

Cobalt

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SUMMARY

In 1995, the cobalt content of metal concentrates produced in Canada was 2126 t, an increase of 15% from 1994, while Canada's production of refined cobalt (including production from ore feed imported from Cuba) increased 7.5% to reach 2895 t. The value of mine production of cobalt in 1995, about \$185 million, was 38% greater than in 1994.

The increase in mine production is mostly due to reduced shut-down time at Inco Limited (Inco) compared to 1994, and to the start of operations at Ego Resources Ltd. (Ego). The increase was possible in spite of lower output at Falconbridge Limited (Falconbridge) caused by production disruptions at surface plants and mine development projects. The increased value was due to higher prices for cobalt throughout 1995 when the free market price for cobalt spot cathode averaged US\$29.21/lb, a hike of 18.4% over 1994. The price increase was a result of strong demand from world economies and a shortage of supplies on the market because of production disturbances in major producing countries. The small margin between supply and demand was compounded by low consumer inventories following de-stocking in recent years. Further cobalt price increases at the end of the year, which closed in the range of US\$31.50-\$32.50/lb, seemed to indicate a continued tightness in supply in early 1996.

World production estimates from the Cobalt Development Institute's production figure and other sources put the 1995 production of refined cobalt at 22 829 t, an increase of about 7.6% from 1994. The improvement in output is mostly attributed to production increases in Zaire and Zambia, in Canada at Inco and Ego, in China, and in Finland. These increases exceeded the decreases caused by lower output at The Cobalt Refinery Company Inc. (Corefco) and continuing production disruptions in Russia.

The outlook for 1996 calls for production in Zaire and Zambia, and in Canada at Inco, Ego and Corefco, to improve significantly relative to 1995, while production in Russia should remain stable at the 1995 level. Further increases in demand are expected as world economies improve, particularly the Japanese economy, which has had difficulties emerging from recession. A supply shortage, especially for higher-grade material, is expected in the first half of 1996 with corresponding general pressure on prices and a widening of the premium for good-quality Western-origin cobalt. Increased sales from the U.S. stockpile, a greater supply of scrap cobalt, and the commissioning in 1996 of new production capacity in Australia, Canada, Morocco and Finland, as well as a general improvement in production at many facilities, will help balance the market later in the year.

USES

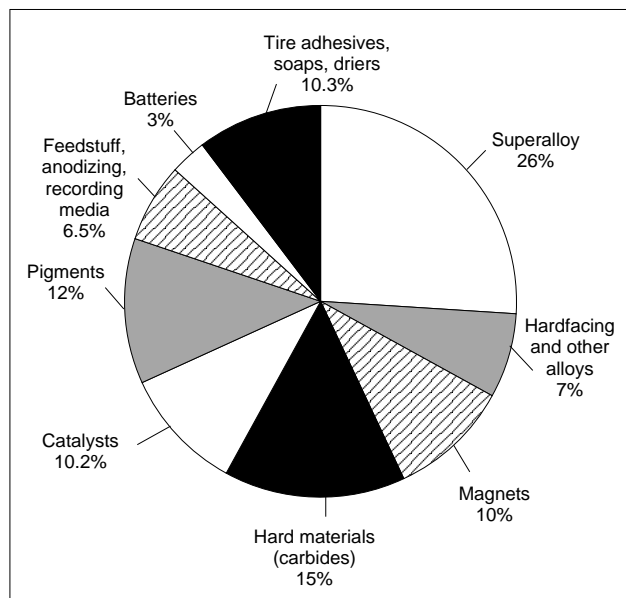
One of the major uses for cobalt is in superalloys where it improves the strength, wear and corrosion-resistant characteristics of alloys at elevated temperatures. The major uses of cobalt-based superalloys are in turbine blades for aircraft jet engines and in gas turbines for pipeline compressors. Cobalt-based superalloys normally contain 45% or more cobalt, while nickel- and iron-based superalloys contain 8-20% cobalt.

The demand for cobalt in the production of magnets has been declining in recent years. The substitution of neodymium-iron-boron magnets for cobalt-rare earth magnets has been a major factor. However, the use of cobalt-rare earth permanent magnets will continue where the specific advantages of reliability and good performance are required.

Cobalt-based alloys are also used in specialized applications such as in machining very hard materials or where high abrasion-resistant qualities are required. In such applications the most important group of cobalt-based alloys is the stellite group, which contains cobalt, tungsten, chromium and molybdenum as principal constituents. The hard-facing or coating of tools with cobalt alloys provides greater resistance to wear, heat, impact and corrosion.

Cobalt metal powder has an important application as a binder in the production of cemented tungsten carbides for heavy-duty and high-speed cutting tools. In chemical applications, cobalt oxide is an important additive in paint, glass and ceramics. Cobalt is also used to promote the adherence of enamel to steel for applications such as appliances, and steel to rubber for the construction of steel-belted tires. A cobalt-molybdenum-alumina compound is used as a catalyst in hydrogenation and for petroleum desulphurization. (Refer to Figure 1 for the importance of cobalt consumption per market segment.)

Figure 1
The Cobalt Market



Source: Cobalt Development Institute.

CANADIAN DEVELOPMENTS

Canada's mine production of cobalt in 1994 was 1846 t, while the preliminary estimate for 1995 is 2126 t. The output of refined cobalt in 1994 totalled 2692 t, and it is estimated at 2895 t in 1995, an increase of 7.5%.

In Canada, Inco and Falconbridge produce cobalt as a by-product of their nickel-copper operations and from purchased concentrates. Inco refines its concentrates in Canada to produce cobalt metal and oxide, while Falconbridge sends nickel-cobalt matte to its refinery in Norway. Corefco (Sherritt) produces refined cobalt at its Alberta refinery from concentrates purchased domestically and abroad. Ego, a new Canadian producer and the world's largest primary cobalt producer, extracts cobalt from arsenic-rich ores and feedstock to produce cobalt carbonate.

Inco Limited

Inco's 1995 mine production of cobalt was 1511 t, up 37.4% from the previous year, while its production of refined cobalt was 1090 t, up 30.7% over 1994. Production in 1994 had been affected by shut-downs related to the poor nickel market. Production disruptions at a number of mines and surface plants prevented the company from reaching its full production capacity in 1995.

Inco's cobalt production comes from several underground mines located in the Sudbury area of Ontario and in Manitoba's Thompson Nickel Belt. In 1995, Inco operated the Copper Cliff North and South mines, as well as the Crean Hill, Creighton No. 9, Frood, Stobie and Little Stobie, Lower Coleman, Garson, McCreedy West, and Whistle mines, all located in the Sudbury area, and also operated the Thompson open-pit and Thompson (T-1) and Birchtree mines in the Manitoba Division.

The nickel-copper-cobalt ores from these operations are processed at the Clarabelle mill near Sudbury and at the metallurgical complex in Thompson. The Sudbury concentrate is then sent to the nearby Copper Cliff smelter for further processing to produce a variety of nickel and copper products, including nickel matte. An intermediate nickel-cobalt carbonate is shipped to Inco's refinery complex at Port Colborne, Ontario, where electrolytic cobalt rounds grading 99.9% pure are produced.

In Thompson, Inco smelts and refines the concentrate to produce electrolytic nickel and by-product cobalt oxide. The cobalt oxide is sent to Inco's Clydach refinery in Wales for final processing and packaging.

In 1995, the Port Colborne, Ontario, cobalt refinery closed for a three-week period starting July 17, while the Ontario and Manitoba divisions scheduled two- to four-week vacation shut-downs. The company is contemplating keeping its Canadian operations running on a 12-month basis. The Clydach refinery in Wales did not have a vacation shut-down in 1995.

At the Sudbury Division, the McCreedy East mine, located 50 km west of Sudbury, is expected to come on stream in late 1996 at a rate of 1000 t/d, and to reach full production of 3000 t/d by 1999. The operation will use ore-handling and materials transportation facilities integrated with those of the existing Coleman mine. At the Creighton mine, as a prelude to deepening the mine, \$18.3 million is being spent on the development of a new ore-handling system to recover 2.6 Mt of ore located beneath the current floor of the mine. The new ore-handling system is expected to begin production in 1997. Inco also started a \$72 million advanced exploration program on the Victor deposit located on the northeast rim of the Sudbury igneous complex, which it plans to complete by the end of 1997.

At the Manitoba Division, development of the Thompson 1-D mine moved ahead. Initial production at 510 t/d of ore started in 1995 and is set to increase gradually to 3630 t/d by 1999. Exploration will also continue on the recently discovered Pipe Deep deposit located 32 km from Inco's processing facilities and 1.6 km from the mine shaft of the Pipe 2 mine. Reserves outlined to date are 3.63 Mt grading 2.32% nickel with copper, cobalt and platinum group metal values, located between 800 and 1500 m deep. Additional drilling and engineering work to assess the orebody's economic feasibility was carried out during the year.

As part of an effort to reduce its dependence on outside sources to meet customer demand, and to optimize the use of its smelting and refining capacity, Inco reactivated its Shebandowan mine and mill located about 100 km west of Thunder Bay in May. Ore production was expected to be 1800 t/d by early fall and to reach a peak of 2500 t/d by early 1996. At this production level, current reserves would allow a three-year mine life.

Falconbridge Limited

In 1995, Falconbridge's Canadian mineral production of cobalt was 540 t, down 27.7% from 1994's level. The lower production stems from difficulties the company experienced in June in bringing the higher capacity electric furnace at its Sudbury smelting facilities on line. The company managed to correct the problem during the annual maintenance shutdown. Production delays were also brought about by lower employee productivity and by mine development at the Craig, Lockerby and Thayer Lindsley mines. Likewise, nickel production decreased at Falconbridge's Nikkelverk refinery in Norway because of a reduction in nickel matte custom feed from Russia. However, cobalt production was reportedly unaffected.

During the year, Falconbridge operated five mines in the Sudbury, Ontario area, namely the Onaping, Craig, Fraser, Strathcona, and Thayer Lindsley mines. In addition, the company announced that it would proceed immediately with the redevelopment of the Lockerby mine, which had been put on care and maintenance on June 1, 1994, for an indefinite period of time because of its high operating costs and market conditions. Production resumed in October 1995 and is expected to reach full capacity in 1998 when ore reserves at depth and to the east are developed. These should ensure the mine a life of ten years at its planned full output.

The nickel-copper-cobalt ore extracted at these mines is concentrated at the Strathcona mill near Sudbury, Ontario, and is further processed at the Falconbridge smelter to produce cobalt-bearing nickel matte. This matte, plus the feed the company obtains from outside sources (up to 75% for the production of cobalt), is sent by ship to the company's refinery at

Kristiansand, Norway, to produce cobalt metal and nickel products.

Falconbridge also pursued exploration on a number of properties. Its most advanced project, the Raglan property located on the Ungava Peninsula in northern Quebec, received final approval for development in February 1995. With all permits in hand, the company has begun construction on site and has moved the start-up date of the project from early 1998 to late 1997. Capital expenditures to bring the 20 000-t/y nickel (about 330 t/y of cobalt) operation into production are estimated at \$486 million. Reserve estimates of 18.1 Mt grading 3.13% nickel, 0.88% copper, 0.05% cobalt and precious metal credits would permit a mine life of over 15 years. Falconbridge plans to mill the ore on site and then truck the concentrate (grading, on average, 16% nickel and 4% copper) 65 km north to the port facility of Deception Bay, Quebec. The concentrate will then be shipped and railed to Falconbridge's Sudbury smelter where it will be processed into a nickel-copper-cobalt matte before being sent to the company's Nikkelverk refinery in Norway for further processing. For this project \$37 million is being spent from the project budget to increase the production capacity of the Sudbury smelter and the Norway refinery to accommodate the increase in matte from Canada.

Falconbridge closed its Sudbury Division for two weeks in July for the summer vacation, but did not close its operations for the Christmas period.

The Cobalt Refinery Company Inc.

As of December 1994, Sherritt's nickel and cobalt business came under the ownership of the joint venture between Sherritt Inc. and La Compania General de Niquel S.A. The three joint-venture companies formed were International Cobalt Company Inc. (ICCI), The Cobalt Refinery Company Inc. (Corefco), and Moa Bay Nickel S.A.

During 1995, Corefco produced 1730 t of refined cobalt at its Fort Saskatchewan refinery located northeast of Edmonton, Alberta, which is 5% less than in 1994. Due to various maintenance issues, feed timing and management decisions, its operation at capacity was not achieved over the full year. However, the refinery had periods in 1995 where its annualized cobalt production hit 2225 t, 11% higher than the plant's designed capacity. Modifications made to the refinery when it was upgraded in 1993 will enable the company to plan cobalt production independently from that of nickel, making it less sensitive to price fluctuations for nickel and copper.

Corefco toll produces cobalt from feedstock owned by ICCI, which is purchased on a contract basis from Moa Bay Nickel S.A. In 1995, Corefco obtained the majority of its feed from ICCI, with the balance coming from North America and Australia through Sherritt Inc. on a separate tolling arrangement.

Moa Bay's better-than-expected production in 1995 will result in a further expansion at both the mine and the refinery with an expected doubling of capacity within the next few years.

Corefco's nickel-cobalt refinery produces cobalt metal in powder form that can then be pressed and sintered into briquettes. Since 1990, as a result of importing feed from Cuba, Sherritt lost the U.S. market because of the U.S. embargo that bans the import of materials originating in Cuba. This ruling has also affected the actions of the joint-venture companies, which are also restricted from selling their products in the United States. The U.S. policy is not expected to change in the near future.

Sherritt Inc.'s specialty products group produces ultrafine cobalt powder used as a bonding agent in the manufacture of tungsten carbide cutting tools and parts, as well as in the manufacture of diamond saw segments. Sherritt's ultrafine cobalt powder is produced in a separate production facility from that of Corefco's.

In November 1995, Sherritt announced a restructuring of the company into two independent public companies: Sherritt Inc. and Sherritt International Corp. Upon completion of the rights offering, Sherritt Inc. will be made up of the company's fertilizer business, the Canadian oil and gas businesses, the specialty products business, and its advanced industrial materials and technology groups. Sherritt International Corp. will be a new publicly traded Canadian company and will own a 50% share of the joint venture between Sherritt Inc. and La Compania General de Niquel S.A. of Cuba, Sherritt's international oil and gas business, and various other businesses including some nonmetal interests in Cuba.

Ego Resources Ltd.

Ego Resources Ltd. (Ego), a junior mining company, became the world's largest primary producer of cobalt on June 22, 1995, when it started operating its new recovery plant at commercial levels. The start-up of the plant in Cobalt, Ontario, follows more than \$20 million in research, development and construction costs. Through its wholly owned private company Cobatec, which has developed a low-cost process to recover cobalt from high-grade feedstock, Ego expects to produce 272 t/y of cobalt salts, a value-added product sector. Initially, the company will produce cobalt carbonate compounds that contain about 49.5% metal, but it may also expand its product base to include cobalt oxide containing 70.5% metal and cobalt sulphate containing 22.4% metal. These products will be marketed by Amalgamet Inc. to end users. Contracts will be made on a "negotiated basis," although Amalgamet will buy the material at spot prices from Cobatec if it remains unsold for 30 days.

The Cobatec process will enable the company to extract cobalt from ores with a high arsenic content, which before had posed a metallurgical barrier. By pressure leaching the ore in the presence of oxygen, arsenides are oxidized to arsenates and react with iron to produce stable ferric arsenate. Sulphides, oxidized to sulphates, react with limestone to form gypsum which, together with the ferric arsenate and other insoluble materials, is separated from the cobalt-rich liquid phase and sent to a landfill or holding pond. The pregnant liquor is then stripped of its metal values in a solvent extraction unit and the loaded organic phase is selectively stripped of first nickel and then cobalt. This process has been endorsed by the Ontario government as consistent with its green industries strategy.

Ego has secured sufficient feedstock through agreements with old producers in the area to ensure about four years of production at its current rated plant capacity. It will also source additional feedstock from Big River Minerals Corp. of Sauget, Illinois, in the form of a copper cake containing 6% cobalt and 36% copper. This copper cake is now considered a waste product by that company because it is laced with high percentages of arsenic, making it impossible for the company to process it further.

Ego signed an agreement with H.C. Starck GmbH & Co. KG (H.C. Starck) of Goslar, Germany, under which it will commit a large part of its production capacity to the manufacture of a high-purity cobalt intermediate that will be supplied to H.C. Starck over a period of ten years. This intermediate is needed for the production of cobalt suboxide which is used to improve the electrical conductivity of electrode materials in high-performance rechargeable nickel-metal hydride batteries. These batteries are used in cars, portable computers, mobile telephones, and other applications. As part of the agreement, H.C. Starck will contribute proprietary technology that will allow Ego to upgrade its cobalt carbonate product to the special grade required by the former company's battery production facility in Mito, Japan. The production of upgraded material should start by mid-1996.

Other Developments

Black Hawk Mining Inc. re-opened the high-grade Redstone mine located 22 km southeast of Timmins, Ontario, in October 1995. Ore is being shipped at a rate of 300 t/d to Falconbridge's Strathcona mill in Sudbury under a custom milling and smelting contract valid for a minimum of two years. Proven mine reserves stand at just over 180 000 t grading 3.28% nickel and 0.038% cobalt.

During the year, **Camco Corporation** built a \$1 million pilot plant to evaluate the feasibility of recovering cobalt and nickel from uranium tailings at its Key Lake facility, located about 550 km north of Saskatoon, Saskatchewan. If tests are positive,

preliminary designs indicate that a \$45 million commercial plant could be built starting in the third quarter of 1996 with a capacity to produce 263 t/y of cobalt and 3175 t/y of nickel from tailing reserves that could last 12 years. Once processed, the waste from the proposed plant would be placed in the nearby Deilman open-pit, an environmentally friendlier location than the present site.

Following the November 1994 announcement of a significant nickel-copper-cobalt discovery on its Voisey's Bay property located 35 km southwest of Nain, on the east coast of Labrador, **Diamond Fields Resources Inc.** stepped up its efforts to delineate the extent of the mineralization. The deposit, as outlined by the end of the year, extends over a strike length of 3500 m and is composed of three zones: the Ovoid, the Eastern Deeps, and the Western extension. These zones are made up of massive and disseminated sulphides that include pyrrhotite, pentlandite and chalcopyrite mineralization hosted in an ultramafic sill. Reserve calculations to date stand at 31.7 Mt grading 2.83% nickel, 1.68% copper and 0.12% cobalt, but these only include the Ovoid and Western extension zones. A year-end evaluation of the Eastern Deeps Zone indicates a resource potential in excess of 50 Mt with similar grades, amenable to relatively low-cost underground bulk mining methods. A minimum production target for the project has been set at 60 000 t/y of nickel, 40 000 t/y of copper and 1360-2270 t/y of cobalt, but it may be expanded depending on the market's supply/demand balance. Details concerning the concentration, milling and refining aspects of the project have not yet been outlined. However, there are plans to build a nickel refinery in Newfoundland; in this regard, the company is studying both hydrometallurgical and pyrometallurgical refining technologies.

To assist with the financing and to provide expertise for the development of the project, Diamond Fields Resources Inc. accepted offers from Teck Corporation and Inco Limited for the purchase of interests in the company. Through these agreements, Teck acquired a 10.4% interest in Diamond Fields and was appointed the primary contractor to conduct the mine/mill feasibility study to be completed by June 1996, while Inco acquired a 25% stake in the project itself plus a direct interest in Diamond Fields for an aggregate interest in the project of 30%. Inco is helping to fund further exploration and is participating in the feasibility study of the mining and processing facilities. It will also market all of the metal produced under a long-term agreement.

Phase I of the engineering feasibility study was completed by year-end and included the surveying of potential sites for the dock, port, camp, borrow pits, airstrip and process facilities. Phase II should be completed by April 1, 1996, when a site will be chosen. Construction of the mine and mill facilities could start by 1997, once environmental approval and the necessary permits have been granted.

Diamond Fields has also reported on the Voisey's Bay property the discovery of the Sarah prospect located about 6 km northeast of the Ovoid Zone where surface assays returned values of up to 1.06% nickel. A regional exploration drilling program to assess the targets outlined so far, including the Sarah Prospect and the Voisey's Bay West target area, will start in early February 1996.

Numerous companies exploring properties in the vicinity of the Voisey's Bay discovery report significant nickel-copper-cobalt values from surface showings. However, few have drill-tested their findings. The companies reporting significant nickel-copper-cobalt drill intersections include **Canadian State Resources** on its 1514H claim group located 80 km northwest of Voisey's Bay, and **Consolidated Viscount Resources** and **Consolidated Magna Ventures** on their Tasisuak Lake property 50 km northwest of Voisey's Bay.

During the year, **Fortune Minerals Ltd.** completed reconnaissance and detailed mapping and geophysical surveys, as well as trenching work, on its NICO claim group 160 km northwest of Yellowknife, Northwest Territories. Aside from the three zones reported on in last year's review, the company is reporting the discovery of several new zones containing copper, cobalt, bismuth, and even tungsten and precious metal values. Of these new zones, the best potential for cobalt appears to rest in the Bowl Zone, the Nico Lake Zone and the Burke Lake Zone. The company plans to drill some of the better zones starting in March 1996.

Canmine Resources Corporation, active on the Werner Lake property located 80 km north of Kenora in northwestern Ontario, reported the intersection of significant copper-cobalt mineralization in seven drill holes. The West Zone, as it is known, has been traced for 280 m along strike and 40 m in depth, and is located about 600 m west of Falconbridge's former producing Werner Lake mine.

Cumberland Resources (50%), **Manson Creek Resources** (25%), and **Comaplex Minerals** (25%) reported assay results from a surface sampling program at their Parker Lake project located 96 km west of Rankin Inlet, Northwest Territories. Grab samples from the Suluk Zone assayed an average of 3.82% nickel, 2.93% copper, and 0.165% cobalt. A drilling program will be carried out in 1996.

Other promising discoveries include that of **First Western Minerals Inc.** on its Mont Paul property in Quebec's Gaspé Peninsula, where trench samples returned assays averaging 8.22% nickel and 0.07% cobalt over a 4-m section. **Cross Lake Minerals Ltd.** is active on its Sewell Township property, 50 km southwest of Timmins, where grab samples returned assays up to 2.3% nickel, 0.5% copper and 0.03% cobalt. Also, **Flag Resources Ltd.** carried out a drill program on a number of base-metal showings with

precious metals and cobalt values, associated with the Wanapitei anomaly, which is a sister anomaly to the one marking the nickel-copper-cobalt-rich Sudbury Basin. Although the program did not return significant mineralized intersections, the company is encouraged by the geological environment outlined, which is similar to that hosting the Sudbury Basin deposits.

In August 1995, **Royal Oak Mines Inc.** and **Geddes Resources Ltd.** finally reached an agreement with the Government of British Columbia on compensation for the cancelled Windy Craggy copper-cobalt project. This followed the 1993 ruling by the Government of British Columbia against the development of the Windy Craggy deposit located in the Tatshenshini wilderness area. The park was later designated a world heritage site by UNESCO. The deposit, which hosts 297 Mt of reserves grading 1.38% copper and 0.06% cobalt, was valued at between \$110 million and \$620 million in January 1993 by the Commission on Resources and the Environment (CORE), a provincial government agency. According to the agreement now reached, the companies will receive \$29 million in cash compensation and economic development assistance totalling almost \$137 million.

Canada's most important cobalt export in 1995 was in the form of matte and "other intermediate products." This trade, directed mostly to Norway, the United States, Japan and the Netherlands, generated revenues of \$304 million, an increase of 42% from 1994. The most important cobalt import on the basis of value was "unwrought cobalt." The greater portion of these products was imported from Zaire for transformation, and made up 60% of total imports. As a general comment on trade, Canada's imports and exports of cobalt products increased significantly in 1995 both in terms of quantity and value compared to 1994 (Tables 1 and 2).

Canada's cobalt trade is significantly greater than indicated in the statistics because much of the cobalt imported or exported in ore, concentrates and matte is counted as nickel and copper imports/exports and is therefore not included in the cobalt statistics. For example, in 1995, Canada imported 33 987 t of Cuban nickel-cobalt matte valued at \$237.9 million, while it exported 69 525 t of nickel-copper-cobalt matte worth \$848.6 million to Norway and the United Kingdom.

WORLD DEVELOPMENTS

Estimating from the Cobalt Development Institute's (CDI) production figure and from other sources, world production of refined cobalt in 1995 will be about 22 829 t, or 7.6% more than in 1994. This figure includes 18 229 t supplied by member countries of the Institute (16 883 t from primary producers, including 75 t by Ego Resources) and 1346 t from

secondary producers), in addition to 4600 t estimated to be the combined production of Russia, China, South Africa, Brazil and India. The production increase seen in 1995 may signal the stabilization of cobalt supplies and a balanced market. (Refer to Table 3 for CDI members' individual production.)

Australia

Australia's mine production of cobalt in 1995 is estimated at 2500 t, 16.3% more than in 1994, despite the severe flooding experienced in Western Australia in February that closed mining operations for a few days. About 1400 t of Australia's production came from the QNI Ltd. Yabulu refinery in Townsville, which produced an intermediate sulphide material grading 42% cobalt and 0.1% nickel from ore imported from New Caledonia and Indonesia. This cobalt sulphide was sent to the Kokkola Chemicals Oy plant in Finland where it was processed into metal and salts by the Outokumpu Mooney Group. However, QNI Ltd. announced in October that it was proceeding with the construction of an A\$30 million cobalt refinery to produce cobalt hydroxide, an ideal feedstock for the production of cobalt chemicals. QNI expects sulphide shipments to Finland to stop in early 1997 when the new plant comes on stream.

The balance of production came from Western Mining Corp.'s (WMC) nickel sulphide operations in Western Australia, which produced about 1000 t, including new production from Mt. Keith, and from Outokumpu Australia Pty's Forrestania mine located in the same area, which produced about 100 t. The ore from WMC's mining operations was smelted at Kalgoorlie and refined at the nearby Kwinana plant before it was exported as a nickel-cobalt matte to Sherritt's plant in Canada for further refining. The Forrestania mine's output was exported for refining to Outokumpu Oy's Harjavalta refinery in Finland in the form of a nickel concentrate grading 0.4% cobalt.

Numerous mining projects are under development and are bound to boost Australia's production in the near future, but no production decisions have yet been announced. The most advanced projects include Anaconda Nickel NL's US\$550 million Murrin Murrin project located near Leonora in Western Australia, where laterite resources estimated at 118 Mt grading 1.14% nickel and 0.07% cobalt could produce up to 3000 t/y of cobalt. A feasibility study to be completed by March 1996 could bring the project on stream in early 1998. The MIM Holdings Ltd. and Savage Resources Ltd. Ernest Henry copper-cobalt-gold deposit located in Queensland in northeastern Australia has passed the feasibility stage and financing is being finalized. The project could come on stream in early 1998 at an initial rate of 1500 t/y of cobalt and rise to 3000 t/y by the end of the decade. The Resolute Samantha Ltd. Bulong laterite nickel-cobalt project located 30 km east of Kalgoorlie in Western Australia is expected to have a completed feasibility study by January 1996 and to come on

stream at an initial rate of 500 t/y of cobalt by 1998/99. Other potential cobalt production from nickel ore deposits include the Yakabindie and Honeymoon Well projects, while production from copper ore deposits include the Mt. Isa and Mt. Cobalt projects.

Brazil

RTZ Mineração Ltda announced the development of its Fortaleza nickel sulphide deposit located in Minas Gerais State. The construction of a fully integrated mine-to-refinery complex is expected to cost about US\$183 million, plus an additional US\$50 million for the subsequent commissioning of the underground mine, to come on stream in 1998. Ore reserves of 10.3 Mt grading 1.89% nickel, 0.36% copper, 0.2% cobalt and precious metal credits will result in a 20-year production life for the project with the first five by open pit and the remainder by underground mining methods.

Cuba

Cuban mine production of cobalt in 1995, estimated at about 2000 t, was produced as nickel-cobalt mixed sulphide matte (with a 10:1 nickel-cobalt ratio) at the Moa Bay smelter and exported for refining to Sherritt's facilities in Canada. The Nicaro and Punta Gorda plants, also located in Cuba's eastern Holquin Province, did not recover the cobalt content of the ore despite their capacity to produce 2200 t/y since it is deliberately suppressed in order to produce on-spec nickel sinter. Cuba's lateritic deposits contain an average of 0.11% cobalt and they are the world's second largest reserves after those in Zaire.

Aside from the joint venture with Sherritt discussed earlier, the Cuban government-owned Commercial Caribbean Nickel has agreed to form a joint stock-holding company with WMC of Australia to explore and develop the Pinares de Mayari West nickel deposit. This deposit, located in the Holquin Province about 200 km west of Moa Bay, is estimated to host reserves of 200 Mt grading over 1.0% nickel and 0.1% cobalt. An evaluation of the financial viability of the project is expected to take at least four years to complete and a further three years to begin operations.

In other developments, Gencor Ltd., the South African mining group, acquired a 75% stake in the state-owned San Felipe nickel-cobalt deposit located in Camaguy Province about 500 km east of Havana. Estimated to be of similar size and grade to the Pinares de Mayari West deposit, the San Felipe deposit could be developed in the same time frame as the former. Finally, the construction of the Las Camariocas plant in Holquin Province, although two thirds completed, was still on hold due to a lack of financing as well as pollution problems associated with the leaching process it uses.

Finland

In 1993, because of a change in feedstock to its Harjavalta refinery following a decline in the supply of domestic ore, Outokumpu Metals and Resources Oy decided to change the design of the facility to treat more imported feed and to expand its nickel and copper refining capacity. In addition, a 500-t/y capacity cobalt circuit to produce metal powder has been added to the plant to refine 250 t/y of cobalt that was formerly sent to the Kokkola refinery as a hydroxide sludge, plus additional input from imports.

Outokumpu officially inaugurated the plant's new copper and nickel facilities in August 1995; however, cobalt production has been delayed until early 1996. The OM Group Inc., which produces cobalt metal powders, oxides and salts at its Kokkola Chemicals Oy plant from cobalt-bearing material imported from Zaire and Australia, will continue to handle the sludge until then.

Ivory Coast

Exploration work on the Biankouma-Touba nickel laterite project, located east of the Sipilou deposit close to the Ivory Coast's western border with Guinea, continued in 1995. The completion of a drill program at the project's two largest deposits, Fougouesso and Moyango, enabled the upgrade of some of the reserves estimate which now stands at 39.5 Mt grading 2.00% nickel and 0.07% cobalt. These reserves are in addition to 54 Mt grading 1.8% nickel and 0.1% cobalt in the Sipilou deposit located on the same concession, and resources of 18.7 Mt grading 1.77% nickel and 0.08% cobalt estimated in the Yamatoulo, Touoba and Viala deposits. Preliminary metallurgical test results on samples from the Fougouesso, Moyango and Viala deposits indicate that ore from these deposits is suitable for ferronickel production; hence, cobalt would not be produced as a by-product. A follow-up US\$1.6 million drilling program in 1995/96 has been proposed by Falconbridge.

Mexico

In 1995, International Curator Resources Ltd. spent approximately US\$3.5 million to pursue the evaluation of the Boleo copper-cobalt deposit located 3 km inland from the port city of Santa Rosalia, Mexico, on the Gulf of California. The mineralization at Boleo occurs in flat-lying seams averaging 1.2 m in thickness that contain both sulphide and oxide ore.

Additional infill drilling was carried out on the main Saturno-Mercurio mineralization area, and on the Apolo, Saturno West, and Dos de Abril areas. Drill-indicated and inferred open-pit resources now stand at 123.9 Mt grading 0.76% copper and 0.073% cobalt, while drill-indicated and inferred underground resources are 49.4 Mt grading 2.67% copper and

0.082% cobalt. Also, bench-scale metallurgical tests by Lakefield Laboratories on oxide ore samples from the Saturno-Mercurio deposit confirmed recovery ratios of 84% for copper and 72% for cobalt using an agitation leaching system. The company is now planning to complete a feasibility study on the project by the end of 1996 at a cost of about US\$4.5 million.

Morocco

La Compagnie de Tifnout Tiranime, a primary cobalt producer that mines high-grade cobalt veins averaging 1.5% cobalt in the Bou-Azzer area, finalized the construction of a cobalt refinery in 1995. The plant, which is expected to be fully operational by March 1996, will have a capacity to produce 300 t/y of cobalt cathode. However, despite this development, the company plans to continue supplying China with as much as 700 t/y of cobalt contained in arsenic-rich concentrate for refining.

New Caledonia

Inco Limited announced in July that it was initiating a feasibility study for the development of its Goro nickel-cobalt project in New Caledonia. One of the main objectives of the study is to ascertain the economic viability of pressure leaching, to be combined with solvent extraction, which would enable the recovery of cobalt from the lateritic ore. The process has successfully been tested on laterites from the Goro deposit on a continuous basis in a fully integrated pilot facility. However, there is no example of this technology presently in commercial use. Aside from Australia's QNI, Brazil's Tocantins, and Cuba's Moa Bay, all lateritic ore-based producers cannot economically recover cobalt. The study is financed by Goro Nickel, an operating company owned 85% by Inco and 15% by France's Bureau de recherches géologiques et minières, and is expected to be completed by the end of 1996. Estimated reserves stand at 165 Mt grading 1.6% nickel and 0.16% cobalt.

Philippines

In December, Pacific Nickel, a consortium comprised of British, Hong Kong, and Indian investors, and also involving Minproc of Australia, was conducting a due diligence survey on site prior to entering into a final agreement concerning the acquisition of the Nonoc nickel operation located near Surigao City on Mindano Island. The acquisition would include the nickel-cobalt-rich lateritic ore reserves estimated at 81.3 Mt grading 1.22% nickel, 0.11% cobalt and 37.3% iron; the refinery, which has a design capacity of about 35 000 t/y of nickel and 1500 t/y of cobalt; and the power plant located on site. If the deal is confirmed, complete rehabilitation of the facilities could take up to three years and cost an estimated US\$187.5 million. Panorama Resources Corp., which had signed a similar memorandum of understanding in May 1994, finally backed out.

Stellar Gold Corporation signed a memorandum of understanding with BHP Minerals International Exploration Inc. for the development of the Palawan laterite nickel project. Stellar is said to have developed a recovery process that consumes less energy than conventional processes, although a pilot plant test has not yet been done. The viability of the project might hinge on the test since power costs are quite high in the Philippines. Current reserves are estimated at 90 Mt of lateritic ore grading 1.14% nickel and 0.17% cobalt, and proven reserves of saprolite ore grading 2.29% nickel.

Russia

Russia's refined production of cobalt in 1995 is estimated at about 4330 t (not including tolled material), taking into account reports of a 10% drop in production compared to 1994 at the Norilsk Nickel Russian Joint Stock Society (Norilsk RJS). In Russia cobalt is mined from nickel-copper-cobalt-rich sulphide deposits and processed at five locations. Norilsk RJS, which accounted for 81.5% of Russia's production in 1994 with 4512 t (including 1267 t tolled) of cobalt in the form of metal (ingots 99.3% pure) and oxide, produces from refineries at its Norilsk and Severonickel complexes, and from a smelter at its Pechenganickel complex. Matte from the smelter is sent for refining to the Severonickel plant or is exported to be treated on a tolling basis. The two other refineries based in the Urals are Ufaley Nickel, which produces cobalt oxide, and Yuzhural Nickel, which relies on Cuban matte imports to produce cobalt metal granules.

In step with nickel production, cobalt output (aside from that of the Norilsk plant which increased by 37.6% over 1994) was reported to have decreased further during the year due to the breakdown of production apparatus caused by a lack of capital for proper care and maintenance. Mechanical problems were compounded by shortages of coking coal and feed at smelters and refineries, the latter coming from domestic sources and imports for tolling. Exports of cobalt are estimated to have stabilized at a level of about 2800 t (including 1300 t of cobalt in tolled material). This results partly from the implementation of a decree in 1994 which tightened up licensing conditions, effectively restricting cobalt sales by Russian producers to licensed domestic consumers.

Tanzania

In 1995, BHP Minerals International Exploration Inc. (BHP) and Sutton Resources Ltd., a Canadian-based junior mining company, concentrated their efforts on the North Zone located 700 m north of the Main Zone of its Kabanga nickel-copper-cobalt deposit. Drilling outlined inferred resources of 12.4 Mt grading 2.00% nickel, 0.27% copper and 0.19% cobalt. BHP, the project operator, plans to complete 16 000 m of drilling on the Kabanga deposit by the end of May 1996 and, depending on results,

plans to begin an underground program during the year. A preliminary economic evaluation of the deposit commissioned by Sutton indicated that the capital costs for a mine/mill/smelter complex to treat 2.55 Mt/y of ore for the production of 29 000 t/y of nickel, 4800 t/y of copper and 2000 t/y of cobalt would be US\$321 million.

The Kabanga and neighbouring Kagera deposits are located in an extensive nickel belt similar in geology to the ones in Canada and Australia. Drill-estimated resources at the Kabanga deposit (outside the North Zone) amount to 25.5 Mt grading 1.19% nickel, 0.20% copper and 0.10% cobalt amenable to production by open pit.

Uganda

Officials involved with the Kasese cobalt project in western Uganda announced in September that financing for the development of the project had been committed by four international groups: the European Investment Bank, the Commonwealth Development Corporation, the International Finance Corporation (a soft loan World Bank affiliate), and the French company Propaco. These groups will provide US\$80 million to fund construction of a cobalt-processing plant and an associated 10-MW hydroelectric plant. The project is to be developed by Kasese Cobalt Co. Ltd., which is owned by the Ugandan government (45%) and Canada's Banff Resources Ltd. (55%). Construction is expected to start in early 1996 and the plant is scheduled to be commissioned in January 1998.

The cobalt plant will process cobaltiferous pyrite concentrates recovered from waste dumps from the old Kilembe copper mine located 10 km uphill. Through bio-oxidation, solvent extraction and electrowinning, the plant is expected to produce 1000 t/y of cobalt cathode. The waste dumps are estimated to contain around 1.1 Mt of pyrite concentrate grading an average of 1.4% cobalt, which would give the project a 12-year life.

In conjunction with the tailings project, Banff Resources Ltd. is planning a US\$1 million exploration program to evaluate the feasibility of re-opening the Kilembe mine where Falconbridge Ltd. milled 16.2 Mt of copper-cobalt ore grading 1.95% copper between 1956 and 1976. The program will include underground drilling to delineate sufficient reserves, as well as surface drilling of various prospects in the vicinity of the mine such as in the Nkenda area.

United States

In May 1992, the U.S. House of Representatives approved the disposal of 5810 t of cobalt from excess reserves in the National Defense Stockpile by the end of fiscal year 1996. Following this decision, the Defense Logistics Agency (DLA) started bi-monthly

sales of cobalt granules and rondelles in fiscal year 1993. Cobalt rondelles grading 98.87% cobalt can be used in the chemical industry, while cobalt granules grading 99.23% cobalt are suitable for the magnet and tool steel industries.

In fiscal year 1995, the maximum amount of cobalt authorized to be sold under the Annual Materials Plan was 1815 t. Because of a certain tightness in supplies, the DLA sales were very popular in 1995 and resulted in the annual materials sales plan being depleted by the end of July, two months before the end of the fiscal year. About 2636 t of cobalt were sold during the calendar year. Sales during fiscal year 1995 equated to an average price of US\$25.94/lb.

For fiscal year 1996, Congress approved the sale of 1815 t of cobalt, split in two lots grading 99-99.29% pure and less than 99% pure, which is to be sold by the DLA through two negotiated sales. However, at year's end, a Bill being evaluated in the U.S. House of Representatives could result in the approval of up to 19 283 t of cobalt for disposal. DLA authorities mentioned that the annual sale levels would be kept similar to 1995 levels, although a proposal to revise the Annual Materials Plan may authorize a further 907 t to be sold in 1996. At the end of fiscal year 1995, reserves at the National Defense Stockpile stood at 20 145 t of cobalt grading between 97.11% and 99.9% pure, split 52% as granules, 29% as cathodes and 19% as rondelles.

Formation Capital Corp. reported increasing reserves at the Sunshine copper-cobalt deposit located 32 km southwest of Salmon, in central Idaho, adjacent to the Blackbird mine, which is a past copper-cobalt producer that Noranda Mining Inc. has agreed to help reclaim environmentally. Based on partial data from a 9975-m drill program, preliminary estimates on the Sunshine Lode Zone in December 1995 outlined drill-indicated reserves of 363 000 t grading 1.1% cobalt, 0.26% copper and 0.71 g/t gold.

Zaire

The economical and political situation in Zaire, until recently the world's largest cobalt-producing country, was still unstable in 1995. However, the restructuring of La Générale des Carrières et des Mines (Gécamines), the refurbishment of production facilities carried out during the year, and the start-up of new mines may signal improvements to the situation. As proof, Zaire's cobalt output reached 4146 t in 1995, up 26% compared to 1994, pursuing the production improvement started during that year. Production in Zaire had dropped to a 2200-t low in 1993 following political upheaval in 1992 and a serious cave-in at the Kamoto mine in 1990 that forced its closure.

The 1995 output is said to have been reached mostly by processing hydrates grading 6-10% cobalt at Zaire's two hydrometallurgical plants at Luilu and

Shituru. With cobalt hydrate material at Luilu exhausted by December 1995, Gécamines, the state-owned mining company, started operations at two new mines: the Kamoya, which has 2 Mt of ore grading 3% copper and 1% cobalt, and the high-grade Kasombo open-pit. The producer also plans to produce from the Kov and Kamoto mines, and from hydrates at Shinkolobwe in 1996.

Financing for 1995 developments came from improved cash flow and from supply agreements signed with Belgium's Union Minière concerning output from the Kasombo mine, and with the OM Group. In November, Gécamines also secured US\$14 million in financing with South Africa's Investec, which will allow work on the mine expansions to continue in 1996. However, to help resolve the situation in the longer term, Zaire is seeking US\$500 million to renovate and upgrade its facilities and develop new mines. But even after banks put the necessary financial packages back in place, experts agree that Gécamines will need three to five years before it can produce at "normal" levels. In the short term, Gécamines expects to increase its production in 1996 to about 5000 t of cobalt.

Zambia

Production difficulties and political problems continued to plague the state-run Zambia Consolidated Copper Mines (ZCCM) in 1995. However, increased production levels in the last quarter enabled the company to produce 2934 t of cobalt in 1995, 11% more than in 1994. Low production levels in the first three quarters were caused by: 1) poor concentrator recovery at the Nchanga operations; 2) smelter problems at the Nkhana Division; and 3) mining constraints at the Baluba Flat mine, whereas the production increase in the last quarter is attributed to the development of a new high-grade ore block at the Nchanga Division. Production is expected to remain at about 5000 t/y in the short term, but in order to stabilize production at that level ZCCM will need a large influx of capital that will only be granted to it when the company is privatized. This is unlikely to occur before the general election in 1996. However, ZCCM did initiate the privatization of some of its mines in 1995 with the sale of the Kabwe facilities.

Zambia's production has been decreasing in the past few years because of a lack of capital to operate the plants properly, upgrade its operations, or develop ore deposits for production. An example of this is the US\$600 million cost to develop the Konkola Deep deposit containing reserves of 340 Mt grading 3.8% copper and 0.07% cobalt, which is scheduled to replace the Nchanga operation when reserves at that location are exhausted at the turn of the century.

In other news, Colossal Resources Corp. and Quasim Mining Enterprises entered into a 60%-40% joint venture to recover cobalt by processing 8.6 Mt of slags from the Nkana dumps that grade between

0.70% and 0.81% cobalt. The companies expect to produce by early 1996 at an initial rate of 520 t/y and to expand to 3500 t/y in the fourth year of operation. The slags will be railed 100 km to the Kabwe facilities where two 15-t electric furnaces will convert the cobalt-rich material to ferro-cobalt grading 65% cobalt. The reserves would give the project a 15- to 19-year mine life.

PRICES

In 1995, the cobalt market was somewhat unstable in response to a perceived tightness in supplies of high-purity cathode used by the superalloy industry, but cobalt chemicals and lower-grade cobalt cathode appeared to be in ample supply. Strong demand from the booming North American, European and some Asian economies, coupled with production disturbances in major producing countries, kept prices high and increasing.

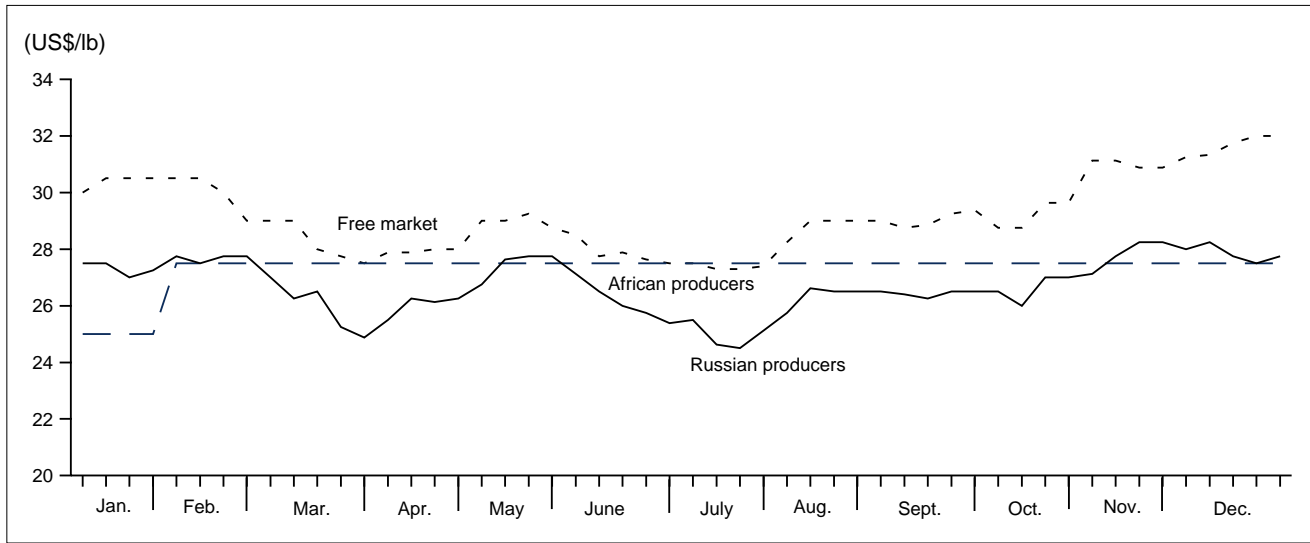
The free market price for cobalt cathode started the year in the range of US\$29.50-\$30.50/lb. However, consumer reluctance to break the US\$30.00/lb barrier kept sales over that mark to a minimum. Prices started falling in mid-February and decreased steadily to a low of US\$27.50/lb at the end of March, only to rebound to a high of US\$29.25/lb in mid-May. Again, prices backtracked to a year low of US\$27.30/lb in July before embarking on a strong, steady rally for the rest of the year to finish at US\$32.00/lb (Figure 2).

The African producer reference price, fixed at US\$25.00/lb in November 1994, was kept at that level until mid-February when ZCCM and Gécamines announced a new reference price of US\$27.50/lb applicable to Zambian Grade B/C (qualities 3 and 4) and Zairean granule products grading 99.6% cobalt. The joint price change followed ZCCM's earlier announcement that it was raising its sales price for February to US\$28.00/lb. Although the new reference price was kept in effect until the end of the year, both producers are said to be selling at higher prices, noting that the reference price is not a selling price.

The price for Russian material followed the price of higher-grade Western-origin material throughout the year except for the rally in December when the price for Russian material stabilized. As a result, and this is probably due to an increased supply tightness for higher-grade material, the price difference between the two widened from a low of under US\$2.00/lb in mid-year to over US\$4.00/lb. Russian material started the year at just above US\$27.00/lb, fell to a low of US\$24.50/lb in July, and finished the year at close to US\$28.00/lb.

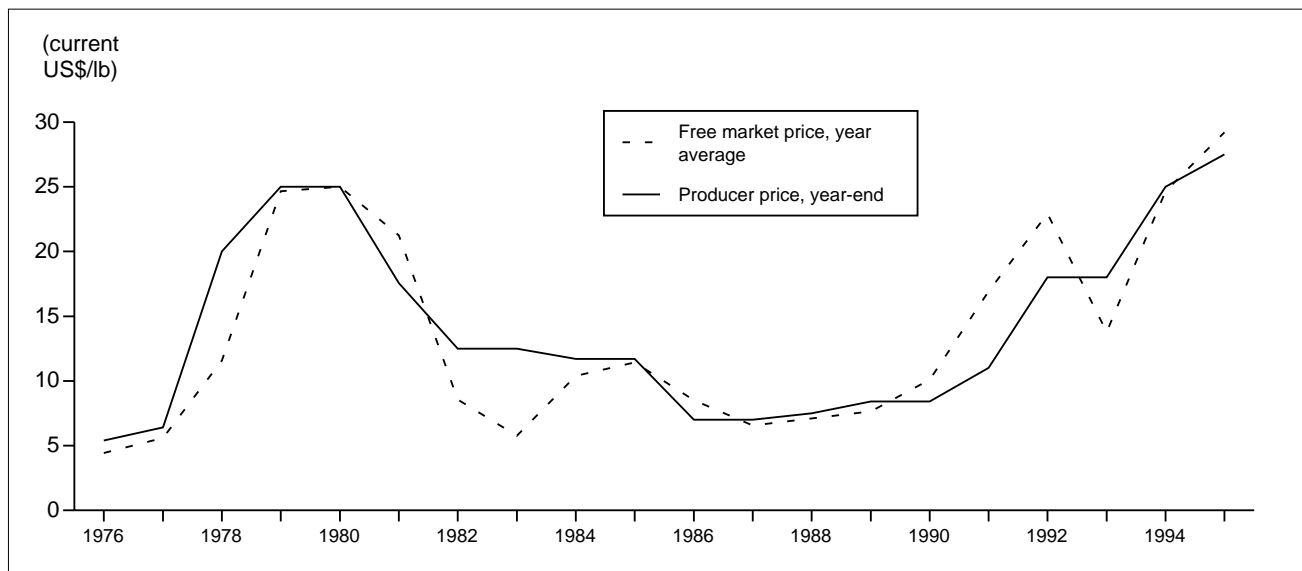
Improved output from major producers, new capacity coming on stream during the year and before 2000, greater cobalt supplies generated from scrap metal and secondary material, and the possibility of

Figure 2
Cobalt Price Variations, 1995



Sources: *Metals Week; Mining Journal; American Metal Market.*

Figure 3
Cobalt Price Variations in the Past Twenty Years, 1976-95



Source: *Metals Week.*

increased sales from the U.S. DLA stockpile will gradually bring balance back to the market in the medium term. However, increased demand in the short and medium term, mostly from the aerospace and battery industries, will keep the market very tight and may even result in a supply deficit for higher-grade material. Prices will remain volatile in 1996, rising further in the first half of the year and settling back to a level of around US\$30.00/lb by the end of the year as new capacity comes on stream.

OUTLOOK

In Canada, production of refined cobalt in 1996 is expected to increase worldwide by 23% to 3570 t. Inco is forecasting higher production of about 1180 t of refined cobalt through the optimal use of its facilities, short shut-down periods, and additional output from the McCreedy East, Garson, Victor, and I-D mines. Inco has announced that its Port Colborne refinery will close for a three-week period during the summer. Production at Falconbridge is expected to remain at least as high as in 1995, keeping its world cobalt output at 2800 t, while production at Corefco (Sherritt) should approach its capacity of 2000 t/y. Finally, Ego, through its wholly owned subsidiary Cobatec, should produce about 270 t of cobalt contained in compounds for its first full year of production at designed capacity.

In 1996, because of improved production levels in Zaire, Zambia and Canada, and despite production disruptions in Russia, world production of refined cobalt is projected to reach 25 310 t, an increase of about 10.9% compared to 1995. This production increase, coupled with a greater supply of scrap cobalt previously uneconomic to recycle, higher sales from the U.S. DLA, and additional cobalt output from new production such as from the tailings operations in Australia and Zambia, will help balance the market.

The world's consumption of cobalt is expected to increase as the global economy, except for Japan which still has a fragile economy, goes through a period of moderate growth. The superalloy sector, which typically uses 40% of cobalt production, is expected to significantly increase its consumption as the commercial segment of the aircraft industry recovers and major airlines replace their ageing fleets of 747s. Orders have increased substantially in the second half of 1995, specifically in the Asian market where domestic airlines are expanding. A major upturn in construction starts is expected in 1996 with deliveries occurring by 1998. Also, the demand for alloys for industrial gas turbines used in power generation and marine transport is still strong. Consumption in the chemical sector, the second most important segment of the market, has already improved significantly, mostly in the recording tape industry in Japan, while consumption in the rechargeable battery industry used for consumer

electronics products should increase substantially in the short term. Consumption in the magnet segment is decreasing because of substitution in uses, while consumption in the cemented carbides and hard facing tool steel segments of the cobalt market increased in 1995 as the world economy improved, and it should stabilize at that level in 1996. The continued tight supply in the market and the lack of price stability, however, hampers the growth of the cobalt industry and favours the switch to substitutes. This is particularly true for the use of cobalt in the battery, magnet, and wear-resistance industries.

In the longer term, the use of cobalt in the chemical industry should expand with the growth of the battery industry and as new applications are found in the tire and medical industries. Likewise, consumption of cobalt in the catalyst industry is estimated to increase by as much as 60% by the year 2000, following an increase in air emission regulations.

In 1996, the increase in production is expected to match the increase in consumption and help balance the market, although there may be a certain tightness in supply for high-grade cobalt during the year. This will send prices up until the market slowly re-balances itself.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 70. (2) Information in this review was current as of January 11, 1996.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2605.00	Cobalt ores and concentrates	Free	Free	Free	Free
2822.00.10	Cobalt hydroxides	Free	Free	Free	Free
2822.00.90	Cobalt oxides, commercial cobalt oxides	Free	Free	Free	Free
2827.34	Cobalt chloride	4%	3%	Free	Free
2833.29.00.40	Cobalt sulphate	1.5%	1%	Free	Free
2836.99.00.20	Cobalt carbonates	3.5%	3%	Free	Free
2915.23	Cobalt acetates	11.1%	7%	Free	Free
8105.10.10	Cobalt mattes and other intermediate products; unwrought cobalt, alloyed; waste and scrap; powders, alloyed	4.5%	3%	Free	Free
8105.10.20	Unwrought cobalt, not alloyed; powders, not alloyed	Free	Free	Free	Free
8105.90.10	Cobalt bars and rods, not alloyed	4.5%	Free	Free	Free
8105.90.90	Cobalt and articles thereof, n.e.s.	4.5%	3%	Free	Free

Sources: Customs Tariff, effective January 1996, Revenue Canada; Harmonized Tariff Schedule of the United States, 1996. n.e.s. Not elsewhere specified.

TABLE 1. CANADA, COBALT PRODUCTION AND TRADE, 1994 AND 1995, AND CONSUMPTION, 1992-94

Item No.	1994		1995P	
	(kilograms)	(\$000)	(kilograms)	(\$000)
PRODUCTION^{1,2} (all forms)				
Ontario	1 488 789	108 616	1 676 667	146 209
Manitoba	357 658	26 093	449 100	39 162
Total	1 846 447	134 709	2 125 767	185 371
EXPORTS				
2605.00	Cobalt ores and concentrates	-	-	-
2822.00	Cobalt oxides and hydroxides; commercial cobalt oxides			
	United Kingdom	150 795	5 811	-
	Singapore	51 000	419	-
	Other countries	1 962	90	-
Total		203 757	6 321	-
2915.23	Cobalt acetates	-	-	-
8105.10	Cobalt, unwrought, matte and other intermediate products, waste, scrap and powders			
	Norway	1 489 091	71 265	1 242 743
	United States	660 375f	43 272f	1 063 979
	Japan	628 113f	37 294f	621 982
	Netherlands	468 643f	30 592f	330 707
	Singapore	76 000	3 439	213 801
	Other countries	476 789	27 571	490 265
Total		3 799 011f	213 447f	3 963 477
8105.90	Cobalt and articles thereof, n.e.s.			
	Japan	15 200	1 061	141 183
	Germany	7 719	991	9 345
	United States	15 241f	1 771f	14 669
	Singapore	16 004	1 212	13 000
	South Africa	-	-	39 510
	Netherlands	64 176	5 170	10 250
	Other countries	5 033	746	14 703
Total		123 373f	10 958f	242 660
IMPORTS				
2605.00	Cobalt ores and concentrates			
	United States	70 658	722	12 878
Total		70 658	722	12 878
2822.00.10	Cobalt hydroxides			
	Belgium	52 000	566	15 502
	United States	5 792	181	6 985
	Other countries	3 460	93	2 259
Total		61 252	841	24 746
2822.00.90.10	Cobalt oxides			
	Russia	-	-	6 804
	Belgium	993	24	1 403
	Belarus	-	-	1 169
	United States	18 174	995	739
	Other countries	760	18	724
Total		19 927	1 038	10 839
2822.00.90.20	Commercial cobalt oxides			
	United States	-	-	4 969
	United Kingdom	39	...	-
Total		39	...	4 969
2827.34	Cobalt chlorides			
	United States	1 175	13	2 512
	Belgium	1 777	24	1 327
	Germany	124	1	591
Total		3 076	40	4 430
2833.29.00.40	Cobalt sulphate			
	United States	39 354	487	70 219
	South Africa	-	-	13 451
	Finland	-	-	4 822
	People's Republic of China	3 024	31	1 270
	Mexico	13 054	65	-
Total		55 432	583	89 762
				900

TABLE 1 (cont'd)

Item No.	1994		1995P		
	(kilograms)	(\$000)	(kilograms)	(\$000)	
IMPORTS (cont'd)					
2836.99.00.20	Cobalt carbonates				
	United States	54 590	1 086	66 022	1 453
	Russia	12 900	303	16 990	691
	Other countries	4 397	89	478	11
	Total	71 887	1 479	83 490	2 156
2915.23	Cobalt acetates				
	United States	2 456	29	3 842	92
	United Kingdom	2 799	34	47	. . .
	Total	5 255	63	3 889	92
8105.10.10.10	Unwrought cobalt; powders; mattes and other intermediate products, alloyed				
	United States	39 760	1 834	53 810	2 782
	Other countries	622	31	4 219	344
	Total	40 382	1 866	58 029	3 129
8105.10.10.20	Cobalt waste and scrap				
	United Kingdom	18 222	470	213 297	4 138
	South Africa	—	—	22 950	1 823
	Zambia	131 840	2 687	19 250	1 582
	United States	200 687	943	153 941	962
	Other countries	21 495	327	94 639	1 263
	Total	372 244	4 430	504 077	9 771
8105.10.20.10	Unwrought cobalt, not alloyed				
	Zaire	322 899	20 103	443 512	36 101
	Russia	8 634	541	31 370	2 583
	Belgium	—	—	30 399	2 308
	Other countries	22 332	964	55 409	4 137
	Total	353 865	21 611	560 690	45 133
8105.10.20.20	Cobalt powders, not alloyed				
	United States	67 122	3 826	31 556	2 279
	South Africa	15 403	750	11 609	946
	United Kingdom	15 012	761	4 423	559
	Other countries	30 448	1 710	15 991	1 024
	Total	127 985	7 052	63 579	4 811
8105.90.10	Cobalt bars and rods, not alloyed				
	United States	501	36	432	40
	Germany	760	39	227	10
	Total	1 261	76	659	50
8105.90.90	Cobalt and articles thereof, n.e.s.				
	United States	52 722 ^r	5 826 ^r	54 667	6 374
	Germany	328	29	3 191	379
	Other countries	1 535	99	1 263	84
	Total	54 585 ^r	5 956 ^r	59 121	6 839
		1992	1993	1994P	
			(kilograms)		
CONSUMPTION³					
Cobalt contained in:					
	Cobalt metal and metallic compounds	67 381	49 889	63 565	
	Cobalt pigments, feed and ground coat frit	5 801	6 751	7 323	
	Cobalt salts and driers and other uses ⁴	131 542	130 258	121 730	
	Total	204 724	186 898	192 618	

Sources: Natural Resources Canada; Statistics Canada.

— Nil; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified; P Preliminary; ^r Revised.¹ Production includes recoverable cobalt in concentrates shipped. ² Revised production numbers for 1995 were made available as of January 11, 1996. ³ Available data as reported by consumers. ⁴ Other uses include glass and chemicals.

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

TABLE 2. CANADA, COBALT PRODUCTION, TRADE AND CONSUMPTION, 1975 AND 1980-95

	Production ¹	Exports			Imports	Consumption ⁴
		Cobalt Metal	Cobalt Oxides and Hydroxides	Cobalt Ores ²	Cobalt Oxides and Hydroxides ³	
(tonnes)						
1975	1 354	431	561	123
1980	2 118	325	1 091	2	26	105
1981	2 080	677	601	24	20	101
1982	1 274	585	212	2	30	81
1983	1 410	885	192	45	30	101
1984	2 123	1 487	373	14	27	113
1985	2 067	1 551	268	36	192	101
1986	2 297	1 805	374	20	31	96
1987	2 490	1 875	440	45	38	120
1988	2 398	3 062	953	98	37	159
1989	2 344	3 262 ^r	371	22	33 ^r	147
1990	2 184	3 039	391	—	73	194
1991	2 171	3 456	459	—	42	166
1992	2 223	2 963	489	—	64	205
1993	2 150	3 581	394	—	52	187
1994	1 846	3 922 ^r	204	—	81	193
1995 ^p	2 126 ^a	4 206	—	—	41	..

Sources: Natural Resources Canada; Statistics Canada.

— Nil; .. Not available; **p** Preliminary; ^r Revised.^a Revised production numbers for 1995 were made available as of January 11, 1996.¹ Production includes recoverable cobalt in concentrates shipped. ² Cobalt content. ³ Gross weight.⁴ Consumption of cobalt in metal, oxides and salts.**TABLE 3. WESTERN WORLD COBALT PRODUCTION, 1992-95**

	1992	1993	1994	1995 ^p
(tonnes)				
Falconbridge	2 300	2 414	2 823	2 804
Gécamines	6 625	2 200	3 300	4 146
Inco	1 465	1 410	1 130	1 362
OMG	2 100	2 200	3 000	3 610
ICCI	686	1 218	1 820	1 730
Sumitomo	105	190	161	222
ZCCM	4 610	4 211	2 639	2 934
Total	17 891	13 843	14 873	16 808

Source: Cobalt Development Institute.

^p Preliminary.