Nickel

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The trend of declining nickel prices seen since March 1997 continued throughout 1998, reaching a low of US$3715/t on December 15. The effects of Asian financial problems translated into decreased demand in that region, especially in Japan. Various producers announced production cuts during the year, but these announcements did not halt the price decline. Demand declined by an estimated 10 000 t while finished nickel production increased by an estimated 6000 t relative to 1997.

CANADIAN DEVELOPMENTS

Canadian mine production of nickel (i.e., nickel contained in concentrates produced) was 200 908 t in 1998, up 11% from a revised figure of 180 624 t in 1997 (Table 1). Quebec became a nickel producer again (16 035 t) as the Raglan mine began commercial production in April. Primary nickel output in Canada was 144 323 t in 1998, compared to 131 639 t in 1997 (Table 1).

Canadian exports of nickel in 1998 were 228 000 t valued at $1.9 billion. This compares with 208 000 t in 1997 valued at $ 2.1 billion, reflecting stronger prices in 1997. Nickel matte exports accounted for 40% of nickel export earnings, unwrought unalloyed nickel for 43%, and nickel powders for 9%. Canadian imports of nickel declined to 70 000 t valued at $419 million. The main nickel import was nickel matte, accounting for 57% of nickel imports by value. When imports are subtracted from exports, the net export earnings were $1.5 billion, down slightly from 1997's value of $1.6 billion.

Falconbridge Limited operated nickel-copper mines in Sudbury, Ontario, and northern Quebec. The concentrate from the Sudbury mines was smelted in the company's smelter near Sudbury. The resulting matte was shipped to Falconbridge's Norwegian refinery where nickel, copper, cobalt and precious metals were recovered. The company also has a subsidiary in the Dominican Republic that produces ferronickel.

Falconbridge is considering new nickel projects in New Caledonia and Ivory Coast. In addition to its nickel-copper and ferronickel operations, the company has copper and zinc facilities, including mines, mills, smelters and refineries, in Ontario and Chile. Noranda Inc. owned 49.9% of Falconbridge at year-end. (Falconbridge's web site[1] is located at http://www.falconbridge.com/.)

Falconbridge's Raglan mine, which began initial production in December 1997, was officially inaugurated in mid-July. In the third quarter, the $500 million project reached its design capacity of 21 000 t/y of nickel, 5200 t/y of copper and 200 t/y of cobalt contained in concentrate. Raglan produced 16 345 t of nickel in concentrate and 4345 t of copper in concentrate in 1998. The concentrate is shipped from Deception Bay, 100 km north of the mine, to Québec City and then railed to Falconbridge's Sudbury smelter. The smelter in Sudbury produced matte containing 70 152 t of nickel and 31 658 t of copper in 1998, including material from Raglan.

Raglan's reserves were 19 Mt grading 2.85% nickel and 0.77% copper. A number of other companies have discovered various nickel deposits in the area near Raglan; when nickel prices recover, it is expected that Raglan's ability to increase production will be closely examined.

Inco Limited operates nickel mines, mills, smelters and refineries in Sudbury, Ontario, and in Thompson, Manitoba, as well as a copper smelter and refinery in Sudbury and a cobalt refinery in Port Colborne, Ontario. The company produces refined nickel in Canada and at Clydach in the United Kingdom. Inco recycles nickel-cadmium (Ni-Cd) batteries at its subsidiary, The International Metals Reclamation Company, Inc. (INMETCO), based in the United

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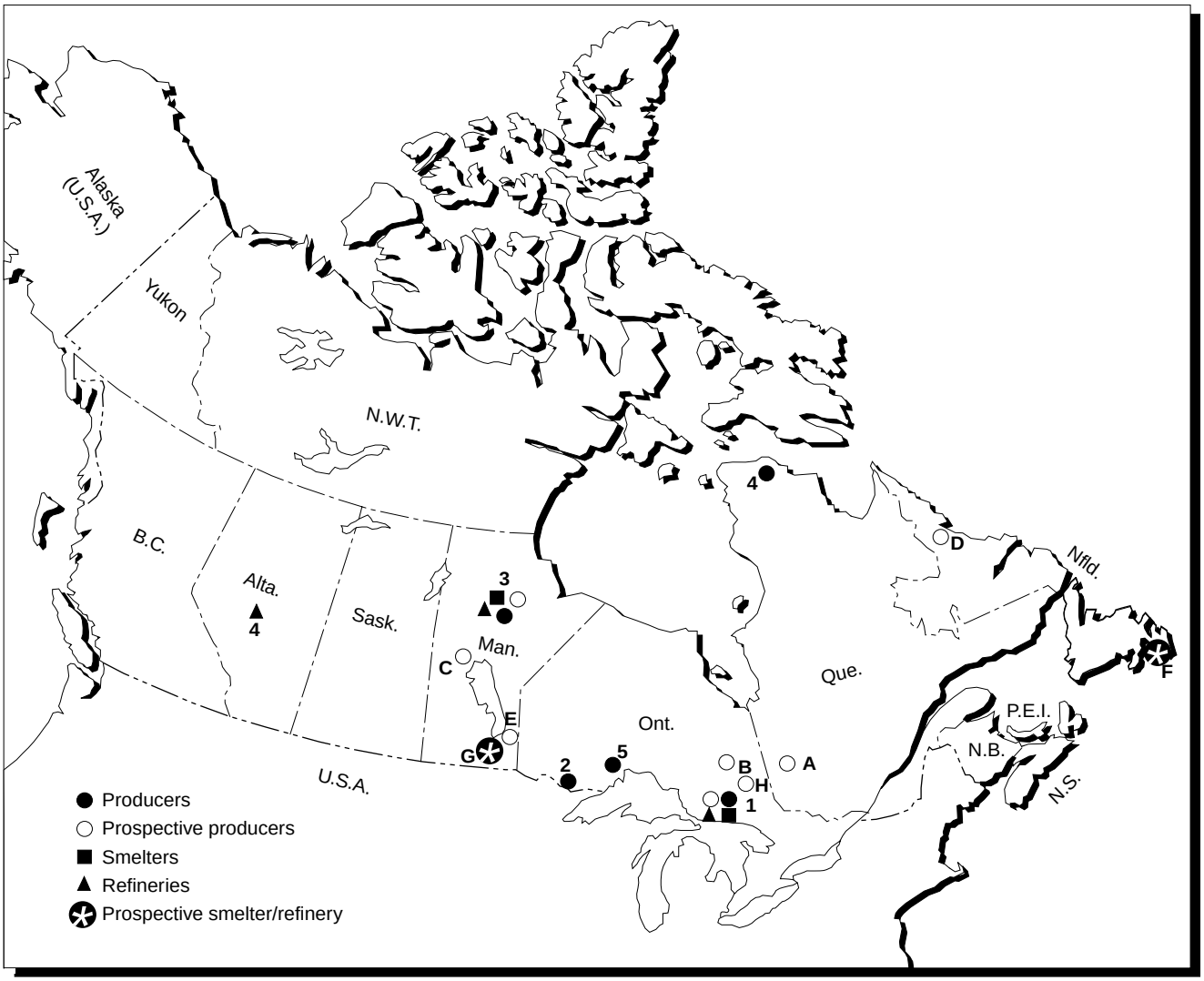
[1] The exact internet address (URL) does not include those periods, brackets, etc., that form part of the sentence's punctuation.

Figure 1

Nickel in Canada, 1998



Numbers refer to locations on map above.

PRODUCERS

1. Falconbridge Limited (Fraser, Lindsley, Onaping-Craig, Lockerby, Strathcona)
   Inco Limited (Coleman, Copper Cliff North, Copper Cliff South, Crean Hill, Creighton, Frood, Little Stobie, McCreedy East, Levack-McCreedy West, Garson, Stobie, Whistle Open-Pit)
2. Inco Limited (Shebandowan)
3. Inco Limited (Thompson, Birchtree)
4. Falconbridge Limited (Raglan)
5. North American Palladium Ltd. (Lac-des-Îles)

SMELTERS

1. Falconbridge Limited (Falconbridge)
   Inco Limited (Copper Cliff)
3. Inco Limited (Thompson)

REFINERIES

1. Inco Limited (Sudbury)
3. Inco Limited (Thompson)
4. Sherritt International Corporation (Fort Saskatchewan)

PROSPECTIVE PRODUCERS

A. Timmins Nickel Inc. (Dumont)
1. Inco Limited (Murray, Totten, Gertrude)
B. Outokumpu Mines Ltd. (Moncalm Township)
   Timmins Nickel Inc. (Langmuir)
   Black Hawk Mining Inc. (Redstone)
3. Inco Limited (Pipe No. 2)
C. Black Hawk Mining Inc. (Minago)
D. Inco Limited (Voisey's Bay mine site)
E. Canmine Resources Corporation (Maskha)

PROSPECTIVE SMELTER/REFINERY

F. Inco Limited (Voisey's Bay smelter/refinery), Argentia
G. Gossan Resources Ltd., Selkirk (master alloy)
H. Cobatec Ltd. (cobalt)

States. It also owns 59% of a large ferronickel operation in Indonesia, P.T. International Nickel Indonesia Tbk. (P.T. Inco). Inco's other interests in Asia include: a 51% interest in Tokyo Nickel Company, Ltd. in Japan; a 49.9% interest in Taiwan Nickel Refining Corporation; a 25% interest in Korea Nickel Corporation in South Korea; and a 65% interest in the joint-venture company Jinco Nonferrous Metals Co., Ltd. in China, of which the Jinchuan Nonferrous Metals Corporation owns the remaining 35%. Inco's principal product is nickel in various forms, including premium foams and alloys. Other co-products and by-products sold by Inco include: copper, cobalt, gold, silver, platinum group metals, selenium and tellurium, sulphuric acid, and liquid sulphur dioxide. Inco has a web site at http://www.inco.com/ that also includes information about Voisey's Bay Nickel Company Limited (VBNC).

Because of objections by the U.S. Department of Justice, Inco could not sell its U.S. subsidiary Inco Alloys International, Inc. (IAI) to Haynes Holdings, Inc. Instead, Inco sold IAI to Special Metals Corporation for US$365 million before fees, taxes and expenses.

Inco announced a major capital and cost reduction program in February. By July, the company announced that it had surpassed its target of reducing costs by US$165 million per year and that cost reductions totalling US$215 million per year were possible. Also in July, Inco announced that its target for labour force reduction of 1175 had been exceeded; company officials noted that as many as 1000 additional job cuts could occur by mid-2000 to mid-2001.

To cut costs and reduce personnel, Inco shut down some mines, cut back on development at other mines, and mined higher-grade ore. The Whistle mine was closed shortly after the announcement of the cost reduction program in November 1997. Inco then shut down the Shebandowan mine near Thunder Bay, Ontario, in the first half of 1998. The scheduled closing of other mines in Ontario was announced in July. Table 10 shows the production rates for the Inco mines in the Sudbury area and their scheduled closing date, where appropriate. The Garson mine, a "marginal mine," achieved its cost-reduction target; Inco announced in October that Garson would continue to operate. There was no announcement in 1998 about the fate of the Stobie mine, another "marginal mine."

In Manitoba, Inco put the Birchtree Lower program on hold pending analysis of its competitive position. By year-end, no further information was available on the status of the Birchtree Lower program, a project that is intended to supply an important portion of the nickel feed to the Thompson smelter in the medium term.

In its second-quarter results, Inco announced plans to reduce finished nickel production at its Ontario operations from 100 000 t/y to 80 000 t/y of nickel over a two- to three-year period. In October, an Inco spokesman forecast that Inco's nickel production, including production from Indonesia, would reach 425 million lb or 192 800 t. In its report of fourth-quarter results, Inco reported total company production in 1998 at 191 603 t, of which 35 500 t was from P.T. Inco.

With the reductions in mine output, Inco has spare smelting and refining capacity available in Canada. In November, Inco entered into an agreement with Jubilee Gold Mines NL for Jubilee to supply 10 000 t/y of nickel in concentrate over three years from its Cosmos deposit. Jubilee has until September 30, 1999, to decide whether to proceed.

In December 1997, VBNC filed its Environmental Impact Statement (EIS) explaining the consequences of the construction, operation and closure of a mine, mill and associated infrastructure. On February 20, the assessment panel extended the period for comments by 30 days to March 31, 1998. On May 1, the panel announced that VBNC had not provided sufficient information in a number of areas and the panel requested further details from VBNC. That information was provided by VBNC and the panel set the period of June 1 to July 16 for interested parties to make comments to the panel. On July 30, the panel concluded that the information submitted by VBNC was adequate to support meaningful discussions of the project at public hearings. The five-person panel held public hearings at various locations in Newfoundland and Labrador from September 9 to November 6. In January 1999, the panel requested additional time to complete its report. At the time of writing, the final recommendations from the panel to the federal and provincial governments were expected to be made public at the end of March 1999. Please refer to the Canadian Environmental Assessment Agency's web site at http://www.ceaa.gc.ca/panels2/voisey/index_e.htm for more current information.

In 1997, a court action was initiated by The Citizens Mining Council of Newfoundland and Labrador to force the environmental hearing of the VBNC mine/mill project in Labrador to include an evaluation of the nickel smelter and refinery planned for Argentia in the assessment of the mine/mill. The case was heard in a Federal Court in Vancouver in March 1998. As of mid-February 1999, a decision by the Court was still pending.

Exploration at Voisey's Bay continued throughout the year. VBNC completed nearly 52 000 m of diamond drilling; exploration expenses totalled US$13 million. In addition to drilling in order to identify near-surface deposits, to investigate deep targets, and to

locate extensions to identified resources, VBNC drilled geophysical targets (such as the Red Dog grid) and started a program to drill the Kiglapait property, 60 km north of the site. A revised statement of ore reserves is shown in Table 9. An updated estimate of total resources is planned for mid-1999.

VBNC continued to negotiate separate Impact and Benefits Agreements (IBAs) with both the Labrador Inuit Association (LIA) and the Innu Nation during the first and second quarters of 1998. Negotiations were said to be principally directed at the questions of shipping schedules, shipping routes, and the financial participation of the LIA and Innu in future revenues from the deposit. During the fourth quarter, no formal IBA negotiations took place.

The province wants a commitment from Inco to build a nickel smelter and refinery, but Inco's view is that such a project is not viable, especially with low nickel prices. Part of Inco's difficulty is due to its inability to explore underground before the environmental review is completed (the result of a court decision in 1997); consequently, projects were costed upon only the Ovoid reserves. Inco announced in its second-quarter report, released in early July, that it could commit to mine only the Ovoid orebody and process the concentrates in its facilities in Ontario and Manitoba. Further processing facilities (e.g., a smelter) were to be evaluated once additional exploration was completed. At the end of July, the province broke off confidential negotiations with Inco, principally over the issue of further processing in the province. In November, the provincial government introduced amendments to *The Mineral Act*. These amendments removed ambiguities about the province's ability to require that a mine's output be smelted and refined in the province. The province also sought to reduce its exposure to legal challenge when enforcing such a requirement. The amendments became law in mid-December.

Also in December, negotiators for the Government of Canada, the Government of Newfoundland, and the LIA reached a tentative agreement on all components of an agreement in principle (AIP). As of the end of 1998, the document was subject to legal and technical review before being presented to the principals for approval. Components of the tentative AIP include aspects announced in November 1997: Labrador Inuit surface ownership of 15 700 km^2, including a 25% share of the province's resource revenues from mining and oil and gas developments on those lands; and co-management on a further 56 000 km^2 with a royalty-sharing scheme for developments on those lands. It also provides for Inuit self-government, harvesting rights and other management rights. Once the AIP has been ratified by all three parties, negotiations towards a final agreement can begin.

Sherritt International Corporation continued the debottlenecking of its nickel-cobalt refinery. Sherritt and General Nickel Company S.A. of Cuba each have a 50% interest in a joint-venture operation that operates a lateritic nickel mine in Cuba and a hydrometallurgical nickel-cobalt refinery at Fort Saskatchewan, Alberta, with a capacity of 27 000 t/y of refined nickel. The mine output is converted to sulphide concentrate in Cuba, shipped to Canada by boat, and then railed to Fort Saskatchewan for final processing. Sherritt produced 20 428 t of nickel and 1962 t of cobalt in the first nine months of 1998, up 6% from the 19 332 t of nickel produced and up 16% from the 1692 t of cobalt produced in the same period in 1997.

Dynatec Corporation is an independent, public Canadian company that now provides the metallurgical services previously offered by Sherritt International Consultants Inc. Of special significance to the nickel industry is the pressure-acid-leach (PAL) technique being commissioned by Anaconda Nickel Limited at its Murrin Murrin operation in Australia. This technology is also being adapted for potential use in New Caledonia (Calliope Minerals Corporation), the Philippines (Mighty Beaut Mineral Inc.), Indonesia, central Africa, and a number of other locations where laterite deposits are being evaluated for the commercial production of nickel and cobalt. (Additional information can be obtained from Dynatec's web site at http://www.dynatec.ca.)

North American Palladium Ltd. (NAPL) operates an open-pit palladium mine near Thunder Bay, Ontario. It produces by-product platinum, nickel, copper and gold. The mine increased its operating rate in 1997 after connecting to the provincial power grid and completing construction of a new crushing system. The mine's reported nickel production for the first nine months of 1998 was 311 t. A scoping study was under way at year-end on a proposal to expand operations from 2720 t/d (3000 st/d) to 9070 t/d (10 000 st/d) in order to process lower-grade ore. The study is expected to be completed in the first quarter of 1999. A $1.1 million exploration program was launched in 1998. Regional exploration targetted Wakinoo Lake and Buck Lake; at the mine property, an extension of the mineralized zone was identified. Additional information can be obtained from North American Palladium Ltd.'s web site at http://www.napalladium.ca/.

Cobatec Ltd., formerly Ego Resources Limited, tried to get its cobalt recovery plant in Cobalt, Ontario, into operation in 1998. During 1997, the company signed a long-term contract with Cuba to import and process cobalt-nickel sulphate precipitates from Cuba. However, after producing only minimal amounts of cobalt and nickel, the operation filed for protection under the Canadian *Bankruptcy and Insolvency Act* in October to give it time to try to restructure its finances and debt. This did not succeed and the plant was closed.

In December, Gossan Chrome Corp., a subsidiary of Gossan Resources Ltd., agreed to lease an idled 6-MW silicon smelter in Selkirk, Manitoba, from Manitoba Hydro for 15 years. The smelter will be converted to produce chrome-nickel master alloy, and the power may be increased to 9 MW. Gossan may use the furnace to process chromite from its Bird River chrome deposits near Lac du Bonnet approximately 110 km away, or could import chrome-bearing material. Gossan is expected to obtain its nickel from purchased concentrates. A master alloy containing about 5000 t/y of contained nickel would be sold to the stainless steel industry. Gossan has two renewable options on the smelter, each for 15 years, as well as an option to purchase that can be exercised during the period 2000-05. Gossan expects to spend $10 million to convert the smelter. The start-up date has not been fixed as this depends upon the outcome of the permitting process. (Gossan has a web site at http://www.gossan.ca.)

Canmine Resources Corporation announced its intention to proceed with its Maskwa deposit in Manitoba at the former Dumbarton mine site, which was operated by Maskwa Nickel Chrome Mines Ltd. Canmine must obtain a permit from the Manitoba Department of Environment before developing and opening the mine. Canmine's application to that department is expected to be filed in the second half of 1999. The indicated reserves as of the end of 1998 were 3 Mt grading 1.27% nickel and 0.21% copper, plus contained cobalt, platinum and palladium. The underground mine would have a life of 10 years if mined at a rate of 300 000 t/y. Subject to permitting, plans call for mine construction to begin in the second half of 1999 with a new 1000-t/d mill to be commissioned by early 2001. Planned output would be about 3400 t/y of contained nickel; the mill would produce separate nickel and copper concentrates. Elsewhere, Canmine will begin drilling at its BINCO nickel project located northeast and west of the Thompson Nickel Belt in Manitoba. Canmine acquired the ground in 1996 and 1997 after new aeromagnetic maps were released by the Geological Survey of Canada (part of Natural Resources Canada). The company plans to begin drilling in mid-1999, targetting a magnetic lineament that appears to run from the Thompson area in Manitoba to the Ungava Nickel Belt in northern Quebec. Drilling in 1998 at Osik Lake revealed a large ultramafic peridotite body. The company's web site is located at http://www.canmine.com.

WORLD OVERVIEW

Russia

The major nickel producer in Russia and the largest in the world is Rossiskoe Aktionernoe Obshestvo Norilsky Nikel (RAO Norilsk Nickel). This holding company has four operating subsidiaries of which the largest and most important is the Norilsk Mining and Metallurgical Combinat located in the Taymyr Region in the northern part of the Krasnoyarsk territory of Siberia. RAO Norilsk produced 219 000 t of nickel, 373 000 t of copper and 4330 t of cobalt in 1997. In the first half of 1998, production was up 6% for nickel, 1.5% for copper and 7.4% for cobalt.

Russian nickel exports to destinations outside the C.I.S. were 191 700 t for the first 11 months of 1998, down 5%, or 10 500 t, from the same period in 1997. Exports in 1997 totalled an estimated 215 000 t, of which perhaps 15 000 t likely came from stockpiles. Part of the reason for the high exports is the continued low domestic demand, which fell from 200 000 t in 1990 to 22 000 t in 1997.

RAO Norilsk needs to modernize equipment and invest in the development of new mining areas. Efforts to secure financing were complicated by the devaluation of the rouble in August, continued low nickel prices, continued responsibility for social costs in the town of Norilsk, and delays in obtaining export quotas for platinum group metals. Capital investment and refurbishment expenses in the first half of 1998 were 640 million roubles (US$106 million), or only 40% of planned investments. In November, the total investment needed at the Norilsk Combinat by 2000 was estimated at US$1.7 billion, with a further US$2.6 billion needed by 2010.

The Norilsk Combinat is accessible only by air or Arctic shipping. This integrated complex operates seven mines, two concentrators, and smelters and refineries. It produces nickel and copper cathodes, copper anodes, refined cobalt, and platinum group/precious metal concentrates. As well, the Norilsk Combinat sends nickel and copper in ore and matte to RAO Norilsk's two subsidiary operations in the Kola Peninsula for further processing. Materials are transported by Arctic shipping via the port of Dudinka on the Yenisei River. About 100 000 workers were employed at the Norilsk Combinat at the beginning of 1998. In September, management and the unions agreed to reduce employment levels to 90 000 by year-end through voluntary departures and a hiring embargo. At the end of 1996 the Norilsk Combinat employed an estimated 140 000 workers.

RAO Norilsk's Severonickel subsidiary in Monchegorsk exhausted its mine reserves in 1977. Severonikel processes nickel-copper ore and nickel matte from the Norilsk Combinat. The subsidiary's facilities include an Outokumpu flash smelter, converting facilities, and copper and nickel refineries. In June, a corporate tax collection commission ordered Severonikel to pay 250 million roubles in back taxes and 400 million roubles in fines. Severonikel disputed the claim, asserting that the government owed it about 250 million roubles in value-added tax

refunds on exports. Severonikel is the major employer for the Murmansk region and provides the region with most of the taxes paid. The back taxes and fines were beyond Severonikel's capacity to pay immediately; a compromise was reached whereby Severonikel could pay the back taxes over time. There were indications that throughput of primary matte at Severonikel could be reduced while, at the same time, the company might offset this by increasing the processing of nickel and cobalt-bearing scrap. In the spring of 1998, Severonikel obtained a tolling contract for nickel- and cobalt-bearing scrap, sludges and turnings from the United States and Europe.

The Pechanganikel subsidiary of RAO Norilsk operates four underground and open-pit mines at Zapolyarny and Nikel in the northernmost part of the Kola peninsula. Unlike those at the Norilsk Combinat, the Pechanganikel deposits do not contain platinum group metals. A concentrator handles the output from the Pechanganikel mines as well as shipments of higher-grade ore from the Norilsk Combinat. Pechanganikel's smelter at Nikel processes the concentrates to produce a copper-nickel matte that is sent to Severonikel for further processing.

There are three other separate, significant nickel producers in Russia: Ufaleynikel Joint Stock Co., the Yuzhralnikel Kombinat Joint Stock Co., and the Rezh Nickel Plant. All of these had difficulties due to the uncertainties in the Russian economy, financing difficulties, and associated problems in obtaining feed material. Their output is believed to be far below their design capacity and below their effective capacity.

Australia

The Murrin Murrin joint venture is owned 60% by Anaconda Nickel Limited and 40% by Glencore International AG. The A$1 billion Stage I plant was 70% commissioned as of mid-December, with the refinery scheduled for commissioning in January 1999. Based upon the Sherritt Acid Pressure Leach, Sulphide Precipitation, Hydrogen Reduction Process technology, Stage I is designed to produce 45 000 t/y of nickel metal and 3000 t/y of cobalt from a feed of 3.75 Mt/y. Initial mining began in March 1998 with ore being stockpiled for subsequent processing. The ore feed in the initial five years of production is estimated at 3.75 Mt/y grading 1.24% nickel and 0.13% cobalt.

During the year, additional reserves were confirmed at Murrin Murrin. The total resource base as of the third quarter of 1998 was 221 Mt grading 1.04% nickel and 0.08% cobalt. This included reserves of the higher-grade Murrin Murrin East orebody of 66.4 Mt grading 1.10% nickel and 0.1% cobalt. In August 1998, Fluor Daniel Pty Ltd. completed the feasibility study for the Stage II plant. The total capital requirement for Stage II was estimated at A$970 million (in addition to the Stage I cost). Stage II would increase the total plant output to 115 000 t/y of nickel and 9000 t/y of cobalt. The operating cost of the combined Stage I plus Stage II facility was estimated by Anaconda to be US$0.35/lb after cobalt credits (based upon cobalt prices of US$6.00/lb). The search for financing of Stage II began in 1998 and is expected to be contingent upon Stage I operating as planned.

A further expansion by Anaconda, involving the Mt. Margaret deposit with inferred resources of 176 Mt grading 0.78% nickel and 0.045% cobalt, was also examined. The plan called for a separate plant with capacity of an additional 45 000 t/y of nickel and 3500 t/y of cobalt to be commissioned in mid-2001. A feasibility study for this plan should be completed in 1999. Operating costs for the three stages (Murrin Murrin I, Murrin Murrin II, and Mt. Margaret) were estimated by Anaconda at US$0.40/lb.

Anaconda then acquired further resources in the third quarter of 1998 by entering into a joint venture with Cobra Resources NL. Anaconda will evaluate and, if feasible, develop Cobra's lateritic resources at the Three Rivers and Marlborough deposits in Queensland and at the Wowo deposit in Papua New Guinea.

In October, Anaconda and Glencore announced a takeover bid for Abednego Nickel Limited after purchasing 19.9% of Abednego shares. Abednego's deposit of an indicated mineable resource of 44 Mt grading 1.18% nickel and 0.083% cobalt is adjacent to Murrin Murrin. Abednego had planned to complete a feasibility study for an operation producing 20 000 t/y of nickel and 1900 t/y of cobalt. The takeover offer was improved and, in December, Abednego directors recommended acceptance.

Resolute Limited sold its nearly completed Bulong nickel project to Preston Resources NL in September for A$319 million. To finance the purchase, Preston's subsidiary, Bulong Operations Pty Ltd., issued US$185 million worth of senior secured notes maturing in December 2008 paying 12.5%. Despite the stated goal of having commercial metal production in October 1998, the plant had not completed commissioning by year-end due to a series of mechanical difficulties. In early 1999, the company announced its intention to produce metal by the end of February 1999. The first stage of the acid pressure leaching/solvent extraction-electrowinning plant has an initial nickel capacity of 9000 t/y and a cobalt capacity of between 700 and 1000 t/y. Plans are being studied to increase production in a possible Stage II expansion, raising the mine's throughput from 540 000 t/y to 2.5 Mt/y. This would yield about 22 000 t/y of nickel and 1500-1700 t/y of cobalt. The proven and probable reserves total 39.9 Mt grading 1.14% nickel and 0.09% cobalt within a resource of 140 Mt grading 1% nickel and 0.1% cobalt.

Centaur Mining & Exploration Limited's US$260 million Cawse project had scheduled commercial metal production for October 1998 but, by year-end, had not achieved this goal. The lateritic ore will be processed by ammonia leaching and electrowinning to produce nickel metal and a cobalt sulphide. Initial feed from higher-grade cobalt areas (grading 1% nickel and 0.68% cobalt) will allow the project to produce about 8000 t/y of nickel metal and 1400 t/y of cobalt in sulphides. Over a one- to two-year period, Centaur plans to ramp up production to between 8000 and 11 000 t/y of nickel and between 1800 and 2000 t/y of cobalt in sulphides. Ore reserves are 30 Mt grading 1% nickel and 0.06% cobalt within total resources of 210 Mt grading 0.76% nickel and 0.04% cobalt.

Preston Resources also owns the Marlborough project in Queensland (near a different deposit known by the same name held by Cobra Resources NL). The global resource at the Marlborough project was 210 Mt grading 1.02% nickel and 0.06% cobalt in 10 separate deposits. The ore can be beneficiated by screening out barren silica, thereby raising the grade of proved plus probable mine reserves to 38.5 Mt grading 1.03% nickel and 0.07% cobalt from 55.7 Mt grading 0.87% nickel and 0.07% cobalt. In September the Queensland government gave its support to the project, declaring it to be a "Major Project," which means it will be fast-tracked. Preston Resources awarded a fixed lump sum price contract of A$545 million to Multiplex Constructions Pty Ltd. for the design, construction and commissioning of the A$640 million Marlborough nickel project. Preston intends to secure financing during 1999.

Jubilee Gold Mines NL (as noted above) has the option of delivering 10 000 t/y of nickel in concentrate or ore to Inco for three years from the Cosmos deposit; Jubilee must decide by September 30, 1999, if it wishes to proceed. Cosmos has a reserve of 420 000 t grading 7.52% nickel plus cobalt. The capital cost to develop the open-pit mine was estimated at $A52 million; construction will take an estimated 36 weeks.

Titan Resources NL, which purchased the Radio Hill property from Resolute Resources Limited in 1997, opened the mine in April 1998. Proven reserves were reported to be 0.98 Mt grading 1.25% nickel, 1.82% copper and 0.11% cobalt in early 1998. Titan signed a five-year agreement with WMC Limited to sell all of its production to WMC's Kambalda smelter.

WMC operates nickel mines in Western Australia, a nickel smelter at Kalgoorlie, and a nickel refinery at Kwinana. The refinery completed its 21-day biannual maintenance shut-down in March; production in the December quarter was a record 15 808 t. The smelter was shut down for 10 days to install hoods on the nickel matte converters intended to route additional sulphur dioxide to the acid plant. The smelter, which produced 100 071 t in 1998, suffered an unplanned shut-down in the first week of 1999. Mill output reached a record 31 461 t in the September 1998 quarter. Throughout the year, WMC continued its drive to cut costs; on September 15, the company announced that three of its highest-cost mines at Kambalda would be put on care and maintenance thereby decreasing its operating capacity by 10 000 t of nickel in concentrate.

In September, Billiton plc made an offer for outstanding shares of QNI Ltd. for 30% over the then current share value. The offer was eventually accepted and QNI will be delisted from the Australian stock exchange. QNI operates a nickel refinery in Queensland that processes imported laterite ores from New Caledonia, the Philippines and Indonesia. The Townsville refinery's capacity is 30 000 t/y of nickel and 2000 t/y of cobalt. QNI also owns the Cerro Matoso ferronickel smelter in Colombia (see below).

In addition, QNI shares an interest in the Maggie Hayes and Emily Ann deposits in Western Australia with LionOre Mining International Ltd., a Canadian company based in Toronto. Subject to regulatory approvals, a plan to rationalize the Australian holdings of LionOre, QNI and Capricorn Resources Australia NL was announced in late 1998. In January 1999, the plan was amended and a new company, LionOre Australia Nickel Limited, would hold 100% of the Emily Ann deposit, 31% of the Maggie Hayes deposit, and certain options and other interests. LionOre would hold 75% of LionOre Australia and would acquire Capricorn Resources Australia NL's 25% interest in the Roundtop Joint Venture in return for LionOre Australia shares. LionOre also owns 41% of Tati Nickel Mining Company (Pty) Ltd. in Botswana (see below) and 22% of Jubilee Gold Mines NL (see above).

New Caledonia

New Caledonian mines produce about 125 000 t/y of nickel in lateritic ore. In 1998, the ore was either exported to smelters and refineries in Australia and Japan, or was processed on the island at the Doniambo smelter of Société Le Nickel-SLN (SLN) of The ERAMET Group.

Inco continued building its US$50 million, 12-t/d pilot plant at Goro to evaluate its proprietary acid pressure leaching and solvent extraction technologies for lateritic ore. The Goro deposit has reserves of 165 Mt grading 1.6% nickel and 0.16% cobalt; it is owned 85% by Inco and 15% by Bureau de Recherches Géologiques et Minières (BRGM) de France. Construction of the pilot plant is scheduled to be completed by mid-1999 after which the process evaluation will begin. An initial mining zone of 47 Mt at an undisclosed grade could supply a commercial operation with an initial capacity of 27 200 t/y of nickel and

2720 t/y of cobalt. In mid-year, Inco's chairman said that the company was considering selling a 20-30% interest in the property; this would reduce the equity that Inco would need to invest to bring the property into production.

An agreement between SLN and Société Minière du Sud Pacifique (SMSP) for exchanging ore reserves was formalized in early 1998. SMSP required larger ore reserves in order to develop a 54 000-t/y ferronickel smelter at the northern end of New Caledonia in alliance with Falconbridge. Under the terms of the agreement, SLN will give up the Koniambo deposit in return for the smaller Poum deposit and financial compensation. Compensation would be set by a commission that would evaluate the swap only after a final decision to proceed with the SMSP-Falconbridge project takes place. Unless this decision is made by January 1, 2005, the two orebodies will revert to their original owners.

In November, New Caledonian voters approved an agreement reached in 1997 allowing the territory to assume increasing autonomy over the next 15 years. A second referendum at the end of that period will allow voters to choose whether they wish to have full self-determination and independence. The power to grant exploration and mining licences will be delegated to local authorities after provincial elections in mid-1999.

In September, SLN announced that it would produce only 57 000 t of nickel compared to its capacity of 63 000 t/y, down 1000 t from the planned 1998 production. SLN plans to cut costs by 15% in three years. SLN and QNI began their feasibility study for a nickel-processing facility on the northern portion of the island. A 20 000-30 000-t/y hydrometallurgical plant to produce an intermediate carbonate nickel-cobalt using limonitic ore as feed is being considered. The intermediates could be sent to QNI's facility in Queensland and to SLN's plant at Sandouville, France, for further processing. The study was apparently delayed and the results were not released in 1998.

Vancouver-based Calliope Metals Corporation changed its plans to build a nickel refinery in Queensland to process imported lateritic ore from New Caledonia using the Sherritt process. Instead, Calliope now wishes to build the refinery at Canala in New Caledonia to process ore from the high-grade Nakety deposit nearby. Final decisions appeared to await the outcome of the commissioning of Murrin Murrin; financing was not yet negotiated by year-end.

Cuba

The Government of Cuba announced in early January 1999 that the three Cuban nickel operations had produced 68 000 t of nickel in 1998. Two of the mines are owned by the government and one is a joint venture involving Sherritt International Corporation and the Cuban government. Cuba forecasts that production in 1999 will reach 73 000 t, which is the nominal capacity of the three operations.

In 1994, Sherritt and General Nickel Company S.A. formed Metals Enterprise, a jointly owned, vertically integrated nickel-cobalt producer. Its business is carried out through three companies: Moa Nickel S.A., International Cobalt Company Inc. (ICCI), and The Cobalt Refinery Company Inc. (Refco). At the mine, lateritic ore is converted to sulphide concentrate by an acid leaching process, while the concentrate is shipped to Canada for further processing. Canada and the European Union object to the *Helms-Burton Law* (Public Law 104-114) in the United States which, among other things, restricts the entry of key Sherritt personnel into the United States and provides rights to sue in U.S. courts.

The Americas

In Brazil in June, Cia Niquel Tocantins announced that its 1998 target for nickel production of 13 000 t (set in April) would be cut to 11 500 t. The company's US$120 million expansion to 17 000 t/y was completed in April 1998; the decision to expand was taken in 1995 when high future nickel prices were forecast. Its cobalt production target was set at 360 t, compared to its capacity of 500 t/y.

At the start of September, Falconbridge announced that its subsidiary Falconbridge Dominicana, C. por A. (Falcondo) in the Dominican Republic would be shut down for three months beginning October 25. This resulted in a production cut of 8000 t/y while maintenance at the Bonao smelter and power plant was undertaken. Because the furnace had suffered corrosion problems, the plant had been running at 80% of capacity during 1998 prior to the shut-down. Hurricane Georges caused an unscheduled shut-down in late September, resulting in an additional loss of 800 t of nickel in ferronickel. Production in 1998 was 28 053 t of nickel in ferronickel, down from 32 425 t in 1997.

In the United States, Cominco Ltd. announced at the end of January 1998 that its subsidiary, Glenbrook Nickel Co., would close due to low nickel prices. The plant closed in March when ore stockpiled at the ferronickel smelter was exhausted. Production totalled about 4300 t of nickel in ferronickel.

The de-bottlenecking of QNI's Cerro Matoso operations (mine and ferronickel smelter) in Colombia continued in 1998. Capacity will be increased from 25 000 t/y of nickel in ferronickel to 35 000 t/y by the year 2000. Production was running at 9% above 1997 levels for the first 11 months of 1998. Once the de-bottlenecking is completed at Cerro Matoso, QNI will examine the feasibility of expanding its capacity to

55 000 t/y of nickel in ferronickel by 2002/03 at a cost of US$330 million.

Africa

Falconbridge Limited continued exploration work on the Touba-Biankouma laterite nickel property in Ivory Coast. Falconbridge is earning a 60% interest in the joint venture; the other partners are Trillion Resources Ltd. of Canada (15%) and the Government of the Ivory Coast (25%). Development plans were submitted to the Government in mid-1997. A US$15 million program of exploration and metallurgical testing took place during the 1997/98 period. (Trillion Resources has a web site at http://www.trillion-resources.com/.)

The Tati Nickel Mining Company (Pty) Ltd. is owned 42% by LionOre, 43% by Anglo American Mining Corporation of South Africa Limited, and 15% by the Government of Botswana. The estimated reserves were increased from 39.7 Mt grading 0.5% nickel to 145 Mt grading 0.34% nickel during 1998. With the increased ore reserves, the company plans to build a concentrator. Tati's smelter produces about 9000 t/y of nickel matte and ships it to the Empress refinery in Zimbabwe.

Bindura Nickel Corporation Ltd. laid off 11% of its work force, or 445 workers, in January to cut costs due to lower nickel prices. In August, Bindura announced that it would close its Epoch mine in 1998 and its Madziw mine in 1999. Over a two- to three-year period, production will be increased at the Trojan and Shanghai mines to compensate for the production losses due to closure of the other mines. The effective capacity of the smelter and refinery was increased in mid-1998 to handle 8000 t of high-grade nickel concentrate imported from Australia.

Asia

China produced an estimated 40 000 t of nickel in 1998, approximately the same as in 1997. China imports about 600 000 t of stainless steel containing about 50 000 t of nickel. The majority of China's nickel is produced by the Jinchuan Nonferrous Metals Corporation in Gansu Province.

The largest nickel producer in Indonesia is P.T. International Nickel Indonesia Tbk. (P.T. Inco), which is owned 59% by Inco Limited. During 1998, work continued on its 50% expansion to 68 000 t/y of nickel contained in matte. The expansion includes an increase in the capacity of the hydro-electric facilities to 258 MW. Targetted production for 1998 was 45 350 t, but lingering drought effects reduced actual production to 35 500 t. Higher production is expected in 1999 as the expansion is brought on line, and the plant is expected to operate at its full capacity rate of 68 000 t/y during the year 2000.

P.T. Aneka Tambang (Persero) Tbk. operates two lateritic nickel mines, one at Gee Island and one at Pomalla on Sulawesi Island, as well as two smelters with a combined capacity of 11 000 t/y on Sulawesi Island. In June, the company announced that it would close one of its smelters from August 1988 to February 1999 for maintenance and upgrading. This decreased its production forecast for 1998 to 8400 t of nickel in ferronickel. Aneka Tambang also has plans to build a third smelter with a capacity of 13 000 t/y of nickel in ferronickel. Bids were received for engineering, procurement and construction. The estimated capital cost of the project is between US$200 million and US$240 million for a plant to be commissioned in 2001. A decision on the bids is expected in the first quarter of 1999. Aneka Tambang negotiated an off-take agreement for 30% of its planned 24 000 t/y output of nickel in ferronickel. (Aneka Tambang has a web site at http://www.antam.co.id/.)

Aneka Tambang also owns 10% of the Weda Bay project, which is managed by Weda Bay Minerals Inc., a Canadian company. The prefeasibility study indicated that a mine/plant with a capacity of 30 000 t/y of nickel and 1350 t/y of cobalt could be built for US$600 million based upon the Sherritt acid-pressure leach technology. The deposit on Halmahera Island in Indonesia has an indicated resource of 63.8 Mt grading 1.51% nickel and 0.09% cobalt, including a cobalt-rich section of 10 Mt grading 0.82% nickel and 0.19% cobalt. A subsequent press release indicated that a production rate of 3 Mt/y of ore yielding 45 000 t/y of nickel and 5000 t/y of cobalt was being considered. A 3-t bulk sample was tested by Dynatec in Fort Saskatchewan and the recoveries were 98% for nickel, 96% for cobalt and 98% for scandium. The project is seeking financing for a full feasibility study. (Weda Bay's web site is at http://wedabay.com.)

Highlands Pacific Ltd. and Nord Pacific Limited completed a bankable feasibility study of the Ramu project in Papua New Guinea (PNG). The study concluded that a mine and hydrometallurgical facility with a capacity of 33 000 t/y of nickel plus 2800-3200 t/y of cobalt in salts could be built for US$838 million, including US$200 million for infrastructure. The estimated operating cost is US$1.38/lb, or US$0.41/lb after cobalt credits (based upon a cobalt price of US$10/lb). The total resource is estimated at 144 Mt grading 1.01% nickel and 0.1% cobalt; the measured and indicated resources total 72 Mt at an undisclosed grade. The PNG government has the right to obtain a 30% share in the project after sunk costs are recovered. The owners hope to commit to construction in 1999 and to see first metal production by the end of 2001. (Nord's web site is located at http://www.nordpacific.com/np-home.html, while Highlands Pacific's web site is at http://www.highpacific.com.au/.)

The continued decline in nickel prices affected the planned rehabilitation of the Nonoc lateritic mine and nickel smelter in the Philippines. Plans to reactivate the refinery, which has been shut down since 1986, using the original ammonia leach process were shelved; studies of pressure acid leaching indicated that metal recoveries could be increased from 80% or less to 90%. A bankable feasibility study began in mid-1998. Mine reserves are sufficient to sustain 20 years of operation at 3.5 Mt/y averaging 1.24% nickel and 0.12% cobalt. These reserves would be supplemented by higher-grade ore from a new mine in Manicani Island, Mindanao. The estimated rehabilitation cost is US$650 million.

In Japan where stainless steel producers reduced production due to low domestic demand and reduced exports caused by the Asian financial crisis, Japanese nickel and ferronickel producers also announced production cuts. Sumitomo Metal Mining Co., Ltd. (SMM) announced decreases in nickel and ferronickel production in early October. SMM's target output for the last six months of its fiscal year ending March 31 was 13 000 t of nickel and 7000 t of nickel in ferronickel, down from 15 000 t of nickel and 9000 t of nickel in ferronickel for the first half of the fiscal year. In late October, Nippon Yakin Kogyo Co., Ltd. cut its monthly ferronickel production from about 1050 t to approximately 750 t of contained nickel. In the same month, Nippon Steel Corporation announced that its stainless steel production in the last quarter of calendar year 1998 would be 45% below the first quarter of the year. In November, Pacific Metals Co., Ltd. announced that its ferronickel output would be cut from 26 000 t of nickel in ferronickel in the first half of the 1998/99 fiscal year to 19 000 t.

Europe

At the end of June, Outokumpu Oyj lost 10 weeks of production due to an accident at its nickel smelter in Finland. The smelting and refining facilities at Harjavalta were expected to produce over 42 000 t of nickel compared to 35 000 t in 1997. Outokumpu mines only about half of the nickel in concentrate that it smelts, most of which is obtained from its operations in Australia. The additional nickel in concentrate is obtained mostly from WMC in Australia. Outokumpu also has a 10-year agreement with Fortaleza to process 10 000 t/y of nickel matte beginning in 1998. (Outokumpu's web site can be found at http://www.outokumpu.com.)

General Mining and Metallurgical Co. S.A. (LARCO) operates a ferronickel smelter at Larymna and laterite mines in Greece. LARCO experienced operational difficulties in December 1997; these difficulties continued and LARCO lost about 2000 t of nickel production during the first quarter of 1998. At year-end 1998, LARCO reduced its operating rate to two thirds of its 18 000-t/y nickel in ferronickel capacity. The Government of Greece plans to privatize the company; tenders for expression of non-binding interest were due on February 26, 1999.

CONSUMPTION

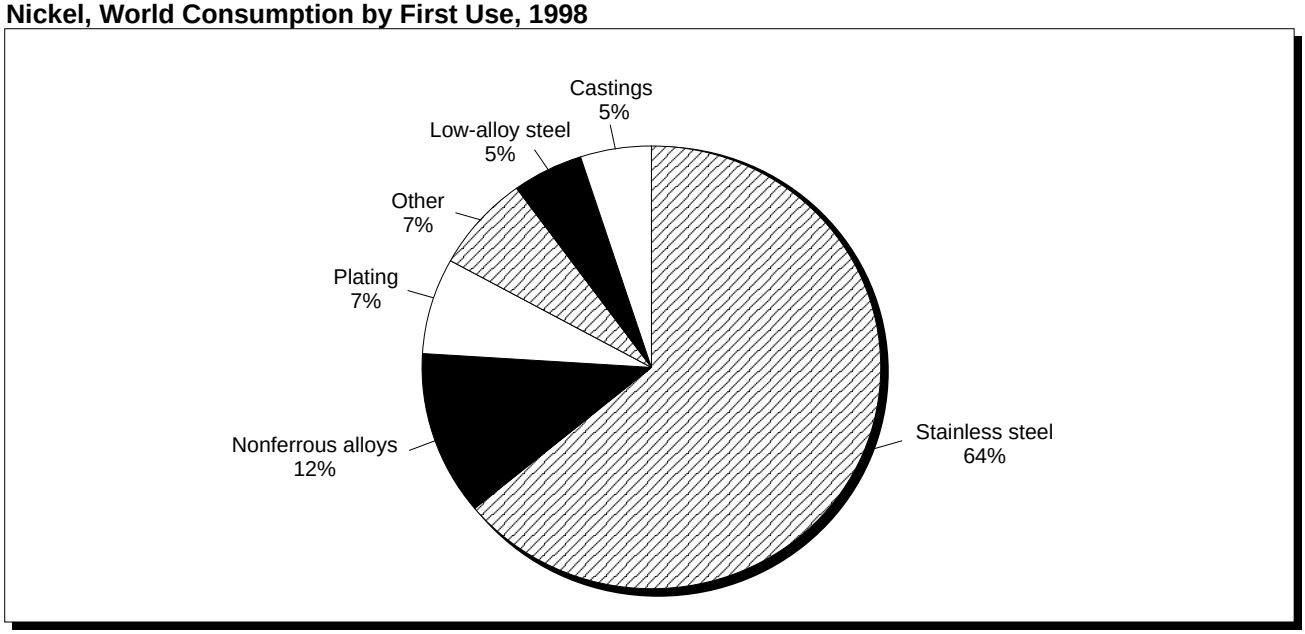
The stainless steel industry is the largest consumer of primary nickel, accounting for about two thirds of consumption. Other important consuming sectors include the nonferrous alloys, plating, low-alloy steel and foundry sectors (Figure 2). Stainless steel is "stainless" or corrosion-resistant because it contains a minimum of 10% chromium by weight. A thin film of chromium oxide adheres to the surface of stainless steel. When damaged, this film is self-healing if sufficient oxygen is present. The presence of nickel gives stainless steel superb resistance to corrosion, even in harsh operating environments. The common form of stainless steel that contains nickel is called "austenitic." Its weldability characteristics are very good, making it a good choice for construction. Austenitic stainless steel has exceptional resistance to extreme temperatures. In addition, austenitic stainless steel is very easily cleaned and therefore has excellent hygienic characteristics.

Stainless steel comes in a variety of grades and types. The most common grade is a 304 grade composed of 18% chromium and 8% nickel. While austenitic stainless steel contains nickel, ferritic stainless steel does not. A guide to these two types of stainless steel as well as others can be found at the web site of the Specialty Steel Industry of North America at the following addresses: http://www.ssina.com/stainless.html and http://www.ssina.com/student.html.

Stainless steel and high-nickel alloys are used in many applications including: gas turbines, petroleum refining, the chemical industry, the food industry, flue gas desulphurization plants, batteries (in both nickel-cadmium and nickel-metal hydride cells), liquified petroleum gas tank liners, cryogenic applications, electronics, surgical equipment, and household goods (such as cutlery, building facings and building trim). Various car manufacturers continued their work on the development of nickel-metal hydride batteries to power electric cars.

Throughout 1998, while producers made painful and public choices to shut down or cut back operations, individual consumers of nickel and stainless steel quietly and independently were finding increased applications, thereby providing a base for healthy future increases in demand. The inevitable price increase that is expected to result from a contraction of supply concurrent with an expansion of demand will be tempered by the prospect of lower-cost nickel laterite production.

Figure 2
Nickel, World Consumption by First Use, 1998



Source: Inco Limited, *Form 10-K*, year ending December 31, 1998.

HEALTH AND THE ENVIRONMENT

Nickel is a naturally occurring element that exists in soil and is believed to make up a large percentage of the earth's core. Nickel is also considered to be an essential element for plants and most animals. It has been proven to be an absolute growth requirement for certain types of bacteria and algae, and nickel deficiencies in animals have been linked to growth retardation. Besides being an essential element for plants and many animals, it is the view of many experts that nickel is likely an essential element for humans as well.

The average human body contains an estimated 7-10 milligrams of nickel, and nickel is present in human fetal tissue. Food is the major route for nickel intake by humans. Ingestion of nickel has not been shown to be either a cause of cancer in humans or a cause of nickel sensitivity. The principal health risks associated with oxidic, sulphidic and soluble nickel compounds include lung or nasal cancer and contact dermatitis.

Nickel dermatitis is caused through long-term direct or indirect contact of the skin with certain nickel-containing items that can dissolve in sweat and penetrate the skin. It is estimated that 10-20% of women and 1-2% of men are "sensitive" to nickel, with nickel dermatitis being one of the principal adverse health effects. However, many nickel alloys, including stainless steel, do not react with sweat and therefore do not cause a nickel allergy.

In the past, increased rates of lung and nasal cancers were experienced by personnel employed in certain dusty nickel-processing facilities where most of the workers involved were also exposed to other substances in the dust, and where tobacco smoking was a compounding factor.

RECYCLING

Nickel is a metal that is intensively recycled. This recycling is driven by economic incentives, not government subsidies. The major competitor for primary nickel's biggest market, stainless steel-making, is nickel in scrap. On a worldwide basis, about 45% of the nickel needed by the stainless steel industry is obtained in the form of stainless steel scrap, or an estimated 450 000 t of nickel in 1997. Stainless steel scrap not only contains nickel but also chrome and iron which are needed to produce stainless steel.

NICKEL ORGANIZATIONS

Fifteen nickel-producing and consuming nations are members of the International Nickel Study Group (INSG) based in The Hague. The Group publishes comprehensive monthly nickel statistics (refer to Table 11 for details). A new directory of nickel mines and plants, including two annual updates, is to be sold starting in mid-1999. The INSG intends to launch its web site in the first half of 1999 and the address will be http://www.insg.org.

The Nickel Development Institute (NiDI), based in Toronto, is funded by most major nickel producers. NiDI provides technical information about nickel alloys to end users and promotes new uses for nickel from offices in Toronto, London, Beijing, Tokyo, India, Australia and South Korea. The organization has a quarterly publication about applications, entitled *Nickel*, with a circulation of 35 000 in over 90 countries. It also publishes *Communiqué*, which is about regulatory developments affecting nickel, twice a year. Both are available free upon request. (NiDI has a web site at http://www.nidi.org/.)

The Nickel Producers Environmental Research Association (NiPERA) conducts and sponsors independent research into the health and environmental effects of nickel and nickel compounds. NiPERA sponsored a workshop on dermal sensitization in the spring of 1997. NiPERA is appealing a decision by a subcommittee of the National Toxicology Program in the United States, which decided in December that all compounds of nickel should be considered as known human carcinogens. NiPERA believes that subcommittee members did not have adequate access to all information about the issue and were not given correct information about the issue upon which they voted. Resolution of the matter is expected in 1999. (NiPERA has a web site at http://www.nipera.org/.)

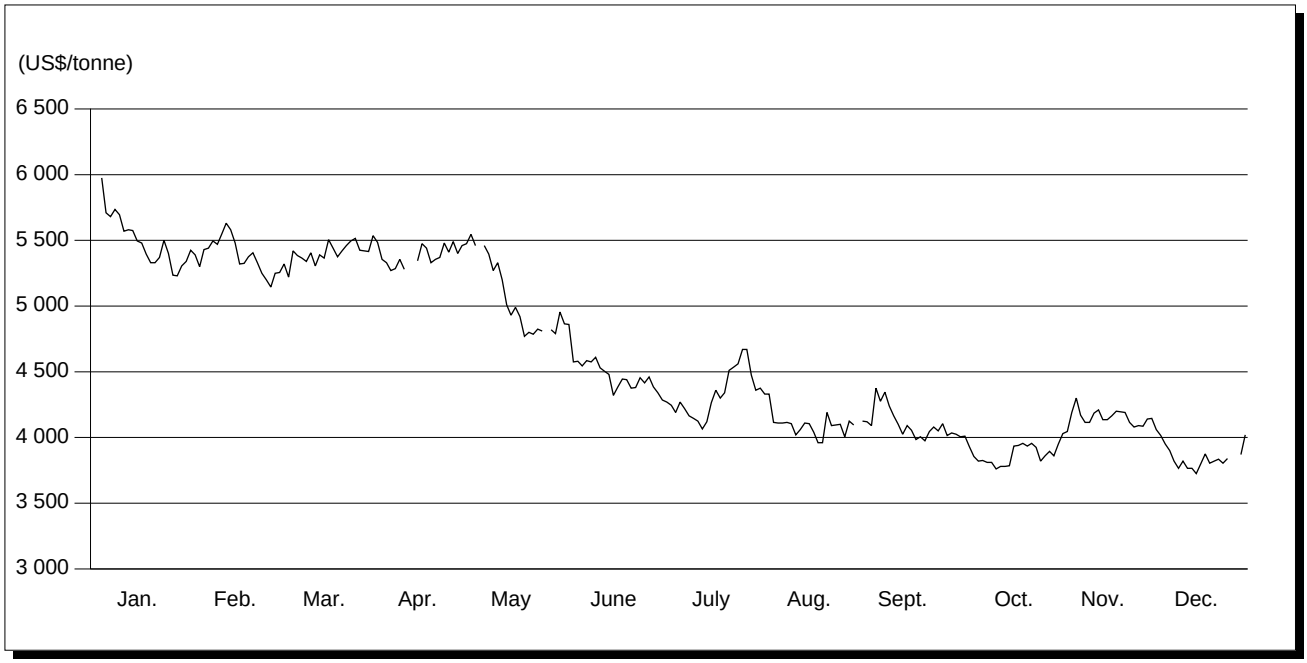
PRICES AND STOCKS

The trend of weakening nickel prices since early March 1997 continued throughout 1998. The London Metal Exchange (LME) cash settlement price declined from US$5975/t (US$2.71.lb) at the start of the year to reach its lowest point of US$3725/t (US$1.69/lb) on December 15. Figure 3 shows the daily cash settlement prices during 1998 and Figure 4 shows daily cash settlement prices for the last five years. Table 7 shows the average yearly nickel prices over the period 1981-98. Table 8 shows the average monthly prices for the period 1994-98. Historical and current LME nickel prices can be found on the Internet at http://www.lme.co.uk and at http://www.metalprices.com.

The LME changed its rules to include the Euro as a permitted currency effective January 4, 1999. Contracts in deutsche marks will not be permitted beyond a prompt date of June 30, 2002. The LME will also permit full plate nickel cathode to be delivered against nickel contracts for a standard US$100/t discount from the price for currently permitted shapes: cut cathode, pellets or briquettes. The US$100/t is said to represent the typical cost to cut cathodes, drum and deliver them to a warehouse.

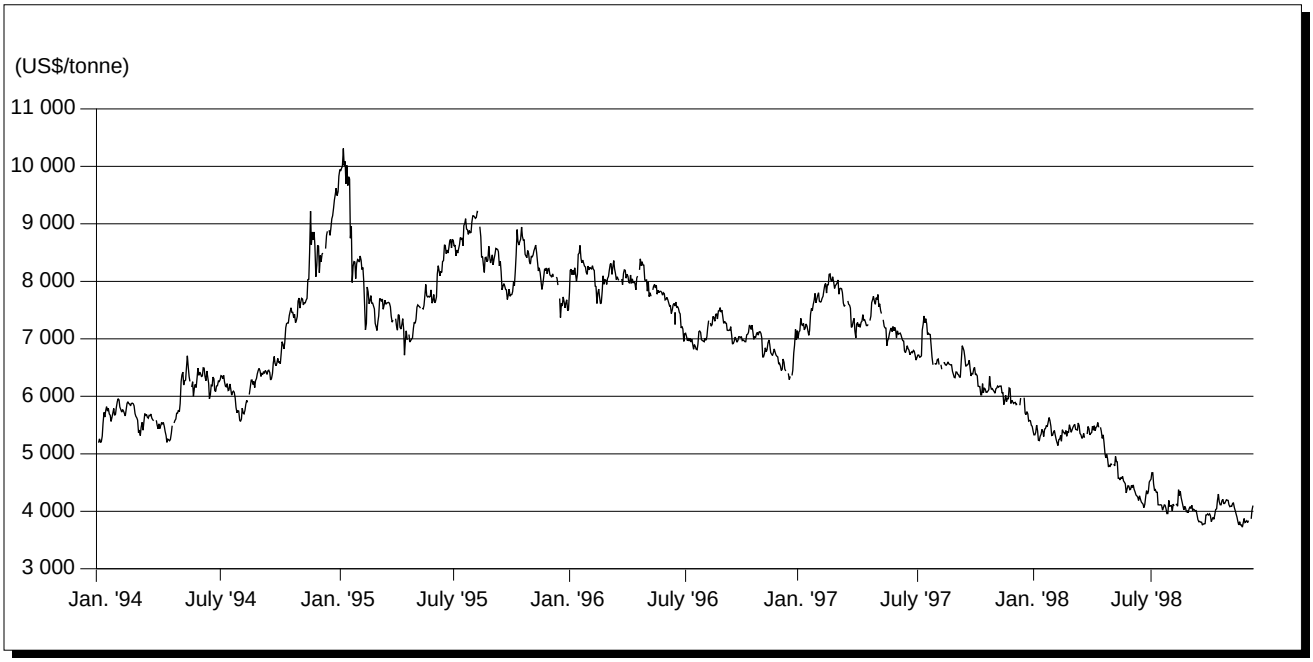
LME stocks did not make dramatic moves during the year. Month-end stocks began the year at 66 500 t;

Figure 3
London Metal Exchange Daily Settlement Nickel Prices, 1998



Sources: International Nickel Study Group; Reuters; World Bureau of Metals Statistics.

Figure 4
London Metal Exchange Nickel Prices, 1994-98



Sources: International Nickel Study Group; Reuters; World Bureau of Metals Statistics.

throughout the year they varied from a low of 59 000 t for June to 66 000 t for December. No shortages of nickel metal threatened customers, although the low prices restricted the supply of nickel available in scrap, most notably in Europe.

OUTLOOK

The demand for nickel is largely a function of the demand for austenitic stainless steel and high-nickel alloy steels. Stainless steel production was estimated to have increased slightly in 1998 to approximately 16.4 Mt. The major factor in nickel and stainless steel demand is the growth in industrial production. Infrastructure growth demands heavy use of stainless steel, and development in Asia is not expected to be stalled indefinitely. The growth rate for austenitic (nickel-containing) stainless steel is expected to exceed that for ferritic (containing no nickel) stainless steel. Presently, about 74% of stainless steel output is austenitic. The demand for primary nickel is expected to continue to increase at over 3% per year on average.

The aggregate non-stainless steel demand for nickel is expected to grow much more slowly. For example, nickel use in iron and steel castings for the automotive industry is expected to decline due to substitution by lower-cost alternatives. However, the automotive industry's demand for nickel may increase rapidly from a small base at present if nickel-metal hydride batteries become the battery of choice for electric and hybrid motor vehicles.

A number of new technologies appear to be vying with each other to become the lowest-cost technology to recover nickel and cobalt from lateritic ores. Australia is the main proving ground at present; its net evaporative climate may give Australia a distinct competitive advantage in managing the residues of hydrometallurgical processing. Sherritt technology is being installed in the Murrin Murrin operation. Sherritt technology is also the choice for the proposed Calliope plant in New Caledonia. Preston Resources NL, which purchased the Bulong project in 1998, will treat ore at its Bulong project with acid pressure leaching and solvent extraction-electrowinning. Centaur will use an ammonia leach and electrowinning process. In New Caledonia, Inco intends to test its proprietary process at its Goro property starting in mid-1999.

With the associated cobalt recovery, such operations have the potential to lower the average operating costs for lateritic nickel producers and reduce overall nickel production costs, putting increased competitive pressures on the rest of the nickel industry. The success of new nickel laterite technologies would also reduce cobalt prices to the US$5-$10/lb range (some guess an even lower price), especially if a number of new cobalt deposits in the Congo also proceed.

Various producers, including Inco, Falconbridge, ERAMET, WMC and LARCO, announced cutbacks in 1998. In early 1999, WMC suffered an early shutdown of its furnace for maintenance, which cut an additional 15 000 t of production scheduled for 1999. Together, these and other cutbacks have moved the market closer to a statistical balance of supply and demand for 1999.

Nickel prices are more volatile than those of other major nonferrous metals. Part of the reason for this is that the nickel industry is very small compared to those other metals. If nickel contained in stainless steel scrap is included, total nickel consumption was about 1.5 Mt in 1998, compared to 6 Mt of lead, nearly 8 Mt of zinc, over 13 Mt of copper and 22 Mt of aluminum. Thus, the forecast for nickel is presented as a range rather than as discreet values by year.

An average nickel price of US$5510/t (US$2.50/lb) is forecast for 1999, based upon continued progress in resolving the financial problems in Asia, continued Chinese economic growth, and a moderately healthy resumption in growth of stainless steel production, but this will not be sufficient to provoke widespread restocking due to supply concerns.

The longer-term price for nickel is expected to range between US$4400-$8800/t (US$2 and $4/lb). This long-term range of average annual prices should gradually decline, by perhaps US$550-$880/t (US25¢-40¢/lb), if new lateritic production technologies operate at or near their predicted rates, recoveries and costs.

While average annual prices for any particular year are expected to fall within this projected price band, unforeseen events at production facilities could cause major supply interruptions and, consequently, substantially higher prices until supply/demand relationships are restored to more normal ranges. Such events would include serious technical problems at leading producers (e.g., extended labour or transportation problems at the Norilsk Combinat) or political problems (e.g., political problems associated with the future of New Caledonia). On the other hand, major new discoveries of high-grade orebodies should lead to a period of lower prices.

It is difficult to say if these prices should be quoted in constant dollars (i.e., inflation adjusted) or current dollars (i.e., dollars of the day). In the longer term, the decline in nickel prices in "real terms" "or constant dollars" is expected to continue because of increases in production efficiency, the application of new technologies, and competitive pressures. There seems to be little reason for changes in prices for this specific industry to mirror the general inflation rate. In the medium term, inflation rates are not expected to be significant; hence, the entry into production of large high-grade deposits or the changing patterns in demand are expected to have more of an effect on nickel prices than is the rate of inflation. In the short term, the size of the nickel inventory compared to demand and the activities of investment funds are expected to be the dominant factors.

Canadian mine production of nickel in concentrate in 1999 is forecast to rise to 205 000 t, with Raglan's output for the entire year at full production expected to more than offset the scheduled decline in Inco's output. Increased prices would allow Inco (and other producers) to restart idled capacity or to defer scheduled closings; therefore, higher prices could result in increased Canadian production. Production by Canmine could start in 2001, but it is expected to be less than 5000 t/y initially. Beyond that, the major uncertainty remains the future of the Voisey's Bay deposit.

With respect to Voisey's Bay, the report of the environmental panel is due on March 31. If the environmental panel recommends that the Voisey's Bay project may proceed with the mine and mill, obstacles still remain. The province and Inco disagree about the economics of building a smelter and refinery in the province. The province's position is that no mining licence will be issued unless a smelter and refinery are included in the proposed project. Land claims between the provincial and federal governments and the two Aboriginal groups in the area have not been completely resolved; the LIA stated in early 1999 that it would not consent to mining until a land claims agreement had been put into effect. A draft agreement in principle between the governments and the Innu Nation was not reached in 1998. Negotiations for separate impact and benefits agreements between Inco and the two Aboriginal groups have not been completed.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of mid-February 1999. (3) To obtain other web site addresses relevant to nickel, please send an e-mail request to bmccutch@nrcan.gc.ca and include the words "web sites for nickel" in the subject line of your message. (4) Various internet sites have been identified in this article. Please note that Natural Resources Canada has no control over the content of the web sites of other organizations, which may be modified, updated or deleted at any time.

NOTE TO READERS

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TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EU MFN	Japan[1] WTO	Brazil MFN	India MFN	Taiwan MFN	Korea[2] MFN
2604.00	Nickel ores and concentrates	Free	Free	Free	Free	Free	Free	5%	5%	Free	1%
2825.40	Nickel oxides and hydroxides	Free	Free	Free	Free	Free	5%	5-13%	30%	2.5%	8%
7202.60	Ferronickel	6.5%	Free	Free	Free	Free	3.9%	9%	20%	Free	3%
7501.10	Nickel mattes	Free	Free	Free	Free	Free	Free	9%	10%	Free	1%
7501.20	Nickel oxide sinters and other intermediate products of nickel metallurgy	Free	Free	Free	Free	Free	Free-51.40 yen/kg[3]	9%	10%	Free	1%
7502.10	Unwrought nickel, not alloyed	Free	Free	Free	Free	Free	51.40 yen/kg	9%	10%	1.25%	3%
7502.20	Unwrought nickel alloys	Free	Free	Free	Free	Free	Free-4.2%[4]	9%	10%	1.25%	3%
7503.00	Nickel waste and scrap	Free	Free	Free	Free	Free	Free	5%	10%	Free	1%
7504.00	Nickel powders and flakes	Free	Free	Free	Free	Free	Free-45.80 yen/kg-3.6%	9%	10%	Free	5%
7505.11	Bars, rods and profiles of nickel, not alloyed	Free	Free	Free	Free	0.9%	3.8%	15%	10%	2.5%	5%
7505.12	Bars, rods and profiles of nickel alloys	Free	Free	Free	Free	3.2%	3.6%	15%	10%	2.5%	5%
7505.21	Nickel wire, not alloyed	Free	Free	Free	Free	0.9%	3.8%	15%	10%	1.25%	5%
7505.22	Wire of nickel alloys	Free	Free	Free	Free	3.2%	3.6%	15%	10%	1.25%	5%
7506.00	Nickel plates, sheets, strip and foil	Free	Free	Free	Free	1-3.6%	Free-3.8%	15%	10%	2.5%	5%
7507.00	Nickel tubes, pipes, and tube or pipe fittings	Free	Free	Free	Free	1.1-2.8%	1.3-3.8%	17%	10%	2.5%	8%
7508.00	Other articles of nickel	Free-3%	Free	Free	Free	0.9%	3.6%	19%	10%	1.25-5%	8%

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States, 1999; Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of the European Union (38th Annual Edition: 1998); Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of Brazil (5th Annual Edition: 1998); Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of India (5th Annual Edition: 1998); Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of Korea (5th Annual Edition: 1998); Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of Taiwan (3rd Annual Edition: 1998); Customs Tariff Schedules of Japan, 1998, WTO column.
1 WTO rate is shown; lower tariff rates may apply circumstantially. **2** South Korea. **3** Free except for nickel oxide sinters containing by weight not less than 88% nickel, for which the tariff rate is 51.40 yen/kg, and nickel oxide containing by weight not more than 1.5% copper, for which the tariff rate is 3.8%. **4** The tariff rate of 4.2% applies to nickel alloys other than those containing by weight less than 50% nickel and not less than 10% cobalt.

TABLE 1. CANADA, NICKEL PRODUCTION AND TRADE, 1997 AND 1998

Item No.		1997 (tonnes)	1997 ($000)	1998p (tonnes)	1998p ($000)
PRODUCTION[1]					
	All forms				
	Ontario	135 667[r]	1 333 875[r]	134 730	951 870
	Manitoba	44 958[r]	442 023	50 143	354 259
	Quebec	–	–	16 035	113 287
	Total	180 624[r]	1 775 898[r]	200 908	1 419 416
	Refined	131 639[r]	–	144 323	–
EXPORTS					
2604.00.40	Nickel ores and concentrates, nickel content				
	United States	–	–	–	3
	China	19	118	–	–
	Total	19	118	–	3
2825.40	Nickel oxides and hydroxides				
	Hong Kong	60	833	210	2 389
	United States	388	5 964	61	949
	Mexico	25	424	10	158
	Brazil	9	135	14	97
	China	188[r]	2 707[r]	7	81
	Other countries	314	4 224	–	–
	Total	984[r]	14 287[r]	302	3 674
7202.60	Ferronickel	–	–	–	–
7501.10	Nickel mattes				
	Norway	39 038	400 909	47 328	398 189
	United Kingdom	36 947	386 293	41 994	357 154
	Total	75 985	787 202	89 322	755 343

TABLE 1 (cont'd)

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
7501.20	Nickel oxide sinters and other intermediate products of nickel metallurgy				
	South Korea	6 298	52 768	9 454	87 133
	Taiwan	1 295	12 697	1 984	16 176
	United States	2 391r	21 309r	2 670	15 276
	Belgium	704	7 126	1 193	8 190
	Other countries	23	216	2	65
	Total	10 711r	94 116r	15 303	126 840
7502.10	Nickel unwrought, not alloyed				
	United States	47 557r	461 473r	52 694	413 045
	Belgium	9 719	93 700	9 365	69 642
	Italy	4 365	41 063	8 756	58 993
	Netherlands	7 057	67 826	7 560	51 254
	Taiwan	5 410r	55 592r	4 719	41 784
	China	3 857	39 760	4 974	36 974
	Hong Kong	1 427	11 883	3 227	24 018
	Japan	4 970	48 232	3 042	23 654
	Switzerland	2 688	24 515	2 862	20 367
	United Kingdom	1 537	15 003	2 389	17 117
	Singapore	2 215	21 223	1 883	14 965
	Other countries	9 797	98 033	5 539	43 512
	Total	100 599r	978 303r	107 010	815 325
7502.20	Nickel unwrought, alloyed				
	United States	286	2 513	158	1 006
	Other countries	19	59	68	221
	Total	305	2 572	226	1 227
7503.00	Nickel waste and scrap				
	United States	3 409	17 660	2 147	5 425
	Japan	363	2 410	79	782
	Other countries	246	1 358	59	541
	Total	4 018	21 428	2 285	6 748
7504.00	Nickel powders and flakes				
	United States	7 267	105 928	6 005	92 526
	Japan	4 651r	53 550r	4 577	39 918
	China	531	8 681	738	11 076
	Belgium	532	5 793	675	6 109
	United Kingdom	49	4 052	204	5 714
	Netherlands	624r	8 762r	526	4 978
	Other countries	1 448	16 486	960	11 105
	Total	15 102r	203 252r	13 685	171 426
7505.11	Bars, rods and profiles of nickel, not alloyed				
	New Zealand	78	236	–	–
	United States	–	2	–	–
	Total	78	238	–	–
7505.12	Bars, rods and profiles of nickel alloy				
	United States	2	80	14	167
	Other countries	3	49	3	39
	Total	5	129	17	206
7505.21	Nickel wire, not alloyed				
	Spain	–	–	24	157
	United States	. . .	10	1	25
	Total	. . .	10	25	182
7505.22	Wire, nickel alloy				
	United States	86	2 015	93	2 320
	United Kingdom	–	–	2	83
	Brazil	–	15	1	24
	Total	–	2 030	96	2 427

TABLE 1 (cont'd)

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
7506.00[a]	Nickel plates, sheets, strip and foil				
	United States	5	205	6	161
	Poland	9	102	3	34
	Other countries	21r	123r	2	18
	Total	35r	430r	11	213
7507.00[b]	Nickel tubes, pipes, and tube or pipe fittings				
	United States	..	3 722r	..	2 842
	Singapore	..	..	..	172
	United Arab Emirates	..	177	..	95
	Other countries	..	137	..	199
	Total	..	4 036r	..	3 308
7508.00	Other articles of nickel				
	United States	..	7 748r	..	9 661
	Germany	..	58	..	90
	Japan	..	208	..	29
	Other countries	..	417	..	56
	Total	..	8 431r	..	9 836
IMPORTS[2]					
2604.00.00.20	Nickel ores and concentrates, nickel content				
	United States	1 065	6 270	1 135	6 842
	Italy	–	–	2	16
	Other countries	1 459r	10 651r	1	5
	Total	2 524r	16 921r	1 138	6 863
2825.40	Nickel oxides and hydroxides				
	Finland	330	2 222	576	9 402
	Other countries	627	591	2 197	1 862
	Total	957	2 813	2 773	11 264
7202.60	Ferronickel				
	United States	...	...	3	18
	United Kingdom	–	–	1	5
	Total	...	...	4	23
7501.00[c]	Nickel mattes, nickel oxide sinters and other intermediate products of nickel metallurgy				
	Cuba	46 723	273 743	35 178	209 629
	Australia	590r	6 011r	6 062	25 169
	United States	1 603	2 703	1 138	1 870
	United Kingdom	601	2 886	110	415
	Other countries	180	971	60	342
	Total	49 697r	286 314r	42 548	237 425
7502.10	Nickel unwrought, not alloyed				
	Norway	1 059r	9 173r	803	6 359
	United States	65	680	255	1 097
	Finland	31	338	63	675
	Russia	99	1 229	43	489
	United Kingdom	146	1 615	26	197
	Other countries	28	298	58	449
	Total	1 428r	13 333r	1 248	9 266
7502.20	Nickel unwrought, alloyed				
	Bermuda	–	–	507	2 933
	United Kingdom	17	346	44	1 015
	United States	1 115r	5 298r	146	951
	Other countries	–	16	...	8
	Total	1 132r	5 660r	697	4 907
7503.00	Nickel waste and scrap				
	United States	14 638	44 212	15 350	51 141
	United Kingdom	904	4 294	486	1 955
	Canada	137	789	129	1 182
	Other countries	894	3 096	675	2 261
	Total	16 573	52 391	16 640	56 539

TABLE 1 (cont'd)

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
IMPORTS[2] (cont'd)					
7504.00	Nickel powder and flakes				
	Australia	896r	9 123r	836	6 305
	United States	353	3 855	267	3 971
	Finland	202	3 011	169	1 672
	Other countries	90	1 282	229	1 458
	Total	1 541r	17 271r	1 501	13 406
7505.11	Bars, rods and profiles of nickel, not alloyed				
	United States	11	186	23	389
	Other countries	1	18	2	44
	Total	12	204	25	433
7505.12	Bars, rods and profiles of nickel alloys				
	United States	378r	7 540r	463	9 200
	Germany	19	312	15	248
	Other countries	23	458	23	398
	Total	420r	8 310r	501	9 846
7505.21	Nickel wire, not alloyed				
	United States	9	95	35	411
	Japan	19	151	18	171
	Other countries	11	166r	2	27
	Total	39	412r	55	609
7505.22	Wire, nickel alloy				
	United States	411r	7 060r	486	7 662
	Germany	69	1 363	51	1 198
	Other countries	9	178	21	429
	Total	489r	8 601r	558	9 289
7506.00	Nickel plates, sheets, strip and foil				
	United States	696r	12 127r	599	11 838
	Germany	115	2 440	182	4 432
	Japan	332	2 272	185	1 840
	Other countries	73	952	95	1 071
	Total	1 216r	17 791r	1 061	19 181
7507.00	Nickel tubes, pipes, and tube or pipe fittings				
	United States	456r	11 013r	357	9 628
	Japan	440r	26 071r	125	8 489
	Singapore	–	–	55	2 534
	Spain	332	4 711	235	2 509
	France	13	338	26	1 053
	Other countries	300	4 735	79	1 648
	Total	1 541r	46 868r	877	25 861
7508.00	Other articles of nickel				
	United States	592r	11 706r	586	11 314
	France	37	409	104	1 198
	United Kingdom	42	589	40	613
	Taiwan	4	44	42	352
	Canada	24	151	39	317
	China	94	715	19	153
	Other countries	22	333	21	280
	Total	815r	13 947r	851	14 227

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available or not applicable; . . . Amount too small to be expressed; p Preliminary; r Revised.
a Included in the data are HS codes 7506.10 and 7506.20. b Included in the data are HS codes 7507.11, 7507.12 and 7507.20.
c Included in the data are HS codes 7501.10 and 7501.20.
1 Recoverable nickel in concentrates shipped. 2 Imports from "Other countries" may include re-imports from Canada.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, NICKEL PRODUCTION AND CONSUMPTION, 1970, 1975, 1980 AND 1985-98

	Production[1] (Mine Output)	Consumption[2]
	(tonnes)	
1970	277 490	10 699
1975	242 180	11 308
1980	184 802	9 676
1985	169 971	7 206
1986	163 640	8 865
1987	193 391	9 732
1988	216 589	9 250
1989	200 899	10 421
1990	196 225	8 410
1991	192 259	13 322[a,r]
1992	186 384	15 528[r]
1993	188 080	17 384[a,r]
1994	149 886	20 746[r]
1995	181 820	20 973[r]
1996	192 649[r]	24 504[r]
1997	180 624[r]	19 447
1998[p]	200 908	. .

Source: Natural Resources Canada.
. . Not available; **p** Preliminary; **r** Revised.
a Increase in number of companies being surveyed.
1 Refined nickel and nickel in oxides and salts produced, plus recoverable nickel in matte and concentrates exported. Data for 1987-98 are nickel contained in concentrates produced.
2 Consumption of metallic nickel, all forms (refined metal, nickel in ferronickel oxides and salts, and other forms of nickel including nickel in purchased scrap) as reported by consumers on the Natural Resources Canada survey "Consumption of Nickel."

TABLE 3. CANADA, NICKEL PROCESSING CAPACITY, 1998

	Inco Limited		Falconbridge Limited	Sherritt International Corporation	Cobatec Ltd.[1]
	Sudbury	Thompson	Sudbury	Fort Saskatchewan	Cobalt
	(t/y of contained nickel)				
Smelter	100 000	63 000	70 000	n.a.	n.a.
Refinery	59 000	55 000	n.a.	27 000	450

Source: Natural Resources Canada.
n.a. Not applicable.
1 Company bankrupt at end of 1998 and plant not operating.

TABLE 4. WORLD MINE PRODUCTION[1] OF NICKEL,[2] 1994-98

	1994	1995	1996	1997	1998[e]
			(000 tonnes)		
Russia	212.0	251.0	230.0	250.0	240
Canada	149.9	181.8	192.6	190.5	201
New Caledonia	97.3	120.7	124.8	137.1	128
Australia	75.9	104.0	113.0	123.4	141
Indonesia	81.2	86.6	87.9	71.1	72
Cuba	26.9	42.7	53.6	61.5	68
China	36.9	41.8	43.8	46.7	45
South Africa	30.1	29.8	33.9	34.8	36
Dominican Republic	30.8	30.9	30.4	32.5	25
Brazil	20.1	19.2	20.5	20.5	28
Other	116.2	116.0	118.7	119.6	116
Total	877.3	1 024.5	1 049.2	1 087.7	1 100

Sources: Natural Resources Canada; *World Nickel Statistics*, International Nickel Study Group, January 1999.
[e] Estimated.
[1] Production for 1998 has been estimated by prorating 11 months of data, except for the Dominican Republic, Canada and Cuba for which estimates for 1998 production were available. [2] Nickel content in concentrate produced (except for Russian Federation, which may refer to nickel content of ore mined).

TABLE 5. WORLD PRODUCTION[1] OF PRIMARY NICKEL, 1994-98

	1994	1995	1996	1997	1998[e]
			(000 tonnes)		
Russia	180.9	200.0	190.0	230.0	214
Japan	112.6	135.0	130.5	128.4	128
Canada	105.1	125.3	130.1	131.6	144
Australia	66.6	76.9	74.0	73.6	78
Norway	68.0	53.2	61.6	62.7	69
New Caledonia	39.5	42.2	42.2	44.3	44
China	31.3	38.1	44.2	39.9	42
United Kingdom	28.4	35.2	38.6	36.1	39
Dominican Republic	30.8	30.9	30.4	32.5	25
South Africa	30.1	29.8	33.9	34.8	36
Other	131.3	152.2	177.7	198.4	199
Total	824.6	918.8	953.2	1 012.3	1 018

Sources: Natural Resources Canada; *World Nickel Statistics*, International Nickel Study Group, January 1999.
[e] Estimated.
[1] Production for 1998 has been estimated by prorating 11 months of data, except for the Dominican Republic and Canada for which estimates of 1998 production were available.

TABLE 6. WORLD CONSUMPTION[1] OF PRIMARY NICKEL, BY COUNTRY AND BY REGION, 1994-98

	1994	1995	1996	1997	1998[e]
			(000 tonnes)		
BY COUNTRY					
Japan	181.1	205.1	187.1	198.3	166
United States	136.3	155.2	153.1	155.6	159
Germany	87.8	93.1	74.9	89.0	96
Taiwan	26.0	48.0	50.0	68.0	65
South Korea	39.0	44.0	50.0	66.0	63
Italy	44.0	49.0	44.0	49.5	50
United Kingdom	38.0	40.9	38.7	33.0	35
China	40.0	40.2	42.0	43.0	42
France	45.6	48.5	45.9	49.8	48
Russia	35.0	36.2	35.0	20.0	20
Other	195.4	218.0	216.8	235.8	253
Total	868.2	978.2	937.5	1 008.0	998
BY REGION					
Africa	14.9	20.6	24.8	30.0	31
Americas	170.4	190.6	189.8	189.5	195
Asia	273.1	327.0	317.0	361.5	321
Europe	326.9	353.9	318.9	352.5	375
Oceania	1.7	1.8	1.9	1.9	3
East[2]	81.2	84.3	85.3	72.6	74
Total	868.2	978.2	937.5	1 008.0	998

Source: *World Nickel Statistics*, International Nickel Study Group, January 1999.
e Estimated.
1 Consumption for 1998 has been estimated by prorating 11 months of data. **2** "East" includes China, the Czech Republic, Poland, Romania, Russia and the Ukraine.

TABLE 7. AVERAGE ANNUAL NICKEL PRICES, 1981-98

	Settlement Price	
	(US$/t)	(US$/lb)
1981	5 985	2.71
1982	4 808	2.18
1983	4 695	2.13
1984	4 783	2.17
1985	4 987	2.26
1986	3 887	1.76
1987	4 849	2.20
1988	14 206	6.44
1989	11 955	5.42
1990	8 880	4.03
1991	8 158	3.70
1992	7 000	3.18
1993	5 283	2.40
1994	6 344	2.88
1995	8 237	3.74
1996	7 500	3.40
1997	6 916	3.14
1998	4 617	2.09

Source: International Nickel Study Group, except for 1998 average, which is from *Metals Bulletin.*

TABLE 8. AVERAGE MONTHLY NICKEL PRICES, 1995-98

	1995	1996	1997	1998
		(US$/t)		
January	9 596	7 866	7 047	5 495
February	8 509	8 219	7 737	5 390
March	7 536	8 024	7 899	5 399
April	7 400	8 047	7 318	5 397
May	7 236	8 030	7 485	5 023
June	7 874	7 712	7 065	4 479
July	8 599	7 207	6 838	4 329
August	8 947	7 057	6 763	4 084
September	8 408	7 321	6 507	4 106
October	8 065	7 034	6 383	3 875
November	8 509	6 946	6 142	4 135
December	8 094	6 584	5 949	3 881
		(converted to US$/lb)		
January	4.35	3.57	3.20	2.49
February	3.86	3.73	3.51	2.44
March	3.42	3.64	3.58	2.45
April	3.36	3.65	3.32	2.45
May	3.28	3.64	3.40	2.28
June	3.57	3.50	3.20	2.03
July	3.90	3.27	3.10	1.96
August	4.06	3.20	3.07	1.85
September	3.81	3.32	2.95	1.86
October	3.66	3.19	2.90	1.76
November	3.86	3.15	2.79	1.88
December	3.67	2.99	2.70	1.76

Source: International Nickel Study Group.

TABLE 9. VOISEY'S BAY MINERAL RESERVES AND RESOURCES AS OF NOVEMBER 1998

Zone/Section	Proven Reserves	Indicated Resources	Inferred Resources	Nickel	Copper	Cobalt
		(millions of tonnes)		(%)	(%)	(%)
Ovoid	31.7			2.83	1.68	0.12
Eastern Deeps - Main Zone		47		1.39	0.6	0.09
Eastern Deeps - Far Zone		5.6		0.79	0.51	0.05
South Eastern - Extension Upper		2.6		0.83	0.46	0.04
South Eastern - Extension Lower			4.5	0.85	0.42	0.04
Discovery Hill - Upper Zone[1]		7.3		1.01	0.81	0.06
Discovery Hill - Lower Zone[1]			5.6	1.00	0.77	0.06
Reid Brook Zone		20.1		1.38	0.6	0.09
Total proven reserve	31.7			2.83	1.68	0.12
Total indicated resource		82.6		1.30	0.61	0.08
Total inferred resource			10.1	0.93	0.61	0.05
Total proven + indicated + inferred	124.4			1.66	0.88	0.09

Source: Inco Limited *Investor Fact Book*, p. 39, November 1998.
[1] Previously referred to as part of the Western Extension.

TABLE 10. INCO'S ONTARIO MINES, PRODUCTION AND STATUS AS OF NOVEMBER 1998

Mines	Annual Production	Status
	(tonnes/year)	
Copper Cliff South	11 300	core mine
Copper Cliff North	8 100	core mine
Creighton	16 700	core mine
McCreedy East Phase I	9 000	core mine
Subtotal, core - production rate	45 100	
Garson	7 200	marginal mine
Stobie	15 800	marginal mine
Subtotal, marginal mines - production rate	23 000	
Coleman	7 200	to close in 2001
Crean Hill	4 500	to close in 2000
Little Stobie	2 700	to close in 1999
Frood	3 600	to close in 1999
Levack/McCreedy West	3 600	to close in 1999
Shebandowan	5 400	closed in 1998
Whistle	4 000	closed in 1997
Subtotal, mines to be shut - production rate	31 000	
Total production rate	99 100	

Source: Inco Limited *Investor Fact Book*, p. 28, November 1998.
Note: The production rate was given in the source as millions of pounds per year. This was converted to tonnes per year and rounded to the nearest 100 t/y.

TABLE 11. INTERNATIONAL NICKEL STUDY GROUP PUBLICATIONS

World Nickel Statistics - Monthly Bulletin (annual special issue in November contains annual statistics for preceding years)
– Readers can purchase yearly subscriptions to the Monthly Bulletin, or purchase single copies. The November special issue costs more than the Monthly Bulletin for other months.

World Directory of Nickel Production Facilities - June 1996
– The Directory is to be updated and will be published during 1999. The purchase price will include annual updates until the next Directory is published.

To purchase these reports contact:

International Nickel Study Group
Scheveningseweg 62
2517 KX The Hague
The Netherlands

Tel.: 31-70-354-3326
Fax: 31-70-358-4612
E-mail: INSG@compuserve.com

Notes: As of January 1999, prices for single issues of the Monthly Bulletin were in the range of $75 and a yearly subscription was in the range of $600, depending upon the title. Additional information will likely be available from the web site at http://www.insg.org once it is operational.