matagami district. A significant zinc-copper deposit of three ore zones (Equinox, Perseverance, and Perseverance West) was discovered in the existing Matagami mining camp. The Equinox deposit was 5 Mt of inferred resource with 16.8% zinc, 1.3% copper, 34 g/t silver, and 0.4% g/t gold. Work continued to further define the three polymetallic ore zones (Chevalier, 2001, p. 62.3).

Magnesium.—Noranda was pursuing an unusual venture—a \$733 million plant to turn asbestos waste, which is cheap and plentiful, into magnesium metal, whose market price averaged just less than \$2,500 per ton in 2000. The processing of asbestos commonly leaves tailings that are very rich in magnesium silicate. After successfully competing a 250-t/yr pilot operation, Noranda committed to the construction of a \$486 million primary magnesium plant at Asbestos, Quebec, where 250 Mt of tailings will be the feedstock for a 58,000-t/yr throughput beginning in near term. Magnola Metallurgy Inc. [Noranda (80%) and Societe Generale de Financement du Quebec (20%)] will be the operator. By using a hydrochloric acid leaching process, the resulting magnesium chloride will be electrolyzed to yield magnesium metal. The plant was expected to reach full production capacity by yearend 2001 (Wagner, 2001b, p. 31.1-31.2).

Cassiar Magnesium Inc. (formerly Cassiar Mines & Metals Inc.) held a 100% interest in the chrysotile project in Cassiar, British Columbia (Giancola, 2000, p. 95). The company planned to complete a bankable feasibility study on its magnesium metal project by early 2001 and to bring its 100,000-t/yr plant into production by 2003. Metal will be extracted from a stockpile of 200 Mt of serpentine tailings that contains 4 Mt of recoverable magnesium metal. Cassiar entered into an MOU with Aluminum of Korea Ltd. (Koralu). If Koralu finances the \$600 million project, then it could earn up to 65% equity (Metal Bulletin, 2000a).

Nickel.—Mine output increased by about 1.3% from that of 2000 with a corresponding huge decrease of 24.1% in value of production, which reflected the declining nickel prices in world markets in 2001. Nickel was the second most valuable metal, following gold, produced in Canada during the year. Nickel production could be attributed to the higher value of production of PGM, which increased by 18.9% in 2001 (Natural Resources Canada, 2002b).

Falconbridge Ltd. was the third largest producer of nickel in the world. Its operation included the Raglan Mines and mill in northern Quebec, the Sudbury operations (four mines, a mill, a

smelter, and an acid plant) in Ontario, a refinery in Norway, and a mine and smelter in the Dominican Republic (McCutcheon, 2001, p. 37.1-37.4).

The concentrate from the Craig, the Fraser, the Lindsley, and the Lockerby Mines in the Sudbury area and from the Raglan Mines was smelted in the firm's smelter near Sudbury. The matte, which contained 50% nickel from the smelter, was shipped to Falconbridge's Nikkelverk refinery in Norway where nickel, copper, cobalt, and precious metals were recovered. The \$360 million Raglan operation was scheduled to produce concentrates of about 20,800 t/yr of nickel and 5,200 t/yr of copper. Raglan concentrates were to be shipped from Deception Bay, which is 100 km north of the mine, to Quebec City and to continue by rail to Falconbridge's Sudbury smelter in Ontario (McCutcheon, 2001, p. 37.4-37.7).

In 2000, Inco operated nickel mines, mills, smelters, and refineries in Sudbury, which produced 99,800 t, and in Thompson, Manitoba, which produced 34,000 t of nickel, and a copper smelter and refinery in Sudbury. Inco produced refined nickel and nickel oxide sinter.

Predictably, the world's biggest newsmaker in nickel continued to be Inco's nickel-copper-cobalt project at Voisey's Bay, where the saga, which involves exploration, environmental activism, aboriginal claims, financial straits, and provincial politics, continued to unfold. While the exploration program progressed in Labrador and at the Voisey's Bay site, other developmental problems came to the fore (see "Environmental Issues"). Inco announced in early 2001 that the hydrometallurgical research and development work will continue. In 2001, proved reserves at the site totaled 32 Mt at a grade of 2.83% nickel and 1.68% copper; indicated resources, 91 Mt at a grade of 1.25% nickel and 0.59% copper; and inferred resources, 14 Mt at a grade of 1.00% nickel and 0.70% copper. Of the resources noted, 95 Mt at a grade of 1.24% nickel and 0.59% copper would be minable by underground mining methods, and 10 Mt at a grade of 0.92% nickel and 0.72% copper would be minable by open pit. No cobalt grades were released for the Voisey's Bay deposit (McCutcheon, 2001, p. 37.8). Existing plans had proposed the production of 15,000 metric tons per day (t/d) of concentrates, which would be shipped to a smelter-refinery complex at Argentia, where refinery output would be 122,500 t/yr. Total capital costs would exceed \$1 billion.

After world market pricing of nickel showed signs of improvement, further negotiation could effect the tentative agreement on Inuit land claims after negotiations among the Government of Canada, the Government of Newfoundland and Labrador, and the Labrador Inuit Association. Declining nickel prices in 2001 and new low-cost lateritic nickel operations in Australia might influence any equation for settlement with the Government of Newfoundland.

Sherritt International Corp. and General Nickel Company S.A. of Cuba entered into the joint venture Metals Enterprise; each company owned a 50% interest. Metals Enterprise operated a lateritic nickel-cobalt mine through Moa Nickel S.A. in Moa, Cuba. The nickel-cobalt (Ni-Co) oxides are transformed into Ni-Co sulfides by leaching with sulfuric acid; they are shipped to Nova Scotia and then railed to Metals Enterprise's

hydrometallurgical Ni-Co refinery in Fort Saskatchewan, Alberta. The feed from Cuba enters Canada classified under the Harmonized System (HS) 2620.90, which records only gross tonnage and gross value (McCutcheon, 2001, p. 37.13-37.14).

Exploration by Nuinsco Resources Inc. in the Lac Rocher area, which is located about 120 km northeast of the town of Matagami, found strong nickel-copper mineralization. This caused a staking rush into the region that included activity by major and junior mining companies.

Platinum-Group Metals.—Mine production of PGM increased by about 18.6% compared with that of 2000; this closely reflected the significant increase in price owing to higher demand for use in autocatalysts in 2001 (Natural Resources Canada, 2002b). Most production has been from Inco and Falconbridge's Sudbury Mines and a smaller amount in Manitoba from Inco's Thompson Mine and from Hudson Bay and Outokumpo Mines Ltd.'s Namew Lake Mine near Flin Flon, which was being decommissioned.

As an approximation based on past experience, Inco's ratio of PGM produced worked out to about 12 to 7.6 to 1 for palladium, platinum, and rhodium, respectively. Although rhodium amounted to only slightly more than one-twentieth of the PGM, its prices have traditionally been significantly higher than those for other members of the group, having traded at more than \$4,000 per ounce in recent years. The largest increase among the PGM was in the price of palladium, which more than doubled at the beginning of 2000. Canada ranked third behind South Africa and Russia in world PGM production (Hilliard, 2002a).

Silver.—Canada ranked fifth in world silver production after Mexico, Peru, Australia, and the United States (Hilliard, 2002b). Canadian silver production has been largely a coproduct of base-metal and gold mining and, therefore, subject to whatever mining incentive applied to the major product, whether gold, copper, and/or lead and zinc. Accordingly, silver output suffers when mines close or go on suspension for reasons that involve supply, demand, and pricing for the major mineral commodities. Production of silver increased by about 4.9% compared with that of 2000; the value of this production dropped by about 4% with a decline in silver prices (Natural Resources Canada, 2002b). Silver production increased significantly starting in 1995 when Prime Resources Group Inc.'s Eskay Creek gold mine in British Columbia came on-stream as the largest producer of silver in Canada; output of silver from this mine until depletion has been projected to be 28% of the total for the entire country.

Titanium.—Output of titanium remained at 950,000 t, which was an increase of about 11.8%, since 1997. QIT-Fer et Titane Inc. of Canada invested \$260 million in the construction of a plant at Sorel, Quebec, to produce an upgraded titanium slag that contains 95% titanium dioxide (TiO_2) compared with its previous Sorel slag that contained 80% TiO_2 . The company aimed for extraction of 3 Mt/yr of ore. Mine output was used primarily to produce titaniferous slag. Reserves and reserve base are ilmenite. Canada, which exported 72,000 t of titanium

dioxide pigment to the United States, ranked first in the world as a supplier of titanium to the United States, followed by Germany (14%), France (8%), Spain (6%), and others (36%) (Gambogi, 2002).

Uranium.—After the previous upward trend in production of uranium ended in 1998 with a decrease of 28% compared with that of 1999, the 2001 production increased by 17.3%; the value of this production increased by 42.8% with an increase in uranium prices (Natural Resources Canada, 2002a, b). As the world's leading supplier of uranium, Canada was well placed in terms of resources, reserves, mining labor experience, and technology to maintain this position amidst increasing longer term world demand. As older mines were shut down in the Elliot Lake district of Ontario, newer ones were being developed and mined in the Cigar Lake, the Cluff Lake, the Key Lake, and the Rabbit Lake districts of Saskatchewan (table 2).

In January 2001, prospects for further nuclear power development in the United States somehow increased spot prices for uranium. Canadian uranium producers in northern Saskatchewan remained well positioned to capitalize on any market upturn because the transition to new production was being centered on tapping high-grade, low-cost uranium deposits in Canada (Vance, 2001).

Industrial Minerals

Asbestos.—Canadian asbestos production and value decreased about 11.4% and 6.7%, respectively, compared with those of 2000 (Natural Resources Canada, 2002a, b). Owing to human health concerns, world production has declined since the early 1980s. Chrysotile is the only form of asbestos in the serpentine group. The amphibole group consists of actinolite, amosite, anthophyllite, crocidolite, and tremolite forms. Of these minerals, chrysotile is the least hazardous to human health and is the only one that is produced in Canada (Perron, 2000, p. 17.1-17.2). After Russia, Canada was the second largest producer of asbestos and supplied about 97% of the United States' demand (Virta, 2002). Total shipments for 2000 were estimated to be 345,000 t at a value of \$400 million. China's asbestos production of almost exclusively short fibers for asbestos cement, which was rapidly gaining on that of Canada and meeting demand in Asian markets, could eventually threaten Russia's leading position. Mounting concern regarding chrysotile substitutes was expected to benefit the chrysotile industry in the near to medium term. Marginal gains were expected in Latin American consumption of Canadian chrysotile; Asia, which was already a significant market (taking more than 50% of exports), was seen as expanding the demand for longer Canadian fibers. Asbestos-cement product demand was fairly steady because many users continued to favor this combination over substitute fibers and steel.

After a 6-year suspension of operations, Cassiar reopened its Cassiar asbestos mine in British Columbia in early 2000. Production increased to 24,000 t/yr from 18,000 t/yr; Cassiar was planning to increase output to 50,000 t/yr by 2003 (Giancola, 2000, p. 85). By far the greatest proportion of Canadian asbestos production was in Quebec in the region that

includes the Thetford Mines of Bell Operations and the town of Asbestos. Principal operators were LAB Chrysotile Inc. and J.M. Asbestos Inc. The production of metallic magnesium from asbestos mine waste materials should improve the economics of the asbestos industry and create better overall labor expectations, particularly in Quebec, where decreased production has taken its toll.

Cement.—Production of cement increased by about 3% from that of 2000 with a corresponding value increase of 4.3% in 2001. On the basis of preliminary data, shipments of cement in 2000 were estimated to have been 12.61 Mt at a value of \$820 million compared with 12.63 Mt at a value of \$800 million in 1999 (Vagt, 2001; Natural Resources Canada, 2002a, b). This trend reflected continued strengthening of the export market in the midst of declining prices. Weakening of the Canadian dollar versus the U.S. dollar has made Canadian cement prices attractive to U.S. consumers. Canada has usually been the chief exporter of cement to the United States except for a brief period in the 1980s when Mexican shipments moderately exceeded those of Canada. The U.S. antidumping duties against grey portland cement and clinker from Japan and Mexico remained in effect in 2000. The 1990 International Trade Commission ruling against the dumping of cement by Mexican producers essentially removed them as competitors and left the field to Canada as the principal foreign source. Total U.S. imports of cement, which excluded clinker, totaled 24 Mt in 2000 (Vagt, 2001).

For the immediate future, the success of Canadian cement producers seems to be based significantly on exports to the United States and, hence, upon the prospects for U.S. economic growth. Canadian growth and construction, particularly in Ontario, which was the largest cement market, will play the key role in determining a balance between domestic and U.S. consumption. According to the Canadian Construction Association, cement production was expected to be marginally higher based mainly on lower interest rates and an increase of about 4% in the value of infrastructure to about \$81.2 billion (Vagt, 2001). Also, the "Infrastructure Canada Program," which involves Federal, Provincial, Territorial, and municipal governments, will contribute about \$4 billion across Canada in the coming decade (Vagt, 2001).

The influx of Asian cement to the United States negatively affected Canadian exports between 1998 and 2000. The fact that Canada has been the major exporter to the United States has kept Canadian cement kilns operating at high rates throughout the past decade and has allowed for gains in pricing (International Cement Review, 2000, p. 93-96).

Diamond.—Diamond continued to be Canada's best friend. Production of diamond increased by about 45.4% from that of 2000 with a corresponding value increase of 35.5% in 2001 (Natural Resources Canada, 2002a, b). In 2001, the country's first commercial producer of diamond BHP Diamonds Inc. (now BHP Billiton) acquired Dia Met Diamonds Inc. for \$446 million to consolidate its interest in the Ekati diamond mine at 80%; the other owners were Charles Fipke and Stewart Blusson, each with 10% (Law-West, 2001). As operations gained in efficiency, production at Ekati's diamond mining complex production,

increased by about 3.6% (2.6 million carats valued at \$638.2 million) compared with that of 2000 (2.51 million carats valued at \$606.3 million) with a corresponding value increase of 5.3% in 2001 (Giancola, 2000, p. 130). BHP Billiton contracted to sell 35% of the Ekati's production to De Beers of South Africa through its subsidiary De Beers Canada Corporation (Giancola, 2000, p. 127).

De Beers Canada Ltd. acquired Winspear Diamonds Inc. in 2000 for \$198 million and controlled 67.8% interest in the Snap Lake diamond project. In early 2001, De Beers purchased the remaining 32.2% interest in the project from Aber Resources for \$112 million. In August 2001, De Beers announced that production at the Snap Lake Mine will begin in 2006. In 2000, Diamond Trading Company (DTC) (De Beers' trading subsidiary) sold a record \$3.7 billion worth of diamond. DTC's sales for 2001 were expected to be down substantially because sales in the first half were down by 26% to \$1.7 billion, and the second-half sales would be usually lower than the first half. In June 1999, the first diamond cutting and polishing factory in the Northwest Territories began commercial production. Sirius Diamonds N.W.T. owned and operated the factory, and rough diamonds are supplied by BHP Billiton (Law-West, 2001, p. 22.1; Natural Resources Canada, 2002a, b).

BHP Billiton officials reported that the quality of diamond recovered to date from the five kimberlite pipes at their Lac de Gras property compared favorably with the best pipes in other parts of the world; the property is about 300 km northeast of Yellowknife. The five pipes, in order of importance, were located under Panda, Koala, Misery, Fox, and Leslie Lakes and would be mined during a 30-year period. The centralized processing plant, which is southwest of the Koala pit, was to receive 9,000 t/d of ore during the first 9 years of operation and 18,000 t/d thereafter. The cutoff grade would be 0.01 carat. Processing was expected to involve mainly crushing, scrubbing, and dense-media separation, as well as high-intensity magnetic separation, X-ray concentration, and sorting. The construction phase work force would reach 1,000 at its peak; after that, about 650 workers were to be employed during production. Future output was projected to be 3 million to 4 million carats per year, or about 5% of the world's diamond supply. Capital investment was to be in excess of \$360 million, but observers expected that at least \$4 billion would eventually be spent in association with the project. As early as May, BHP Billiton noted that it would channel a portion of its production through the De Beers' Central Selling Organization (CSO). In July, De Beers Consolidated Mines Ltd. completed a sales contract to take 35% of Ekati's run-of-mine production for a period of 3 years.

In Canada, Monopros Limited (De Beers' prospecting subsidiary) discovered more than 220 kimberlites, several of which have the potential to become diamond mines, such as the Snap Lake project that will be in full production by 2004 at a cost of \$1 billion (Giancola, 2000, p. 127). This project will be De Beers' first mine outside of Africa, the first underground mine in Canada, and the first time that a kimberlite dyke will be mined on a large scale (Giancola, 2002, p. 250; Ralfe, 2002).

Diavik Diamond Mines Inc., which was the Rio Tinto PLC (60%) and Aber Resources Ltd. (40%) joint venture, received its regulatory permits allowing construction to begin at the \$850 million mine site and proceeded with plans for a 2-Mt/yr

operation to begin production in early 2003 (Law-West, 2001). The Diavik diamond project is located about 35 km southeast of Ekati and 300 km northeast of Yellowknife in the Northeast Territories. The project would mine four separate kimberlite pipes with a projected production that could reach 8 million carats per year in the first year of an estimated mine life of 16 to 22 years. At least 90% of Diavik's production would be of gem quality.

More than 500 companies, off and on, have been exploring for diamond, especially in the Northwest Territories, but also in Alberta, British Columbia, Labrador, Manitoba, Ontario, Quebec, and Saskatchewan. The field seemed to be narrowing somewhat as various kimberlite pipes proved disappointing upon testing. BHP -Billiton has supported the establishment of a diamond- valuation facility in a community in the Northwest Territories to be used for training, basic sorting, and valuation for Government royalty purposes. This could lead to more- skilled and detailed sorting that would afford sales to qualified manufacturers in the northern region at prices, terms, and conditions similar to BHP Billiton's other marketing arrangements in Europe and with the CSO. First Canadian Diamond Cutting Works in Montreal became Canada's first fully integrated cutting and polishing factory with the aim of handling Canadian diamond production at a lower cost than European competitors; artisans were brought over from Belgium.

Gypsum and Anhydrite.—Production of gypsum and anhydrite decreased to 8.6 Mt in 2001 from 9.2 Mt in 2000. Production in either 2000 or 2001, however, did not equal the 1989 output of more than 12 Mt (Natural Resources Canada, 2002a).

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

Production data for anhydrite are combined with those for gypsum but make up only about 2% or 3% of the total for the two materials. Heavier than gypsum and about twice as hard, anhydrite was produced in Nova Scotia by Fundy Gypsum Co. Ltd. at Wentworth and Little Narrows Gypsum Co. Ltd. at Little Narrows. In 2001, Canada was the world's third leading producer of gypsum after the United States and Iran (Olson, 2002).

Potash.—Potash production, which decreased by about 10.6% compared with that of 2000, totaled 8.2 Mt of potassium

oxide (K_2O) equivalent, and its value decreased by 3.8%. Most of the production came from mines in Saskatchewan, but about 5% came from New Brunswick. Canada, which led the world in potash production, probably has the largest reserve base of the material. Value of production decreased to about \$1.6 billion in 2001 from \$1.7 billion in 2000; this reflected lower market prices (Natural Resources Canada, 2002a, b). Canada was the world's leading exporter of potash as well. Most Canadian potash was shipped to the United States (about 55%), Asia (about 30%), Latin America (about 10%), and Oceania and Western Europe (about 5%). Exports to the United States have risen steadily to satisfy agricultural needs, but lower prices for grains during 2000 and decreased production in Canada and the United States diminished the requirement for fertilizers. Exports to Asia, which climbed owing to an increase in shipments to China, accounted for about one-third of all seaborne exports of potash from Canada.

On January 1, 2000, the U.S. International Trade Commission issued a termination notice for the antidumping suspension agreement against Canadian potash producers that had been in effect since 1988. The United States imported 4.3 Mt of potash, or 93% of its total needs, and was the dominant destination for Canadian potash in 2000 (Pearse, 2001; Searls, 2002).

PCS, which was the largest publicly held potash producer in the world, operated four mines in Saskatchewan and one underground mine and two mills in Sussex, New Brunswick. PCS's production milling capacity was estimated to be 8.2 Mt/yr of K_2O equivalent, which equated to 61% of Canada's total potash capacity (Pearse, 2001; Giancola, 2002, p. 30).

Sulfur.—Production of all forms of sulfur decreased by 6.3% compared with that of 2000. Sulfur from smelter gases decreased by 6.2% to 796,000 t with an accompanying decrease in value of about 5.8%. Output of sulfur from natural gas, crude oil, and byproducts decreased by about 1.6% to 8.1 Mt with an increase in value of 1.4% compared with those of 2000. Most smelter-gas sulfur is converted to sulfuric acid. No Canadian production was derived from Frasch mining (Natural Resources Canada, 2002a).

With a projected 17% share, Canada maintained its position as the world's largest producer of sulfur followed by the United States and remained a leading exporter with roughly a 38% slice of world trade in sulfur. Most sulfur production was in Alberta, British Columbia, and Saskatchewan. Other Provinces produced small amounts of sulfur, mostly from oil refineries (Morel-à-l'Huissier, 2001; Ober, 2002).

Mineral Fuels

Coal.—Although coal production was still declining from the record high of about 78.9 Mt in 1997, it increased by 1.7% to 70.4 Mt compared with that of 2000. The total value of production was \$1.0 billion, which was an increase of 8.4% compared with that of 2000 and about 16% compared with that of 1997 owing mainly to price declines and only slightly to a progressively lower conversion rate for the Canadian dollar (Natural Resources Canada, 2002a, b). In April, industry spokesmen noted that price slumps in hard coking coal for Japanese steel mill consumption were going to contribute to

the worst export year in a decade for Canadian coal and that companies were going to have to be cutting, chopping, and bargaining on all fronts to keep mines open and operating. In 2001, fewer than 20 coal mines were operating in Canada, and the number was decreasing. At the same time, increased diversification and expansion into foreign markets were called for as a means to survive. In 2001, Canada accounted for only about 2% of the world's coal production; it exported almost one-half of that production, thus making it the world's fifth largest exporter after Australia, the United States, China, and South Africa. All exports were from the lower cost exporters in western Canada; metallurgical coal remained the country's major export (28.5 Mt). Domestic coal consumption remained high at about 58 Mt, and much of the eastern Canadian demand was being supplied by imports. The Appalachian region of the United States and the Cerrojón coal mine of Colombia were supplying bituminous coal for the Canadian steel and electricity industries, and Western U.S. subbituminous coal was being delivered into Manitoba and Ontario. Imports of coal into Canada during 2000 were about 14 Mt, of which the United States supplied more than 8 Mt and Colombia furnished the remainder (Natural Resources Canada, 2001c).

Luscar Ltd., which was Canada's largest coal producer, intended to open the Cheviot Mine, which is located 65 km south of Hinton, Alberta, as a replacement for the nearly depleted Luscar Mine, which is located 42 km south of the town of Hinton; both mines are in the foothills of the Rockies (Giancola, 2000, p. 245). A consortium of environmental groups led by the Sierra Club Legal Defense Fund vigorously opposed the Cheviot opening and won a preliminary ruling that Luscar's environmental assessment was incomplete. The previously approved Cheviot project was overturned, and the Sierra Club faction urged that the region shift from dependence on mining to other sources of income, such as tourism. Environmental air and climate change issues are priorities for coal mining companies and industries that use coal and will affect coal production and consumption in the future. The Zero Emission Coal Alliance, which had been formed by coal companies and stakeholders and was led by the Coal Association of Canada, was pursuing long-term solutions to coal-related environmental issues and concerns (Natural Resources Canada, 2001c).

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

Natural Gas.—The value of natural gas (\$22 billion) increased by 21.5% compared with that of 2000, and natural gas byproducts (\$3 billion) decreased by 17.3% compared with that of 2000 as both products, however, responded to supply-and-demand imbalances. Canada ranked third in the world after Russia and the United States in output of natural gas (Natural Resources Canada, 2002b). 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

decreased to about 202 billion cubic meters from 210 billion cubic meters in 2000. Production of marketed gas was 172 billion cubic meters compared with 162 billion cubic meters in 2000; marketed gas is gross production minus reinjected gas, shrinkage, and producer consumption (plant use).

About 89.4 billion cubic meters of natural gas, or roughly 10% of the U.S. supply, was exported to the United States in 2000. Gas exports to the United States were expected to increase to about 100 billion cubic meters by 2006 in anticipation of the increasing inability of U.S. domestic production to meet demand. At the beginning of 2000, Canada's natural gas reserves were projected to be about 1.81 trillion cubic meters, which was a net decrease of 1.8% compared with those of the preceding year (Natural Resources Canada, 2002a).

Spurred by increasing U.S. demand, exploration for new discoveries of natural gas continued the expansion, primarily in Alberta and Saskatchewan, that began at least two decades ago. Chevron Canada Resources Ltd. (a unit of ChevronTexaco Corp.), had one of the largest natural gas strikes in recent history near Fort Laird, Northwest Territories, where projections by the company showed "between 11.3 billion and 17.0 billion cubic meters (400 billion and 600 billion cubic feet) of gas in place in more than 366 meters (1,200 feet) of pay zone." Accessing Canada's abundance of fuels, particularly oil in northern Alberta and natural gas in the Northwest Territories, has become economically feasible because of new technology and rising fuel prices. Opposition to natural gas exploration, production, and transmission, however, 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. In 2000, a National Energy Board report, which assessed supplies and demand to 2025, put known natural gas reserves in Canada's "northern frontier" at 680 billion cubic meters (24 trillion cubic feet) with estimated reserves at 4.8 trillion cubic meters (170 trillion cubic feet) (Natural Resources Canada, 2002d). The United States consumed almost 609 billion cubic meters (21.5 trillion cubic feet) per year of gas, with demand expected to grow by about 2% per year for the next 20 years (Washington Times, 2001a).

Petroleum.—Production of petroleum reached a new record high of 821 million barrels (Mbbl) in 2001 compared with 803.9 Mbbl in 2000 and 807.6 Mbbl in 1998; this was an increase of almost 2.1% from 2000 and 1.7% from 1998, respectively. The value of the increased production, however, decreased by 17.8% compared with that of 2000, which reflected the worldwide effect on market pricing of the coordinated decrease in production by the exporting states of the Organization of Petroleum Exporting Countries in 2000. The value of the crude oil produced amounted to \$25.9 billion, which was down from \$31.5 billion in 2000 (Natural Resources Canada, 2002a, b).

After selling 30% of PC, the Government continued with privatization by offering much of the other 70% with the aim of reducing its share to perhaps 20%. During 2000, PC relinquished conventional crude production in western Canada when it shifted its interest to oil sands, natural gas, and offshore projects. The company was lauded as a model for state-owned

oil company privatization and appeared to be expanding its revenues by cost cutting and restructuring. It owned a 25% share of the immense Hibernia petroleum field offshore Newfoundland and a 25% share in Terra Nova field adjacent to Hibernia in the Jeanne d'Arc Basin, for which PC can claim discovery. Terra Nova development began in mid-1999 with first production in 2000. After Terra Nova, the White Rose field, also in the Jeanne d'Arc Basin, was considered for development.

The Hibernia field, which is beneath 75 m of water, was initially thought by its operators to contain perhaps 615 Mbbl of light waxy oil. The field was being developed in a \$6.5 billion project by PC and a consortium of companies that included Mobil Oil Canada Ltd. (ExxonMobil Corporation), Chevron Canada Resources (ChevronTexaco), and Murphy Oil Company Ltd.; large subsidies were provided by the Government. Production began in late 1997, which was ahead of schedule, with an output of 24,000 barrels per day (bbl/d). The offshore platform, which was put on location in early 1998, used new and unique technical design features to resist damage by icebergs. ExxonMobil, which owned 33% of the project, predicted that output would increase to 180,000 bbl/d and upped its reserve estimate for the Hibernia field to 750 Mbbl out of about 3 billion barrels (Gbbl) in place (Natural Resources Canada, 2002e).

The Athabasca oil sands (bitumen) north of Fort McMurray, Alberta, played an increasingly important role in Canadian oil production. Output from bitumen plus synthetic crude was 215 Mbbl in 2000, which was about 25% of Canada's total production. Technological development and increased operating efficiencies have steadily reduced production costs by Suncor Energy Inc. and Syncrude Canada Ltd., which were the two major operators, at their sites in northern Alberta and Saskatchewan, respectively. These operations, which accounted for more than one-fifth of Canada's crude oil, were in the process of substantial expansion. Suncor's operating costs at the Suncor oil sands plant in Alberta dropped from \$15 per barrel in 1992 to below \$12 per barrel in 1995 and was projected to have dropped to \$9 per barrel in 1998. Hence, the crude from the Athabasca sands 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 (Natural Resources Canada, 2001e).

The Athabasca, the Peace River, and other bitumen and heavy oil deposits in Alberta amount to 2.5 trillion barrels of oil in place, which is about 40% of the world's known bitumen. As of 1996, the 300 Gbbl considered to be recoverable exceeded the 265-Gbbl reserves of Saudi Arabia, but the latter could be extracted for less than \$1 per barrel. The Province of Alberta lowered its royalty on oil sand crude late in 1995 and stipulated that it be 1% on all production until companies pay off capital costs and earn a return that matches interest rates for long-term bonds. They would then pay a 25% royalty on each barrel produced (Natural Resources Canada, 2002e).

Syncrude's North Mine expansion will increase bitumen production to support output of 260,000 bbl/d of synthetic crude oil, and further expansions will increase crude oil production to 460,000 bbl/d by 2007. Suncor's Steepbank and new Millennium Mines will increase production by more than 80% as crude oil production increases to 220,000 bbl/d by 2003. The total capital investment in these large surface mines would

be on the order of \$6.25 billion from 1999 through 2007. The Athabasca oil sands mining region is positioned to become a hub of mining technology innovation and equipment advances that will have an impact on open pit mining worldwide (Natural Resources Canada, 2001e).

Reserves

Table 3 lists the levels of Canadian reserves of copper, gold, lead, molybdenum, nickel, silver, zinc, and other selected mineral commodities on or about January 1, 2002. Data are shown in terms of metal contained in ore for the base and precious metals or recoverable quantities of other mineral commodities, which included industrial minerals and mineral fuels. These mineral reserves represent "proven" and "probable" categories and exclude quantities reported as "possible." Reserves were defined as being well-delineated and economically minable ore from mines committed to production.

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

Other than for gold, reserves of major metals fell steadily from 1977 through 2000. During this period, gold reserves trebled from about 500 t to more than 1,500 t as rising prices and the possibility of more price increases provided a strong incentive to exploration. Silver reserves, however, fell by 45% to less than 17,000 t from about 31,000 t during the same period.

During 2000 and 2001, reserves of the leading base and precious metals increased significantly. The only exception was lead, which decreased 13.5%. Other metals increased—copper, 19%; nickel, 15.8%; zinc, 7.8%; and gold, 5.6%.

Reserves of major metals were distributed unevenly throughout Canada and were mostly the result of mineralization of the Precambrian shield, the Rockies (Cordillera), and the Coast Ranges. Several Provinces dominated the reserves position in terms of proven and probable minable reserves of major metals. From east to west, New Brunswick had 76% of the lead reserves, 35% of the zinc, and 25% of the silver; Quebec had 26% of the zinc, 20% of the gold, 18% of the silver, 10% of the nickel, and 9% of the copper; Ontario had 72% of the nickel, about 51% of the gold, 50% of the copper, 22% of the silver, and 18% of the zinc; Manitoba had 18% of the nickel, 6% of the zinc, and 4% each of copper and gold; and British Columbia had 100% of the molybdenum, about 35% of the copper, 32% of the silver, and 19% of the gold. Future discoveries will alter the distribution of reserves among the Provinces and the Territories (Natural Resources Canada, 2002a, b).

Infrastructure

With a total land area of about 9.22 million square kilometers, which is slightly larger than the United States, Canada had networks of highly developed infrastructure, and vast areas of trackless wilderness. The country had 902,000 km of roads

that comprised 318,400 km of paved highway, which included 16,600 km of expressways, and 584,000 km of unpaved gravel or other loose-surface roads. Bulldozed temporary roads have been established for mining exploration in many remote places, but these deteriorate readily where not maintained.

A total of 36,114 km of standard-gauge railroads included two main systems, the Canadian National and the Canadian Pacific. The country also had about 3,000 km of inland waterways, which included the Saint Lawrence Seaway (one of the busiest in the world), that lead into the Great Lakes and mark the boundary with the United States in many places. Principal ports were Halifax, Montreal, Quebec, St. John (New Brunswick), St. John's (Newfoundland), and Toronto in the east and Vancouver on the west coast. Canada's merchant marine comprised about 114 ships of 1,000 or more gross registered tons.

The country had 1,417 airports. Among these, 517 had permanent-surface runways—18 had runways longer than 3,047 m; 15 had runways from 2,438 to 3,047 m long; 151 had runways from 1,524 to 2,437 m in length; 244 had runways from 914 to 1,523 m in length; and 89 had runways under 914 m in length. Civil aviation included about 636 major transport aircraft; Air Canada was the major carrier (U.S. Central Intelligence Agency, 2001§).

Canada generated electrical power from coal, natural gas, and nuclear fuels, as well as massive hydroelectric facilities. Total capacity was roughly 114 gigawatts. About 567 net terawatt hours, which was significantly less than capacity, was produced in 1999 (the last year for which complete data are available). Hydroelectric plants generated more than 60% of Canada's electricity; coal and fossil fuel, 26.4%; nuclear reactors, about 12.3%; and others, 1.3%. Quebec and Ontario produced the most electricity, 154 and 141 megawatt hours, respectively. Nearly 97% of Quebec's electricity came from hydroelectric plants, and the remaining 3% was produced mainly by nuclear facilities. In contrast, about 61% of Ontario's electric power was derived from nuclear plants, and the remainder, from hydroelectric and coal-fired plants. Most of Canada's electricity exports originated in New Brunswick, Ontario, and Quebec and was sold to consumers in New England and New York. British Columbia and Manitoba also exported large amounts of electricity, mainly to California, Minnesota, Oregon, and Washington. Except for Alberta, all Canadian Provinces that border the United States had transmission links to the neighboring systems (U.S. Central Intelligence Agency, 2001§).

An extensive system of pipelines connected oil-and gas-producing and consuming areas in Canada and the United States. The 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 and to the Puget Sound area of Washington. Canadian natural gas was transported largely by TransCanada PipeLines Ltd. of Calgary, which owned 13,600 km of mainline gas pipelines in Canada and 56 compressor stations that linked western Canadian gas producers with consumers in eastern Canada and the United States. The Canadian pipeline network included about 24,000 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 (U.S. Central Intelligence Agency, 2001§).

Outlook

Mining continues to offer the prospect of diversifying and strengthening the Canadian economy. Canada's mineral industry is encouraged by a real commitment by the Federal Government to work with the sector to improve the permitting process. The goal is to allow exploration and mining companies to comply with the regulatory requirements in a timely and efficient way and at the same time to operate within high environmental and social standards. Progress is being made toward improving the regulatory regime in northern Canada. Government and industry are enthusiastic about the concept of a Northern Mines Ministers Conference to be held each year to report on progress, to identify challenges, and to network with all affected stakeholders to re-establish an attractive investment climate and to reverse any economic difficulties, in particular, of the Yukon Territory, after having been battered by economic and environmental factors (Excell, 2002; Steele, 2002c).

Canada's dollar weakened slightly once more against the U.S. dollar; presumably this helped exports but discouraged imports of certain necessary commodities, specialized equipment, and ad hoc professional expertise. Increased exports boded well for credit markets, but equity markets, especially for junior mining companies, still suffered in the wake of the Bre-X scandal.

The new law "Standards of Disclosure for Mineral Projects," which was instituted in early 2001 and will be implemented across Canada during 2001 and 2002, is expected to avert future scandals. Demand for base metals in world markets strengthened after prices had been soft at a critical time for many companies, whether starting up or expanding, and relief was slow in coming. The value of metal production in 2000 and in 2001 remained almost identical after declining for the past 3 years. This can be attributed to a significant increase in the value of diamond, natural gas, and uranium and the continued strong demand for PGM in autocatalyst usage. In 2001, the overall value of fuel minerals production remained stable with a small increase of 0.8%. Despite the overall increases in the volume of most fuels, lower energy prices caused the record high value in 2000 (\$65.4 billion) and a slight increase in 2001 (\$66.0 billion). Increases in the value of production for natural gas (21.5%) and coal (8.4%) were offset by declines in the value of natural gas byproducts (17.3%) and crude oil (15%) (Natural Resources Canada, 2002b).

The Hibernia offshore oil project began production with the promise of rich payoffs to come. After Hibernia will come the Terra Nova and the White Rose fields in the Jeanne d'Arc Basin; others will be tested. Comparisons continue to be heard between the Canadian offshore and the development of the now-legendary North Sea fields.

The nickel-copper-cobalt discovery at Voisey's Bay makes an impressive case for more exploration in Canada, no matter how attractive the situations in Asia, Australia, and/or Latin America. Furthermore, new prospects for gold are being found in many parts of Canada even though current (2001) market pricing promises little encouragement for the near future.

The concerted effort to reconcile conflicting interests (in order of importance) 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 Canadian mining industry.

Inco has agreed on a “statement of principles” (SOP) with the Province of Newfoundland and Labrador to develop the Voisey’s Bay deposit. The SOP consists of a 30-year mining operations with an investment of \$1.9 billion, development to begin in July 2002, and first concentrate production in 2006. The full support by the Federal Government will assure sustainable economic development of the Province (Inco Limited, 2002§).

Canada continues to be well positioned in terms of its mineral-resource base and its access to markets in the United States and the rest of the world. Canada’s mineral industry is primarily export oriented with as much as 90% of the production of some commodities going to world markets. 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.

Canada cannot escape the realities of growing international competition, especially from mineral-rich developing countries that have liberalized economic and political systems to attract foreign investment. Canada’s greatest long-term asset may be the achievement of a popular consensus in support of sustainable development that respects the interests of mining companies, First Nation peoples, and the preservation of the environment.

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580 Booth Street
Ottawa, Ontario K1A 0E8
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
- Statistics Canada
Tunney's Pasture
Ottawa, Ontario K1A 0T6
- Indian and Northern Affairs Canada
Terrasses de la Chaudiere
10 Wellington Street, North Tower
Ottawa, Ontario K1A 0H4

- Environment Canada
Terrasses de la Chaudiere
27th Floor
10 Wellington Street
Ottawa, Ontario K1A 0H3
- The Mining Association of Canada
1105-350 Sparks Street
Ottawa, Ontario K1R 7S8

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- Ministry of Energy, Mines, and Petroleum Resources
Parliament Buildings
Victoria, British Columbia V8V 1X4
- Department of Energy
Petroleum Plaza, North Tower, 9945 108 Street
Edmonton, Alberta T5K 2G6
- Department of Energy and Mines
Room 306, Legislative Building
Regina, Saskatchewan S4S 0B3
- Administration of Mining Lands
Toronto-Dominion Bank Building
1914 Hamilton Street
Regina, Saskatchewan S4P 4V4
- Department of Energy and Mines
Room 301, Legislative Building
Winnipeg, Manitoba R3C 0V8
- Ministry of Northern Development and Mines
10 Wellesley Street East
Toronto, Ontario M4Y 1G2
- Department of Natural Resources and Energy:
Minerals and Energy Division
Hugh John Flemming Forestry Centre
Fredericton, New Brunswick E3B 5H1
- Ministere des Ressources Naturelles
5700, 4^e Avenue Ouest, 3^e Etage
Charlesbourg, Quebec G1H 6R1
- Mines and Minerals Division
933 Ramsey Lake Road
Willet Green Miller Centre, Level B-6
Sudbury, Ontario P3E 6B5
- Department of Mines and Energy
1701 Hollis Street
P.O. Box 1087
Halifax, Nova Scotia B3J 2X1
- Department of Energy and Forestry
P.O. Box 2000
Charlottetown, Prince Edward Island C1A 7N8
- Newfoundland Department of Mines and Energy
P.O. Box 8700
St. John's, Newfoundland A1B 4J6
- Northwest Territories Chamber of Mines
P.O. Box 2818
Yellowknife, Northwest Territories X1A 2R1
- Yukon Chamber of Mines
P.O. Box 4427
Whitehorse, Yukon Territory Y1A 2B7

British Columbia and Yukon Chamber of Mines
840 West Hastings Street
Vancouver, British Columbia V6C 1C8
Chamber of Mines of Eastern British Columbia
215 Hall Street
Nelson, British Columbia V1L 5X4
Mining Association of British Columbia
P.O. Box 12540, 860
1066 West Hastings Street
Vancouver, British Columbia V6E 3X1
Alberta Chamber of Resources
1410 Oxford Tower, 10235 101 Street
Edmonton, Alberta T5J 3G1
Saskatchewan Mining Association Inc.
1740 Avord Tower
Regina, Saskatchewan S4P 0R7
The Mining Association of Manitoba
700-305 Broadway
Winnipeg, Manitoba R3C 3J7
Ontario Mining Association
1114-111 Richmond Street West
Toronto, Ontario M5H 2G4
Quebec Asbestos Mining Association
410-1140 Sherbrooke Street West,
Montreal, Quebec H3A 2M8
Quebec Mining Association Inc.
942-2635 Boulevard
Hochelaga, Ste. Foy
Quebec G1V 4W2
New Brunswick Mining Association, The
Suite 312-236 St. George Street
Moncton, New Brunswick E1C 1W1
Chamber of Mineral Resources of Nova Scotia
202-5525 Artillery Place
Halifax, Nova Scotia B3J 1J2

Major Publications

Canadian Geoscience Council, annual report.
Canadian Institute of Mining and Metallurgy, Bulletin, 10 issues per year.
Canadian Mineral Analysts, monthly.
Canadian Mining Journal, Canada's Top Mining Companies, six issues per year.
Natural Resources Canada:
Canadian Minerals Yearbook, annual.
Canadian Mineral Industry Reports, monthly.
Canada's Mining Industry—Current Situation, February-March 1995.
Minerals and Metals Policy of the Government of Canada—Partnerships for sustainable development, 1996.
Mineral Policy Sector, Canadian Minerals, annual.
Mining and Mineral Processing Operations in Canada, annual mineral bulletin.
Production of Canada's Leading Minerals, monthly.

Geological Association of Canada, Geoscience Canada, quarterly.
Indian and Northern Affairs Canada, Mines and Mineral Activities, annual.
Industrial Minerals [London, Ontario], monthly: Industrial Minerals Information Ltd.
International Mining of London, Canadian Mining, monthly.
The Journal of Commerce (U.S.) newspaper, weekdays.
L'Industrie Miniere du Quebec, annual.
Metal Industry, Trends and Outlook, monthly.
Mining Journal Ltd., London, Mineral Markets and Mining Finance, monthly.
Mining Journal Ltd., London, Mining Journal, weekly.
Northern Miner Press Inc.:
Canadian Mines Handbook, annual.
Canadian Oil & Gas Handbook, annual.
The Northern Miner, weekly.
PennWell Publishing Co.:
Natural Gas Industry Directory, annual.
Oil & Gas Journal, Worldwide Report, monthly.
International Petroleum Encyclopedia, 1995.
Production et Investissements de l'Industrie Miniere du Quebec—Statistiques, annual.
Prospectors and Developers Association of Canada:
In Brief, quarterly.
Exploration and Development Highlights, annual.
Québec Prospectors Association, monthly.
Répertoire des Etablissements Menant des Opérations Minières Au Québec, annual.
Rock Products Register, annual: Intertec Publishing, Chicago, Illinois.
Statistics Canada:
Coal and Coke Statistics, monthly.
Crude Petroleum and Natural Gas Production, monthly.
International Trade Division:
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Exports: Trade Merchandise, annual.
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United Nations, Energy Statistics Yearbook, annual.
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TABLE I
CANADA: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity		1997	1998	1999	2000	2001 p/
METALS						
Aluminum:						
Alumina, gross weight	thousand tons	1,165	1,229	1,233	1,200 e/	1,200 e/
Primary, metal		2,327,188	2,374,118	2,389,835	2,373,460	2,582,746
Antimony 3/		630	428	357 r/	433 r/	278
Arsenic trioxide e/		250	250	250	250	250
Bismuth 3/		196	219	311	243 r/	310
Cadmium:						
Mine output, Cd content 3/		1,471	1,361	1,390	1,051 r/	1,183
Metal, refined		2,260	2,090	1,911	1,941 r/	1,429
Calcium	kilograms	W	W	W	W	W
Cobalt:						
Mine output, Co content 3/		5,709	5,861	5,324	5,298 r/	5,334
Metal:						
Shipments 4/		2,168	2,262	2,015	2,022 r/	2,048
Refined, including oxide		3,792	4,415	3,972 r/	4,079 r/	4,063
Columbium (niobium) and tantalum:						
Pyrochlore concentrate:						
Gross weight		5,090	5,110	5,140	5,070 r/	7,070
Nb content		2,290	2,300	2,313	2,280 r/	3,180
Tantalite concentrate:						
Gross weight		196	228	208	228 r/	308
Ta content		49	57	66	57 r/	77
Nb content		10	11	13	11 r/	15
Copper:						
Mine output, Cu content 3/		659,500	703,245	581,583	633,855 r/	629,684
Electrowon		2,700	1,800	--	--	--
Total		662,200	705,045	581,583	633,855 r/	629,684
Metal:						
Smelter:						
Primary, blister		529,525	553,133	542,439	545,514 r/	552,512
Secondary and scrap		96,957	71,338	66,782	66,800	74,128
Total		626,482	624,471	609,221	612,314 r/	626,640
Refined:						
Primary		464,000	489,941	476,079	480,093 r/	491,619
Secondary		99,300	72,635	72,484	71,300	73,012
Total		563,300	562,576	548,563	551,393 r/	564,631
Gold, mine output	kilograms	171,376	165,599	157,617	156,207 r/	159,714
Iron and steel:						
Ore and concentrate:						
Gross weight	thousand tons	37,277	37,808	33,900	36,740 r/	29,341
Fe content	do.	24,914	24,082	21,650	22,744	17,186
Metal:						
Pig iron	thousand tons	8,679	8,937	8,783	8,900 r/	8,780
Direct reduced iron	do.	1,391	1,240	920	920	920
Ferroalloys, electric arc furnace: e/						
Ferrosilicon	do.	56	56	56	56	56
Silicon metal	do.	30	30	30	30	30
Ferrovanadium	do.	1	1	1	1	1
Total	do.	87	87	87	87	87
Crude steel	do.	15,554	15,930	16,300	15,900 r/	16,300
Lead:						
Mine output, Pb content		186,234	189,752	162,180	148,769 r/	157,127
Metal, refined:						
Primary		139,736	129,750	137,172	143,303 r/	149,489
Secondary		131,659	135,737	129,243	141,030 r/	77,393
Total		271,395	265,487	266,415	284,333 r/	226,882
Lithium, spodumene e/		22,500	22,500	22,500	22,500	22,500
Magnesium metal, primary e/		57,700	77,109	80,000 e/	80,000 e/	80,000 e/
Molybdenum, mine output, Mo content		8,223	8,469	6,250	7,457 r/	8,210
Nickel:						
Mine output, Ni content 3/		190,529	208,302	176,749	190,793 r/	193,361
Refined 5/		131,639	146,755	124,260	134,225	140,591

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

Commodity		1997	1998	1999	2000	2001 p/
METALS--Continued						
Platinum-group metals, mine output	kilograms	12,459	16,408	13,872	16,110 r/	19,109
Selenium, refined 6/	do.	592,000	398,000	359,000	335,000 r/	261,000
Silver						
Mine output, Ag content	do.	1,223,983	1,195,943	1,174,000	1,212,000 r/	1,271,000
Refined	do.	1,322,779	1,579,030	1,246,000	1,188,000	1,224,400
Tellurium, refined 6/	do.	59,000	62,000	64,000	53,000 r/	60,000
Titanium Sorel slag e/ 7/		850,000	950,000	950,000	950,000	950,000
Uranium oxide (U)		14,174	12,896	10,157	10,683 r/	12,527
Zinc:						
Mine output, Zn content		1,076,385	1,061,645	963,321	1,002,242 r/	1,070,294
Metal, refined, primary		703,798	745,131	776,927	779,892 r/	654,562
INDUSTRIAL MINERALS						
Asbestos		455,000	302,000	337,000	307,000 r/	272,000
Barite		77,000	90,000	123,000	121,000 r/	124,000
Cement, hydraulic 8/	thousand tons	11,736	12,124	12,634	12,612	12,986
Clay and clay products 9/	value, thousands	\$105,269	\$91,579	\$164,718	\$175,449	\$195,200
Diamond	carats	--	300,006	2,429,000	2,533,750 r/	3,685,171
Diatomite e/		10,000	10,000	10,000	10,000	10,000
Gemstones, amethyst and jade		394	136	218	235 r/	195
Gypsum and anhydrite	thousand tons	9,117	8,967	9,345	9,232 r/	8,596
Lime 8/	do.	2,477	2,514	2,565	2,525 r/	2,221
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		647,000	636,000	676,000	717,000 r/	734,000
Nitrogen, content of ammonia		4,081,000	3,899,900	4,134,900	4,129,000 r/	3,438,700
Potash, K ₂ O equivalent	thousand tons	8,989	9,201	8,475	9,202 r/	8,224
Pyrite and pyrrhotite, gross weight e/		5,000	5,000	5,000	5,000	5,000
Salt	thousand tons	13,534	13,296	12,686	11,994 r/	13,154
Sand and gravel	do.	225,419	229,780	242,369	238,494 r/	226,489
Silica (quartz) 10/	do.	1,896	1,905	1,702	1,514 r/	1,615
Sodium compounds, n.e.s.:						
Sodium carbonate (soda ash) e/	do.	300	300	300	300	300
Sodium sulfate, natural 11/	do.	326	320	305	305	305
Stone 12/	do.	120,953	129,057	130,226	139,188 r/	140,290
Sulfur, byproduct:						
Metallurgy	do.	801	836	843	849	796
Petroleum	do.	8,280	8,404	8,656	8,621 r/	8,080
Total	do.	9,081	9,240	9,499	9,470 r/	8,876
Talc, soapstone, pyrophyllite	do.	73	71	79	86	86
MINERAL FUELS AND RELATED MATERIALS						
Carbon black e/		165,000	165,000	165,000	165,000	165,000
Coal:						
Bituminous and subbituminous	thousand tons	67,034	63,596	60,834	58,037 r/	59,042
Lignite	do.	11,653	11,790	11,663	11,126 r/	11,319
Total	do.	78,867	75,386	72,497	69,163 r/	70,361
Coke, high-temperature	do.	3,370	3,142	3,307	3,307	3,300
Gas, natural:						
Gross	million cubic meters	199,422	204,022	190,912	195,457	202,387
Marketed	do.	156,842	173,359	162,219	166,078	171,966
Natural gas liquids:						
Pentanes plus	thousand 42-gallon barrels	67,439	68,370	67,735	67,700	66,000
Condensate	do.	2,735	2,827	2,930	2,900	2,800
Total	do.	70,174	71,197	70,665	70,600	68,800
Peat		1,054 r/	1,125 r/	1,253 r/	1,277 r/	1,187
Petroleum:						
Crude 13/	thousand 42-gallon barrels	770,275	807,612	768,934	803,919 r/	821,010
Refinery products:						
Propane, butane, naphtha, LPG 14/	do.	15,265	14,990	12,700 e/	13,300 r/ e/	13,700 e/
Gasoline:						
Aviation	do.	726	933	790 e/	900 r/ e/	850 e/
Other	do.	254,386	256,372	218,000 e/	228,000 r/ e/	235,000 e/
Petrochemical feedstocks	do.	33,746	33,530	28,500 e/	29,800 r/ e/	30,800 e/

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

Commodity	1997	1998	1999	2000	2001 p/
MINERAL FUELS AND RELATED MATERIALS--Continued	165,000	165,000	165,000	165,000	165,000
Petroleum--Continued:					
Refinery products--Continued:					
Jet fuel thousand 42-gallon barrels	33,935	34,953	29,700 e/	31,100 r/ e/	32,100 e/
Kerosene do.	3,106	1,995	1,700 e/	1,700 r/ e/	1,800 e/
Distillate fuel oil, diesel and light do.	201,737	196,511	167,000 e/	175,000 r/ e/	180,000 e/
Lubricants including grease do.	8,478	7,884	6,700 e/	7,000 r/ e/	7,200 e/
Residual fuel oil, heavy do.	47,477	50,736	43,100 e/	45,100 r/ e/	46,500 e/
Asphalt do.	24,938	26,007	22,100 e/	23,200 r/ e/	23,900 e/
Petroleum coke do.	7,122	7,207	6,200 e/	6,500 r/ e/	6,700 e/
Unspecified do.	25,114	26,489	22,500 e/	23,600 r/ e/	24,300 e/
Refinery fuel and losses 15/ do.	24,491	25,601	21,800 e/	22,800 r/ e/	23,500 e/
Total do.	680,521	683,208	581,000 e/	608,000 r/ e/	613,000 e/

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

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

2/ Table includes data available through June 11, 2002.

3/ Metal content of concentrates produced.

4/ Cobalt content of all products derived from Canadian ores, which includes 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, which include imports and secondary sources. Excludes intermediate products exported for refining.

7/ Refined Sorel slag has been upgraded to 95% titanium dioxide.

8/ Producers' shipments and quantities used by producers.

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

10/ Producers' shipments of quartz.

11/ Excludes byproduct production from chemical plants.

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

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

14/ Liquefied petroleum gas.

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

TABLE 2
CANADA: STRUCTURE OF THE MINERAL INDUSTRY IN 2001

(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 in Laterriere, Quebec	204.
Do.	do.	Smelter in Isle-Maligne, Quebec	73.
Do.	do.	Smelter in Beauharnois, Quebec	48.
Do.	do.	Smelter in Shawinigan, Quebec	84.
Do.	do.	Smelter in Grande-Baie, Quebec	180.
Do.	do.	Smelter in Arvida, Quebec	232.
Do.	do.	Smelter in Kitimat, British Columbia	272.
Do.	Alcan Inc. (Alcan Aluminium Ltd., 54%; Alusuisse Lonza Group Ltd., 46%)	Smelter in Alama, Quebec	400.
Do.	Aluminerie de Becancour Inc. (Pechiney Corp., 25%; Quebec Government, 24.95%)	Smelter in Beacancour, Quebec	360.
Do.	Canadian Reynolds Metals Co. Ltd. (Reynolds Metals Co., 100%)	Smelter in Baie-Comeau, Quebec	400.
Do.	Aluminerie Alouette Inc. (Vereinigte Aluminum-Smelter in Sept-Iles, Quebec Werke (VAW), Germany, 20%; Corus Group plc, Netherlands, 20%; Austria Metall (AMAG), Austria, 20%; La Société Générale de Financement, Canada, 20%; Kobe Steel, 13.3%; Marubeni Corp., Japan, 6.7%)	218.	
Do.	Aluminerie Lauralco Inc. (Alumax Inc., United States)	Deschambault, Quebec	215.

See footnote at end of the table.

TABLE 2--Continued
CANADA: STRUCTURE OF THE MINERAL INDUSTRY IN 2001

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners		Location of main facilities	Annual capacity
Asbestos	Lac d'Amiate du Quebec, Ltee (LAQ) (Jean Dupere, President of LAB Chrysotile, Inc.; Connell Bros. Co. Ltd.)		Black Lake, Quebec	160 (fiber).
Do.	Bell Operations (Mines D'Amiate Bell)		Thetford Mines, Quebec	70 (fiber).
Do.	JM Asbestos Inc.		Jeffrey Mines at Asbestos, Quebec	250 (fiber).
Cement	Lafarge Canada Inc.		Bath, Ontario	1,045 (dry-process).
Do.	do.		Exshaw, Alberta	1,029 (dry-process).
Do.	do.		Kamloops, British Columbia	194 (dry-process).
Do.	do.		Richmond, British Columbia	474 (wet-process).
Do.	do.		St. Constant, Quebec	991 (dry-process).
Do.	do.		Brookfield, Nova Scotia	527 (dry-process).
Do.	St. Lawrence Cement Inc. (Independent Cement Inc.)		Joliette, Quebec	991 (dry-process).
Do.	do.		Mississauga, Ontario	1,876 (wet and dry).
Do.	ESSROC Canada Inc.		St. Basile, Quebec	1,124 (dry-process).
Do.	North Star Cement Ltd.		Corner Brook, Newfoundland	152 (dry-process).
Do.	Federal White Cement Ltd.		Woodstock, Ontario	170 (dry-process).
Do.	St. Marys Cement Corp.		Bowmanville, Ontario	1,550 (dry-process).
Do.	do.		St. Marys, Ontario	645 (dry-process).
Do.	Inland Cement Ltd. (S.A. Cimenteries CBR)		Edmonton, Alberta	726 (dry-process).
Do.	Tilbury Cement Ltd. (S.A. Cimenteries CBR)		Delta, British Columbia	1,040 (dry-process).
Coal	Quinsam Coal Corp. (Hillsborough Resources Ltd., 63%; Marubeni Corp., 33%; remainder unknown, 4%)		Quinsam Coal Mine at Campbell River, British Columbia	14,400 (open pit and underground).
Do.	Cape Breton Development Corp. (Government of Canada, 100%)		Sydney, Nova Scotia	2,000 (underground).
Do.	Luscar, Ltd.		Obed Mountain Mine in Hinton, Alberta	13,500 (open pit).
Do.	do.		Cheviot Mine in Hinton, Alberta	14,000 (open pit).
Do.	Gregg River Resources Ltd. (Gregg River Coal Inc., 60%; 7 Japanese companies, 40%)		Gregg River Mine in Hinton, Alberta	3,960 (open pit).
Do.	Manalta Coal Ltd. (Transalta Utilities Corp.)		Highvale Mine at 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).
Columbium (niobium)	Niobec Ltd. (Cambior Inc., 50%; Teck Corp., 50%)		Niobec Mine, Chicoutimi, Quebec	3,500 (underground).
Copper	Cassiar Mining Corp. (Princeton Mining Corp., 100%)		Similcom Mine in Princeton, British Columbia (suspended in 1996)	9,000.
Do.	Falconbridge Ltd. (Noranda Inc., 50%; Trelleborg AB, 50%)		Sudbury operations, Sudbury, Ontario	4,250.
Do.	do.		Strathcona and Timmins operations in Timmins, Ontario	4,860.
Do.	do.		Smelter in Timmins, Ontario	440.
Do.	Gibraltar Mines Ltd.		McLease Lake, British Columbia (suspended)	29.
Do.	Highland Valley Copper (Cominco Ltd., 50%; Billiton plc., 33.6%; Teck Corp., 13.9%; Highmont Mining Co., 2.5%)		Logan Lake, British Columbia (suspended)	4,500.
Do.	Inco Ltd.		Thompson district, Manitoba	Variable (polymetallic).
Do.	do.		Smelter in Sudbury, Ontario	500.
Do.	do.		Refinery in Sudbury, Ontario	170.
Do.	Noranda Inc.		Smelter in Thompson, Manitoba	686 (projected).
Do.	do.		Mines Gaspe, Murdochville, Quebec	4,000 (ore).
Do.	do.		Horne Smelter in Noranda, Quebec	770.
Do.	Huckleberry Mines Ltd. (Imperial Metals Corp., 50%; Japanese consortium, 50%)		Huckleberry Mine in Omineca, southeast of Houston, British Columbia	37,000 (Cu contained).
Do.	Imperial Metals Corp.		Mount Polley Mine at Williams Lake, British Columbia	17,000 (Cu contained).
Do.	Northgate Exploration Ltd.		Toodoggone River, British Columbia	28,000 (Cu contained).
Diamond	carats	Dia Met Minerals Ltd. (BHP-Billiton, 80%; Charles Fipke, 10%; Stuart Blossom, 10%)	Ekati Mine in Lac de Gras region, Northwest Territories	1,350,000.
Gold		Barrick Gold Corp.	Holt-McDermott Mine at Harker Township, Ontario	405 (ore).

See footnote at end of the table.

TABLE 2--Continued
CANADA: STRUCTURE OF THE MINERAL INDUSTRY IN 2001

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Gold--Continued:	Barrick Gold Corp.	Bosquet Mines 1 and 2, northwestern Quebec	954 (ore).
Do.	do.	Macassa Mine at Teck Township, northern Ontario	473 (ore).
Do.	Princeton Mining Corp.	Similco Mine in Princeton, British Columbia	450 (kilograms metal). (suspended)
Do.	Echo Bay Mines Ltd.	Lupin Mine in Contwoyo Lake; Northwest Territories (suspended)	612 (ore).
Do.	Royal Oak Mines Inc.	Giant Mine in Yellowknife, Northwest Territories	407 (ore).
Do.	do.	Giant mill-tailings in Yellowknife, Northwest Territories	3,265 (ore).
Do.	Hemlo Gold Mines Inc. (Noranda Inc., 44.1%)	Golden Giant Mine in Hemlo, Ontario	1,080 (ore).
Do.	Placer Dome Inc.	Campbell Mine in Red Lake, Ontario	584 (ore).
Do.	do.	Detour Lake Mine in northeastern Ontario	1,278 (ore)
Do.	do.	Dome Mine in South Porcupine, Ontario	9.8 (tons metal).
Do.	do.	Sigma and Kiena Mines in Val d'Or, Quebec	730 (ore).
Do.	Teck-Corona Corp. (Teck Corp., 100%)	David Bell Mine in Hemlo, Ontario	456 (ore).
Do.	Huckleberry Mines Ltd. (Imperial Metals Corp., 50%; Japanese consortium, 50%)	Huckleberry Mine in Omineca, southeast of Houston, British Columbia	250 (kilograms metal).
Do.	Imperial Metals Corp.	Mount Polley Mine in Williams Lake, British Columbia	3,100 (kilograms metal).
Do.	Northgate Exploration Ltd.	Toodogone River, British Columbia	8,700 (kilograms metal).
Graphite	Strategic Exploration Inc.	Kearney Lake, Ontario	W.
Gypsum	Atlantic Gypsum Resources Inc.	Fischell Brook at St. George's, Newfoundland	1,300.
Do.	Georgia-Pacific Corp.	River Denys, Sugar Camp, Nova Scotia	1,460.
Do.	Little Narrows Gypsum Co. Ltd. (USG Corp., 100%)	Little Narrows, Nova Scotia	1,640.
Do.	National Gypsum (Canada) Ltd. (Aancor Holdings Corp., 100%)	Milford, Nova Scotia	3,300.
Do.	Westroc Industries Ltd.	Windermere, British Columbia	1,170.
Iron and steel	Iron Ore Company of Canada (North Ltd., 56.1%; Mitsubishi Corp., 25%; Labrador Iron Ore Royalty Income Fund, 18.9%)	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), 657 (sinter).
Do.	Wabush Mines (Stelco Inc., 37.9%; Dofasco Inc., 24.2%; Cliffs Mining Co., 22.8%; Acme Steel Co., 15.1%)	Wabush, Labrador, and Pointe Noire, Quebec	6,200 (concentrate).
Do.	Dofasco Inc.	Hamilton, Ontario	3,642 (pig iron), 4,500 (crude steel).
Lead	Brunswick Mining and Smelting Corp. Ltd. (Noranda Inc., 63.3%)	No. 12 Mine in 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 in Kimberley, British Columbia	3,600 (ore).
Do.	do.	Polaris Mine in Cornwallis Island, Northwest Territories	1,000 (ore).
Do.	Breakwater Resources Ltd.	Nanisivik Mine in Baffin Island, Northwest Territories	785 (ore).
Limestone	Lafarge Canada Inc.	Steep Rock, Manitoba	906 (quarry).
Do.	Atlantic Industrial Minerals Inc.	Iris Cove, Sydney, Nova Scotia	720.
Do.	Inland Cement Ltd. (CBR Materials Corp.)	Cadomin, Alberta	2,160.
Do.	do.	do.	2,160 (quarry).
Do.	Havelock Co. (Kickenson Mines Co., 100%)	Havelock, New Brunswick	864 (limestone).
Do.	Continental Lime Ltd.	Faulkner, Manitoba	1,440 (crushed stone).

See footnote at end of the table.

TABLE 2--Continued
CANADA: STRUCTURE OF THE MINERAL INDUSTRY IN 2001

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners		Location of main facilities	Annual capacity
Magnesium	Magnola Metallurgy Inc. (Noranda Inc., 80%; Societe Generale de Financement du Quebec, 20%)		Asbestos, Quebec	58 (asbestos waste).
Molybdenum	Huckleberry Mines Ltd. (Princeton Mines Corp., 60%; Japanese consortium, 40%)		Southeast of Houston, British Columbia	635 (Mo contained).
Nickel	Falconbridge Ltd. (Noranda Inc., 46.4%; underwriting syndicate, 28.3%)		Fraser, Lockerby, Onaping, and Strathcona in Sudbury district, Ontario	30 (metal contained).
Do.	do.		Raglan Mine in Ungava, Quebec	21 (metal contained).
Do.	do.		Smelter in Falconbridge, Ontario	45 (rated capacity).
Do.	Inco Ltd.		Frood, Stobie, Creighton, Copper Cliff North and South, Garson-Offsets, McCreedy East and West, Coleman, Crean Hill, and Totten in Sudbury district, Ontario	106 (metal contained).
Do.	do.		Smelter in Sudbury, Ontario	110 (metal contained).
Do.	do.		Refinery in Sudbury, Ontario	57 (metal contained).
Do.	do.		Refinery in Port Colborne, Ontario	30 (metal contained).
Do.	do.		Thompson, Birchtree Mines in Manitoba	62 (metal contained).
Do.	do.		Smelter in Thompson, Manitoba	82 (metal contained).
Petroleum: 1/	Sherritt International Corp.		Refinery in Fort Saskatchewan, Alberta	24 (metal contained).
Gas million cubic meters	BP Canada Inc. (The British Petroleum Co. PLC London, 100%)		Noel Area, northern Alberta; Chauvin, Sibbald, North Pembina, Alberta	47.
Crude million 42-gallon barrels	do.		do.	12.
Do. do.	Gulf Canada Corp. (Olympia & York Developments, 80%; Gulf, 20%)		Fenn-Big Valley, Swan Hills, Goose River, Peerless, and Sene, Alberta	18.
Do. do.	Home Oil Co. Ltd. (Interhome Energy Inc., 100%)		Red Earth, Garrington, Cherhill, Medicine River, and Swan Hills, Alberta	11.5.
Gas billion cubic meters	do.		do.	1.8.
Crude thousand 42-gallon barrels	Imperial Oil Ltd. (ExxonMobil Corp., 70%; others, 30%)		Judy Creek, Cold Lake, Alberta; Mackenzie Delta, Beaufort Sea, Yukon Territory and Northwest Territories	670.
Gas million cubic meters	do.		do.	36.4.
Crude million 42-gallon barrels	Mobil Oil Canada Ltd. (ExxonMobil Corp., 100%)		Hibernia, Grand Banks, southeast of Newfoundland and Sable Island, Nova Scotia, and others in Alberta	26.1.
Gas billion cubic meters	do.		do.	3.0.
Crude million 42-gallon barrels	do.		Terra Nova, near to Hibernia, Jeanne d'Arc Basin, Newfoundland	25.0.
Gas billion cubic meters	do.		do.	2.0.
Crude million 42-gallon barrels	Norcen Energy Resources Ltd. (Hollinger Inc., 59%; Hees International, 41%)		Pembina, Bodo, Majorville, Alberta	12.1.
Do. do.	Oakwood Petroleums Ltd. (Sceptre Resources Ltd., 100%)		Grantham, Hays Ronalane, Peace River, Normandville, Randell, Alberta, and Grizzly Valley, British Columbia	24.6.
Do. do.	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	3,828 (KCl).
Do. do.	Rocanville, southeast Saskatchewan		2,295 (KCl).	

See footnote at end of the table.

TABLE 2--Continued
CANADA: STRUCTURE OF THE MINERAL INDUSTRY IN 2001
(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Potash (K ₂ O equivalent)--Continued:	Potash Corp. of Saskatchewan Inc. (private, 37%; Provincial government, 63%)	Allan Division, Allan, Saskatchewan	5,256 (KCl).
Do.	do.	Cory, near Saskatoon, Saskatchewan	1,361 (KCl).
Do.	do.	Sussex, New Brunswick	800 (KCl).
Do.	International Minerals & Chemical Corp. (Canada) Ltd. (IMC Fertilizer Corp., 100%)	Esterhazy, southeast Saskatchewan	951 (KCl).
Do.	Agrium Products Inc.	Vanscoy, Saskatchewan	1,750 (KCl).
Salt and brine operations	The Canadian Salt Co.	Pugwash, Nova Scotia	1,400 (rock salt and brine salt).
Do.	do.	Iles-de-la-Madeleine, Quebec	1,625 (rock salt).
Do.	do.	Ojibway, Ontario	2,600 (rock salt).
Silver	Prime Resources Group Inc.	Eskay Creek Mine in British Columbia	340.
Do.	Breakwater Resources Ltd.	Caribou Mine in Bathurst, New Brunswick	7.5 (tons mill feed).
Do.	Kinross Gold Corp.	Macassa Mine in Ontario	438 (mill feed).
Do.	Barrick Gold Corp.	Bousquet Mine in Quebec	876 (mill feed).
Do.	Similco Mines Ltd.	Princeton, British Columbia (suspended)	8,250 (Ag-Au-Cu concentrate).
Sodium chlorate production using salt	Dow Chemical Canada Inc. (Dow Chemical Co., 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 (ExxonMobil, 100%)	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., 100%)	East Crossfield-Elkton, Alberta	650.
Do.	Canadian Occidental Petroleum, Ltd.	East Calgary-Crossfield, Alberta	610.
Do.	Chevron Canada Resources Inc. (ChevronTexaco Corp., 100%)	Kaybob South III, Alberta	1,281.
Do.	Husky Oil Ltd.	Ram River, Ricinus, Alberta	1,646.
Do.	Shell Canada Ltd.	Waterton, Alberta	1,120.
Principal SO ₂ and H ₂ SO ₄ production capacities	Canadian Electro Zinc Ltd. (CEZ) (Noranda Inc., 90.17%)	Valleyfield, Quebec	430 (H ₂ SO ₄).
Do.	Inco Ltd.	Copper Cliff, Ontario	950 (H ₂ SO ₄).
Do.	Falconbridge Ltd. (Noranda Inc., 50%; Trelleborg AB, 50%)	Kidd Creek, Ontario	690 (H ₂ SO ₄).
Do.	ESSO Chemical Canada (ExxonMobil, 100%)	Redwater, Alberta	910 (H ₂ SO ₄).
Uranium	Cogema Resources Inc.	Cluff Lake, Saskatchewan	1,815 (metal).
Do.	Cameco Corp.	Cigar Lake, Saskatchewan	6,500 (oxide).
Do.	do.	Key Lake, Saskatchewan	6,395 (oxide).
Do.	do.	Rabbit Lake, Saskatchewan	5,445 (oxide).
Zinc	Breakwater Resources Ltd.	Nanisivik Mine on Baffin Island, Northwest Territories	60 (Zn contained).
Do.	do.	Bathurst, New Brunswick	1,100 (Zn in concentrate).
Do.	Brunswick Mining and Smelting Corp. Ltd. (Noranda Inc., 100%)	do.	232 (Zn in concentrate).
Do.	Falconbridge Ltd. (Noranda Inc., 49.9%)	Timmins operations and smelter in Timmins, Ontario	212 (Pb-Zn contained), 133 (slab zinc).
Do.	Hudson Bay Mining and Smelting Co. Ltd. (Anglo American plc., 100%)	Snow Lake concentrator, Manitoba	1,125 (Pb-Zn ore).
Do.	do.	Flin Flon Mine and Smelter in Manitoba	85 (slab zinc).
Do.	Cominco Ltd. (Teck Corp., 36.34%)	Sullivan Mine in Kimberley, British Columbia	70 (Pb-Zn contained).
Do.	do.	Smelter in Trail, British Columbia	300 (slab zinc).
Do.	Boliden Ltd.	Myra Falls Mine in Strathcona Provincial Park, British Columbia	110 (Zn ore).
Do.	Noranda Inc.	Bell Allard Mine in Matagami, Quebec	85 (Pb-Zn ore).

W Withheld to avoid disclosing company proprietary data.

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

TABLE 3
CANADA: RESERVES OF MAJOR MINERALS IN 2001

(Thousand metric tons unless otherwise specified) 1/

Commodity		Reserves
Asbestos, fiber		35,700 e/
Coal, all types		6,220,000 e/
Copper		10,000
Gold	metric tons	1,500 2/
Gypsum		450,000 e/
Iron ore		1,700,000 e/
Lead		1,600
Molybdenum		450
Natural gas	billion cubic meters	1,731 e/
Nickel		6,600
Petroleum crude	million barrels	6,700 e/
Potash, K ₂ O equivalent	million metric tons	4,400 e/
Salt	thousand short tons	264,000 e/
Silver	metric tons	35,000
Sodium sulfate	thousand short tons	84,000 e/
Sulfur		160,000 e/
Uranium		420 3/
Zinc		11,000

e/ Estimated.

1/ 1999 and 2000 "Canadian Minerals Yearbook," Natural Resources Canada, except for natural gas and petroleum crude; U.S. Geological Survey Mineral Commodity Summaries 2002.

2/ Excludes metal in placer deposits.

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