

# Nickel

## Bill McCutcheon

The author is with the Minerals and Metals Sector,  
Natural Resources Canada.

Telephone: (613) 992-5480

E-mail: [bmccutch@nrca.gc.ca](mailto:bmccutch@nrca.gc.ca)

(Author notes: [1] For more detailed information about Canadian facilities, refer to the Nickel chapter of the "2000 Canadian Minerals Yearbook." [2] Only material related to events in 2002 is covered in this review. [3] This chapter includes some information about cobalt as it relates to nickel; it does not provide a comprehensive review of cobalt.)

Abbreviations used in this review include:

Au Gold; Co Cobalt; Cu Copper; Fe Iron;  
FeNi Ferronickel; PAL Pressure acid leach;  
Pd Palladium; Pt Platinum; Ni Nickel; PGMs  
Platinum group metals.

## OVERVIEW

World nickel mine production increased by 5000 t from 2001 to reach 1.229 Mt in 2002, an increase of 0.4%. World production of refined and finished nickel rose by 18 900 t to reach 1.179 Mt in 2002, an increase of 1.6%. Nickel use (formerly called "consumption") reversed its decline to increase by 67 000 t to 1.117 Mt in 2002, up 6.1%. Prices started out at the year's low of US\$5625/t on January 3, peaked in mid-June at US\$7725/t, slipped back to a trough of US\$6234/t in September, moved up to US\$7565/t in early December, and then finished the year at US\$7100/t. The average price for the year was US\$6772/t, or US\$3.07/lb, compared to US\$5948/t in 2001.

Cobalt data are less well documented than nickel data. A principal source of world information is The Cobalt Development Institute (CDI) ([www.thecdi.com](http://www.thecdi.com)). Data from the

CDI are shown in [Table 13](#), which shows cobalt production plus deliveries from stockpiles for the period 1997-2002.

A list of Canadian nickel producers, their web sites, and the locations from which Canadian securities filing information can be obtained are provided in [Table 3](#).

Canadian mine production of nickel (nickel contained in concentrates produced) was 188 071 t in 2002 (a revised 194 058 t<sup>1</sup> in 2001).<sup>2</sup> Canadian primary nickel production of Class I and Class II nickel, as defined by the International Nickel Study Group (INSG), was 144 476 t (140 591 t) in 2001. The locations of Canadian nickel production facilities are shown in [Figure 1](#).

### WORLD NICKEL DATA

	2001	2002
	(000 t)	
Mine production	1 224	1 229
Finished production (1)	1 148	1 179
Usage (consumption)	1 104	1 171

Source: International Nickel Study Group (INSG), *World Nickel Statistics - October 2003* (data rounded to nearest 1000 t).

(1) Includes production of nickel in chemicals.

Note: See [Tables 8, 9](#) and [10](#) in this article for data from 1998 to 2002.

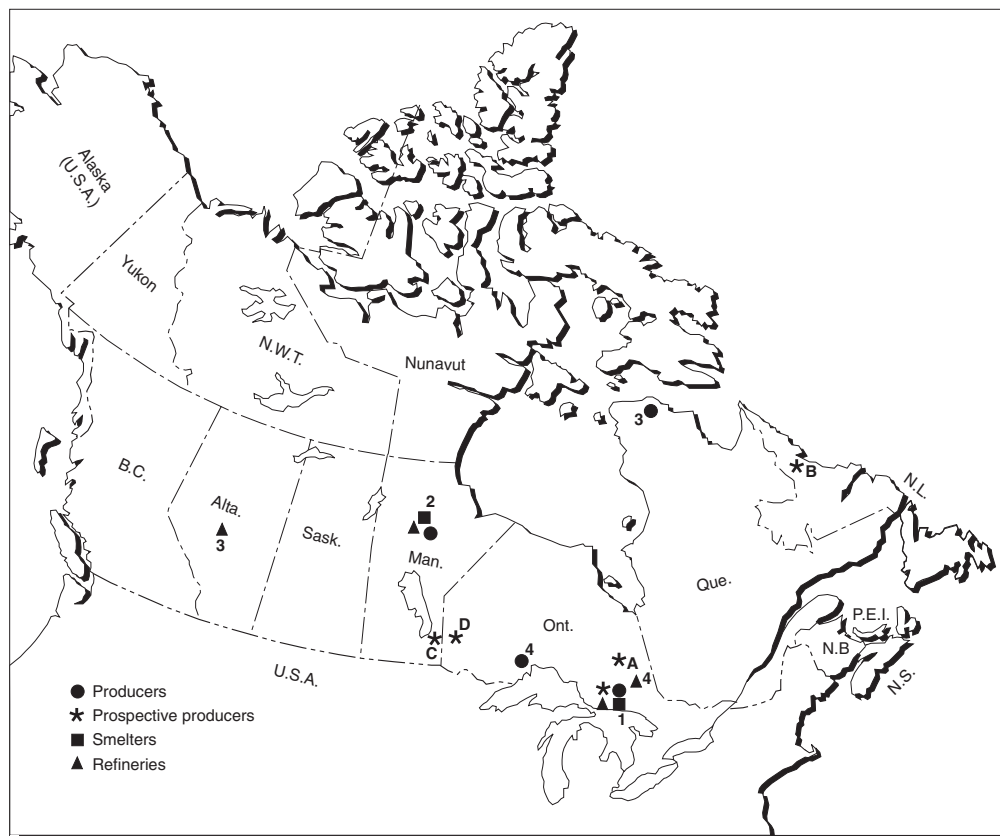
### LME ASK PRICES, 2002

	Cash	Month		
		3	15	27
	(US\$/t)			
Average	6 772	6 750	6 677	6 588
Maximum	7 725	7 735	7 480	7 355
Minimum	5 625	5 510	5 575	5 550

Sources: INSG; London Metal Exchange (LME).

Notes: Cash ask price = settlement price. Refer to [Figure 4](#) for a graph of nickel prices in 2002 and for the period 1986-2002.

**Figure 1**  
**Nickel and Cobalt in Canada, 2002**



*Numbers and letters refer to locations on map above*

#### **PRODUCERS**

1. Falconbridge Limited (Fraser, Lindsley, Onaping-Craig, Lockerby)
1. Inco Limited (Copper Cliff North, Copper Cliff South, Creighton, Garson, Gertrude, McCreedy/Coleman, Stobie)
2. Inco Limited (Thompson, Birchtree)
3. Falconbridge Limited (Raglan)
4. North American Palladium Ltd. (Lac des Iles)

#### **SMELTERS**

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

#### **REFINERIES**

1. Inco Limited (Sudbury)
2. Inco Limited (Thompson)
3. Sherritt International Corporation (Fort Saskatchewan)
4. Canmine Resources Corporation (Cobalt, Ontario)

#### **PROSPECTIVE PRODUCERS**

- A. Outokumpu Mines Ltd. (Moncalm Township) (mine)
- B. Inco Limited (Voisey's Bay mine)
- C. Canmine Resources Corporation (Maskwa) (mine)
- D. Canmine Resources Corporation (Werner Lake) (mine)

**CANADIAN DATA**

	2001	2002
	(t)	
Ni mine production (1)	(r) 194 058	187 791
Ni in concentrates shipped (2)	(r) 184 300	178 338
Ni refined production (3)	(r) 140 591	144 476
Ni usage (4)	17 735	18 955
Co mineral production (2)	2 112	2 027
Co metal production (3)	4 063	4 303
Co usage (4)	94	92

Sources: Nickel data: Table 7 of Production of Canada's Leading Minerals, ISSN 0709-292X, SS # 02-12; available at: <http://mmds1.mms.nrcan.gc.ca/mmsd/data/2002/02mtly12.p>

(r) Revised.

Ni = nickel; Co = cobalt.

(1) Metal in concentrates produced from Canadian mines.

(2) Recoverable metal in concentrates shipped from Canadian mines. (3) Metal produced, whether from domestic or foreign origin. (4) Use includes metal in scrap and other recycled forms.

Canada is a large net exporter of nickel. [Figure 2](#) presents a snapshot of the major components of Canadian trade in 2002. The values are shown in U.S. currency for ease of international comparison; the trade tables [1a](#) and [1c](#) show detailed trade in Canadian currency. As can be seen from [Figure 2](#), exports outpaced imports; Canadian nickel exports were 437% greater than nickel imports in 2002, providing a trade balance of US\$1165 million or C\$1823 million. The imports with the largest values are the residues and concentrates imported for further processing, which together amounted to 75% of total nickel imports by value. The most significant exports were unwrought nickel at 43% of nickel exports followed by nickel in matte and nickel in nickel oxide sinters at 24% and 22%, respectively. These three categories accounted for 89% of total Canadian nickel exports.

Canadian exports and imports of various forms of nickel are shown in [Table 1a](#); some data refer to contained nickel and other data refer to gross weights, according to the definitions of the Harmonized Commodity Description and Coding System (Harmonized System) for trade classification. Additional detail has been presented in [Table 1a](#) to clarify whether the tonnage is nickel content or the weight of material shipped.

### Inaccuracies in Trade Data

Canadian trade data are inaccurate with respect to the imports of nickel in concentrates. Statistics Canada data show import tonnages from Australia of 73 365 t of nickel in concentrates – this is many times higher than actual exports from Australia; it is likely that the import data show the tonnage of concentrates imported rather than the nickel content of the concentrates as the trade classification requires. The origin of the errors has not been determined and corrections are not available after six months of investigation.

Instead, the INSG's data for Australian exports to Canada of 18 600 t of nickel in concentrates for 2002 and 11 765 t for 2001 are used in trade [table 1a](#). The unit value of C\$109.5 million is equivalent to US\$69.7 million, which indicates a unit value of US\$1.70/lb, roughly consistent with the figure of US\$2/lb, which one can obtain by deducting the treatment and refining charges plus transportation expenses reported by Jubilee Mines from the average London Metal Exchange (LME) price for the period October 1, 2001, to September 30, 2002.

Data are not available on the 10 772 t of nickel in concentrates supposedly imported from the United States, which has no domestic nickel production, nor the 6179 t of nickel in concentrates reported to have been imported from Germany, another country with no domestic nickel production. Assuming these errors are similar to the Australian data, if the grade of the material shipped is assumed to be about 15% nickel, then the imports allegedly from Germany and the United States would have contained in the range of 2500 t of nickel. Alternatively, the trade may refer to material other than ores and concentrates.

Residues imported from Cuba are believed to be from the Moa leaching operation brought in for processing at the Fort Saskatchewan refinery. These residue imports totaled 62 000 t in 2002 valued at C\$273 million. The tonnage and value are believed to reflect both the nickel and the cobalt content of these residues.

As noted in the 2001 chapter on nickel, a number of errors exist with respect to 2001 nickel in matte trade other than to Norway; these errors remain uncorrected.

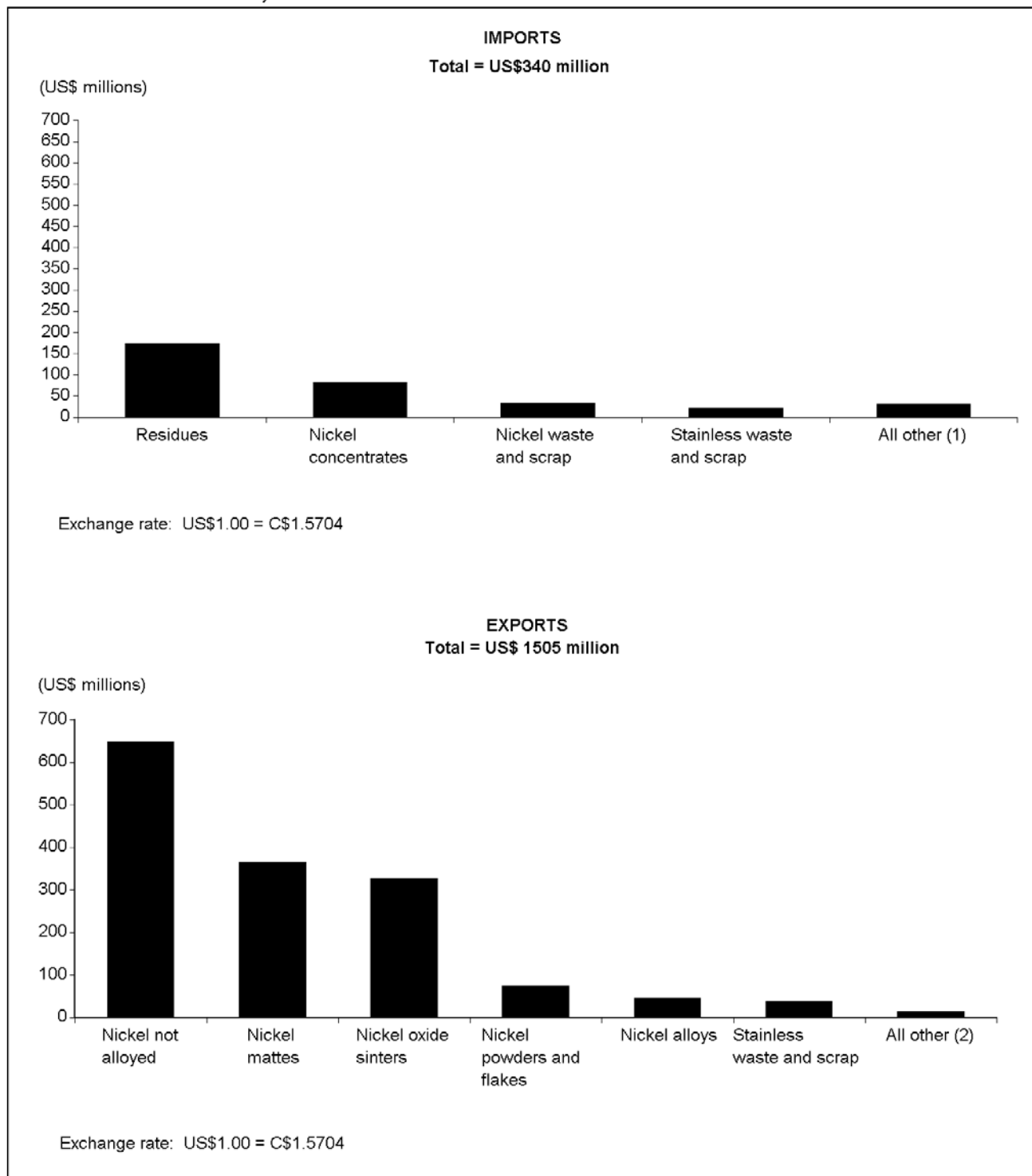
[Table 1b](#) provides an historical summary of nickel production and use from 1970 to date for selected years.

Additional trade information is also presented in [Table 1c](#), which shows the total trade of cupro-nickel, nickel-silver, stainless steel, and nickel-containing batteries. These data do not show the weight of the contained nickel but, rather, the entire weight of the material; thus, stainless steel data show the weight of nickel plus iron plus chromium plus other alloying elements.

Canadian shipments of recoverable cobalt in concentrate from Canadian mines totaled 2027 t in 2002 compared to 2112 t in 2001. Refined cobalt production was 4303 t in 2002, compared to 4062 t in 2001. [Table 2a](#) provides cobalt production and trade data for 2001 and 2002. Note that the unit of measurement for the data in [Table 2a](#) is kilograms. [Table 2b](#) provides an historical summary of Canadian cobalt production and use from 1975 to 2002 for selected years.

Canada uses only a small amount of nickel compared to national production. A very large user of nickel in all

**Figure 2  
Canadian Nickel Trade, 2002**



Sources: Trade values from Statistics Canada; graphed by Natural Resources Canada criteria.

(1) All other = unwrought nickel and alloys, sulphates, mattes, oxides, hydroxides, oxide sinters, chlorides and ferronickel.

(2) All other = nickel waste and scrap, sulphates, oxides, hydroxides and concentrates.

forms in Canada is Slater Stainless Corp., a subsidiary of Slater Steel Inc. Slater Stainless operates two facilities in Canada: a mill in Welland, Ontario, and a mill in Sorel, Quebec.

## CANADIAN DEVELOPMENTS

There were four nickel and cobalt producers in Canada in 2002. In addition, Canmine Resources Corporation started commissioning its hydrometallurgical refinery at the end of 2001, but encountered financial difficulties by mid-year and was forced to close the refinery. It is likely that the Sudbury Basin Joint Venture ([see below](#)) will commence production in 2003. As noted earlier, [Table 3](#) provides data on where to get additional information from the Internet for Canadian nickel-producing companies.

[Table 4](#) provides summary details about Canadian nickel and cobalt production facilities in 2002. This table shows the type of output at each facility (e.g., nickel in concentrate is processed to nickel in matte, which is then processed to refined nickel, so counting all tonnages would triple-count production); therefore, the “production” data are not additive. For additional information about these facilities, readers can refer to the corporate web sites listed in [Table 3](#), to the securities information available from the sources listed in [Table 3](#), and to the “Nickel” chapter of the *2000 Canadian Minerals Yearbook* ([www.nrcan.gc.ca/mms/cmy/content/2000/42.pdf](http://www.nrcan.gc.ca/mms/cmy/content/2000/42.pdf)), which presents a detailed review of Canada’s nickel and cobalt production facilities in 2000.

[Table 7](#) presents the capacities of nickel production facilities in Canada.

For more information about events during 2002, the reader may also examine the 2002 *Nonferrous Metals Outlook*, prepared in October 2002 and available on the Internet at [www.nrcan.gc.ca/mms/pdf/nfo/nfo02/nick-e.pdf](http://www.nrcan.gc.ca/mms/pdf/nfo/nfo02/nick-e.pdf).

In addition, monthly Canadian nickel data are posted monthly at [http://mmsd1.mms.nrcan.gc.ca/mmsd/data/default\\_e.asp](http://mmsd1.mms.nrcan.gc.ca/mmsd/data/default_e.asp). At this site, data are available in three file formats by month for:

- mine output (nickel content in concentrates produced);
- primary production (recoverable nickel in concentrates shipped);
- refined production (includes nickel in chemicals and in Class II forms); and
- domestic shipments of refined production.

All mine production in Canada is derived from the exploitation of nickel sulphide ores as Canada possesses no nickel laterite reserves. These sulphide ores yield important by-products such as copper, cobalt, gold, silver, platinum group elements, selenium, tellurium, sulphuric

acid and liquid sulphur dioxide. Domestic mine production is supplemented by imported intermediate forms of nickel that are further processed in Canadian facilities; nickel in concentrates is imported into Canada from Australia to be processed in Canadian smelters, and nickel in nickel-cobalt sulphide residues is imported from Cuba, to name two examples. Conversely, some forms of nickel are exported for further processing in other countries; nickel matte is exported for further refining in Norway and nickel-copper intermediates are exported to the United Kingdom for the production of Class I refined nickel. Finished nickel contained in nickel oxide sinter is exported to Taiwan and South Korea for upgrading in those countries.

## Mines

**Falconbridge Limited**, Inco Limited, and North American Palladium Limited own and operate 15 mines in Canada that produce nickel as either a primary product or as a by-product.

Falconbridge Limited operates four mines in the Sudbury area plus the Raglan mine in Quebec. The company produced 52 500 t of nickel in concentrates from its mines in 2002 compared to 59 800 t in 2001. The smelter produced 53 500 t of nickel in matte from primary sources and 4400 t of nickel from recycled sources in 2002, compared to 51 500 t and 3400 t, respectively, in 2001. It should be noted that production in 2001 was affected by a labour strike. The matte from the smelter is exported to Falconbridge Nikkelverk Aktieselskap, Falconbridge’s refinery in Kristiansand, Norway.

Falconbridge’s exploration work at the Nickel Rim South property resulted in the resource estimate being increased to 6.3 Mt grading 1.7% Ni, 3.4% Cu, 2.2 g/t Pt, 2.5 g/t Pd, and 1.5 g/t Au by year-end 2002. The company plans to decide by mid-2003 whether to proceed with shaft sinking and an underground exploration program. During the year, the possibility was raised that with the indefinite postponement of Inco’s Victor program, that perhaps the Victor shaft could be utilized to advance the Nickel Rim South work more quickly. Falconbridge also added to its mineral inventory at its Fraser mine.

Falconbridge is scheduled to decide in 2003 whether to proceed with development of the Montcalm project near the company’s Kidd copper-zinc operations in Timmins, Ontario. If approved, the property could yield 8000 t/y of refined nickel with initial production starting in late 2004. Capital expenses of about \$63 million (about US\$40 million) have been forecast for 2003 if the project proceeds. Ore would be milled at the Kidd operations and the concentrate would be sent to Sudbury for smelting. Indicated resources at Montcalm at year-end 2002 were 7 Mt grading 1.36% Ni, 0.67% Cu and 0.06% Co, plus inferred resources of 0.7 Mt grading 1.7% Ni, 0.70% Cu and 0.07% Co.

**Inco Limited** produced nickel from nine underground mines in Canada in 2002: seven located in Ontario and two in Manitoba. Sections of the former Frood mine in Sudbury are now operated as part of the Stobie mine. During 2002, Inco increased its production from lower-grade ores, including ore from the Gertrude mine, which was re-opened. The Ontario Division operated without a summer vacation and maintenance shut-down. Work to increase recovery rates at Inco's Clarabelle mill continued in 2002 with rates increased by 4.5%, or about 4500 t of nickel, during the year. Inco produced less nickel than was targeted due to ground control problems at the Creighton, Copper Cliff North and Stobie mines during the second half of the year and due to the maturity of the Thompson mine where stopes were smaller and grades were lower. The Thompson mine produced about 4500 t below target in 2002.

Development work at the Creighton deep mine project continued and production was 0.3 Mt grading 3.3% Ni and 2.3% Cu in 2002. A feasibility study was begun to examine the second phase targeted at 3 Mt grading 3.19% Ni and 3.12% Cu down to 2500 m below surface. Capital expenditures of US\$47 million would be required in 2004 alone to develop the lower levels. At Inco's Garson mine, a decision was taken to deepen the mine, thereby extending its life from one year to nine years. Production will be increased from about 1900 t/d to nearly 2100 t/d by spending US\$43 million to access 7 Mt grading 1.76% Ni, 1.36% Cu and 1.1 g/t PGMs plus Au located between 1360 m and 1550 m below surface. Dynatec Corporation won a \$27 million contract to complete a 1000-m ventilation shaft at the Garson mine over a two-year period.

In 2002, development was undertaken at the Copper Cliff North mine's 138 orebody extension, targeted at higher levels of PGMs and gold. Exploration work in 2002 centred on: the Pump Lake deposit and the 191 orebody, both near the Copper Cliff North mine; the 830 orebody of the Copper Cliff South mine; a high-grade area at the Murray mine between 1200 and 1600 m below surface; and a new footwall zone at the McCreedy/Coleman mine. Subsequent to the agreement in principle to develop Voisey's Bay, Inco deferred indefinitely its Victor deep project, as [noted above](#).

In an arrangement somewhat akin to those between WMC Resources Ltd. and various companies operating in the Kambalda area, an agreement between Inco and the Sudbury Basin Joint Venture (SBJV), owned by **FNX Mining Company Inc.** and **Dynatec Corporation**, became effective in January 2002. The SBJV purchased five properties from Inco, subject to certain conditions. The SBJV began a \$14 million work program that includes drilling, development work, and various engineering and geological studies of the McCreedy West mine, the Levack mine, the Victoria mine, the Kirkwood mine and the Norman North PGM-Cu-Ni mineralized zone. Future production from

these locations would be sent to Inco for milling, smelting and refining, subject to available capacity at Inco facilities.

At Inco's Manitoba operations, development of the lower Birchtree mine continued. The development will increase the output of Birchtree to partially offset the declining production from the mature Thompson mine where grades and stope sizes are declining. The production from the Birchtree mine created some operational difficulties for Inco due to a change in the magnesium oxide content of the Birchtree ore vis-à-vis Thompson ore, complicated by the increasing amount of imported Australian nickel concentrates from the Cosmos and Emily Ann operations. The continued imports of concentrates are designed to support Thompson's smelter and refinery output until concentrates from Voisey's Bay arrive, starting in 2006. The refinery was able to raise output of plating-grade nickel cathode to 94% of its output, up from 85% in 2001.

Inco has an agreement with **Nuinsco Resources Limited** whereby Nuinsco can acquire 100% in the Mel property by spending \$6 million over a five-year period that ends August 31, 2004. Inco has an ability to re-acquire 51% under specific circumstances. Nuinsco's first goal is to outline a near-surface orebody of about 1 Mt grading 1.6-2% nickel that can be accessed and mined by a ramp.

**North American Palladium Limited** operates an open-pit palladium operation near Thunder Bay, Ontario. In 2001, the operation was expanded from 2400 t/d to 15 000 t/d at a cost of \$220 million. Since that time, mineral processing difficulties in the mill and the crusher prevented the mine/mill from reaching its rated capacity. A new crusher is scheduled for completion by mid-2003 after which the operation is expected to operate at capacity. Nickel is one of the minor by-products of this operation and is contained in the concentrates that are sent to Inco and Falconbridge smelters in Sudbury for processing. Production in 2002 was 1254 t of nickel, up from 724 t in 2001.

## Nickel Processing

Inco and Falconbridge Limited operate smelters in Canada; three are located in Sudbury, Ontario, and one is located in Thompson, Manitoba. Inco Limited and Sheritt International Corporation operate the processing facilities that produce Class I and Class II<sup>3</sup> nickel in Canada. A third company, Canmine Resources Corporation, owns a refinery capable of producing cobalt and nickel salts, but the refinery was put on standby in 2002 due to corporate financial difficulties.

**Falconbridge Limited** operates an electric smelter in the Sudbury area. This facility processes nickel, copper and cobalt in concentrates from its nickel mines in Canada and also processes nickel and cobalt from recycled sources. In 2002, the smelter produced 57 854 t of nickel in matte of which 4400 t was from recycled material.

**Inco Limited** operates two flash smelters at Sudbury that process bulk nickel-copper-cobalt concentrates. Inco's smelter throughput was increased to 4300 t per day during the year. The matte is slow cooled and then crushed, milled and processed by flotation to produce separate nickel concentrate and copper concentrate. Inco does all of its copper concentrate smelting and refining in Sudbury, including small amounts of copper concentrate shipped from Inco's Thompson operations.

Nickel separated from the copper in matte processing is either sent to a carbonyl refinery in the Sudbury basin where nickel pellets and powders and ferronickel pellets are produced, or it is sent as an intermediate nickel-copper oxide to Inco's carbonyl plant at Clydach in Wales, United Kingdom, for processing to refined nickel. Residues from Clydach are returned to Sudbury for further processing to recover copper and precious metals.

Inco groups its Sudbury and Clydach refineries into one division, reporting the production from these facilities as "Ontario" production. Production of the Ontario division in 2002 was 226 million lb or about 102 500 t. Subtracting the Clydach nickel output of 33 800 t for 2002,<sup>4</sup> the estimated output of refined nickel and nickel in nickel oxide sinter was 68 700 t in 2002.

In Thompson, Inco produces electrolytic nickel in an electro-refinery. Plating-grade nickel with its higher premium is the major output of this operation, accounting for 94% of the refined output in 2002. As noted above, Inco experienced problems at the smelter during the year due to high levels of magnesium oxide.

The Inco and Falconbridge smelters in Sudbury were affected by a new Control Order issued in February 2002 by the Ontario government. The order reduced permissible ground-level concentrations of sulphur dioxide by 34% to 0.34 ppm as of April 1, 2002. As well, the Control Order cut the allowable annual emission limits for both companies by 34% effective December 31, 2006. The Province requires the companies to report annually to the government and the public on research and development investigations into the technological and economic measures possible to further reduce emissions of sulphur dioxide. A final report is due December 31, 2010. Falconbridge's emissions in 2002 were well below the new annual emission limit to be instituted in 2007. Inco intends to meet the new targets by installing scrubbers in the SO<sub>2</sub> off-gas emissions from the fluid bed roaster at a cost of US\$76 million. The scrubbing will also reduce metal emissions and increase sulphuric acid production.

The tonnages of SO<sub>2</sub> emissions by nickel smelters in Canada in 2002 and 2001 were:

	2002	2001
• Falconbridge Sudbury	38 300	29 600 <sup>5</sup>
• Inco Sudbury	243 000	232 000
• Inco Thompson	210 000	217 000

**Sherritt International Corporation** operates a joint venture with the Cuban government (50:50 ownership) called Metals Enterprise. Metals Enterprise operates a nickel laterite mine and acid pressure leach plant at Moa Bay in Cuba that ships nickel-cobalt sulphide residues to the joint venture's hydrometallurgical refinery at Fort Saskatchewan, Alberta. The Cobalt Refinery Company Inc., owned by Metals Enterprise, operates the hydrometallurgical refinery, which gets most of its nickel feed from the imported nickel-cobalt residues. During 2002, the refinery produced 31 694 t of nickel (and 3065 t of cobalt), record production for the plant. The hydrometallurgical plant produces nickel and cobalt powders and briquettes. In addition, the plant produces ammonium sulphate fertilizer.

**Canmine Resources Corporation** owns a hydrometallurgical cobalt-nickel refinery in Cobalt, Ontario, and a number of mineral properties, including a nickel-copper-cobalt property in Manitoba and the Werner Lake cobalt property in Ontario near the border with Manitoba. In December 2001, Canmine started the commissioning of the refurbished refinery, progressing by April 2002 to start the commissioning of the autoclave section. By July, after producing initial product, financial pressures forced the company to suspend operations at the refinery. The company sought protection under the *Companies Creditors Arrangement Act* to enable it to restructure. The restructuring was still in progress by year-end and the refinery remained on care-and-maintenance status.

## Voisey's Bay Project

In June 2002, Inco Limited and the Province of Newfoundland and Labrador agreed upon the principles for the development of the Voisey's Bay nickel deposit, located on the coast of Labrador. In May 2002, Inco's subsidiary, **Voisey's Bay Nickel Company Limited** (VBNC), reached separate agreements with two Aboriginal groups; these groups then ratified the agreements in July 2002. In October, the Province and VBNC released their definitive agreements, dated September 30, 2002, to implement development of the project. Complete details of the Voisey's Bay Employment and Industrial Benefits Agreement and the Voisey's Bay Development Agreement are available (14-Mb file) at [www.sedar.com/csfsprod/data33/filings/0048530/00000001/3A%5CINCO%5C2002%5C8Koct8.pdf](http://www.sedar.com/csfsprod/data33/filings/0048530/00000001/3A%5CINCO%5C2002%5C8Koct8.pdf). Information from the provincial government is available through links located at [www.gov.nf.ca/voiseys](http://www.gov.nf.ca/voiseys).

As a consequence of the completion of the arrangements required to develop Voisey's Bay, Inco was able to evaluate the carrying value of the project. This resulted in a write-down of US\$1.5 billion net of deferred taxes of the carrying value of the asset to US\$2.2 billion.

Briefly, the agreements include<sup>6</sup>:

- initial work worth at least \$35 million at the mine site and at Argentia to be undertaken by March 31, 2003;
- a \$130 million R&D program, including a pilot plant at Argentia to be completed by December 31, 2006, with no nickel concentrate shipments from the province to occur before completion of the pilot plant or before shipments of concentrate to the pilot plant;
- a \$170 million mine, concentrator and infrastructure to be built from 2003 to 2006 capable of producing 6000 t/d of ore into nickel and copper concentrates providing 400 jobs; production to be limited to 2.2 Mt/y of ore for the first 10 years of mine production and to 5.5 Mt/y of ore thereafter;
- copper concentrate may be shipped outside the province unless sufficient quantities are discovered to warrant processing facilities or construction of a processing facility by a third party;
- nickel concentrate may be shipped outside the province after completion of a pilot plant at Argentia until the earlier of: a total of 355 000 t of contained nickel in concentrates shipped, or completion of the hydrometallurgical plant, or there is no decision about a hydrometallurgical plant by November 15, 2008; after completion of a hydrometallurgical plant, up to a further 85 000 t of contained nickel in concentrates may be shipped out of the province until the commercial production date of the hydrometallurgical plant (defined as an annualized production rate of 30 000 t/y of a nickel product containing at least 99.8% Ni for a period of 90 days);
- before mining ceases, shipment of nickel in intermediates to commence at a rate yielding not less than 25 000 t/y of finished nickel products (at least 99.8% Ni content) and must continue until the total tonnage of nickel plus cobalt shipped into the province is equal to the total tonnage of nickel plus cobalt contained in concentrates shipped out of the province;
- a \$20 million advanced surface exploration program to be conducted between 2002 and 2006 as part of a \$95 million exploration program designed to define sufficient reserves to permit expansion of the mine and concentrator;
- a \$750 million expansion of the concentrator and construction of an underground mine providing 800 jobs, designed to keep the hydrometallurgical plant operating at full capacity;
- the decision about the processing plant (hydrometallurgical plant or the matte processing plant) is to be made

by November 15, 2008, with plans delivered to the government by December 31, 2008, so that the plant is built by December 31, 2011; the \$800 million hydrometallurgical plant, built over three years, is to produce approximately 50 000 t/y of nickel products of at least 99.8% Ni and provide 400 jobs; a matte-processing plant would be built if the hydrometallurgical plant is technically unfeasible such that the matte plant would produce approximately 50 000 t/y of nickel products grading at least 99.8% Ni; and

- the Province granted the mining lease to Voisey's Bay on September 30, 2002, subject to various conditions.

Inco's Annual Report for 2002 described the federal government's involvement in the region as:

"the Government of Canada is making available up to C\$150 million from its existing programs to support activities in and around the Voisey's Bay project as they relate to innovation, training and business development opportunities for Aboriginal people."

A government press release and details about the relevant programs of four government departments can be found on the Internet at [www.acoa.gc.ca/e/media/press/press.shtml?1813](http://www.acoa.gc.ca/e/media/press/press.shtml?1813).

## WORLD NICKEL PRODUCTION

[Table 5](#) shows a list of world nickel producers and their web sites, where available. [Table 6](#) provides information about world nickel producers for 2002. [Tables 8](#) and [9](#) show selected mine production and primary production data for nickel, respectively.

## WORLD COBALT PRODUCTION

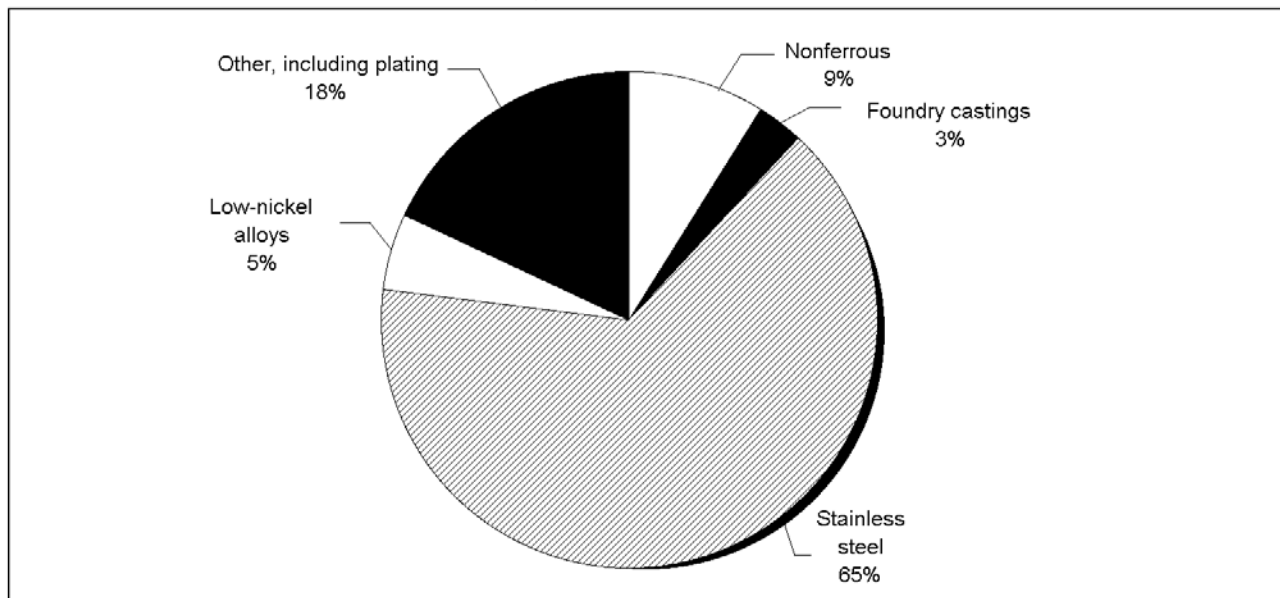
World cobalt mine and metal production data by country from the International Consultative Group on Nonferrous Metals Statistics for the period 1991 to 2000 were presented in Figures 3 and 4 of the Nickel chapter in the 2000 *Canadian Minerals Yearbook* ([www.nrcan.gc.ca/mms/cmy/content/42.pdf](http://www.nrcan.gc.ca/mms/cmy/content/42.pdf)). [Table 13](#) presents CDI information about cobalt availability by company for the period 1997-2002.

## NICKEL USE

The important world markets for primary nickel are shown in [Figure 3](#). In addition to the 1.17 Mt of primary nickel used in 2002, there were approximately 600 000 t of nickel contained in stainless steel scrap used by stainless steel mills in 2002.



**Figure 3**  
**Western World Plus China Nickel Use, 2002**



Source: Inco Limited's 10K report, 2002.

Notes: Western World excludes the Russian Federation, Cuba, the former Eastern Europe and the C.I.S. About 78% of stainless steel is estimated to be nickel-containing.

Stainless steel production in 2002 was reported by the International Stainless Steel Form (ISSF)<sup>7</sup> as 20 Mt in 2002, up from 19 Mt in 2001. *Metal Bulletin's* weekly stainless steel prices<sup>8</sup> for Grade 304 CR coil 2B c.i.f. East Asian port increased from US\$1180/t to US\$1590/t over the course of the year.

## COBALT USE

Information about cobalt uses can be obtained from The Cobalt Development Institute's Internet site at [www.thecdi.com](http://www.thecdi.com) (click on "about cobalt"), the U.S. Geological Survey's Internet site at <http://minerals.usgs.gov/minerals/pubs/commodity/cobalt>, and the OM Group Inc.'s Internet site at [www.omgi.com](http://www.omgi.com).

On the OM Group site at [www.omgi.com/industries/default.htm](http://www.omgi.com/industries/default.htm), there is a list of applications; each title can be clicked on for more information about the specific application of cobalt and nickel as well as other OMG products. Canadian cobalt use is reported in [Table 2b](#).

## RECYCLING, HEALTH AND THE ENVIRONMENT

Health and environmental issues related to nickel are examined briefly in a general fact sheet on nickel that is

available on the Internet at [www.nrcan.gc.ca/mms/cmy/mfs\\_e.htm](http://www.nrcan.gc.ca/mms/cmy/mfs_e.htm).

To calculate a recycling rate, one needs to know the product life for the materials used in goods. Stainless steel is used in relatively long-life applications due to its higher initial cost and lower maintenance costs over its years in service. So this means that there is a long period of time between production of the nickel-containing stainless steel and its recycling. But, during that time, demand and production grow. At a 6% growth rate, stainless steel demand more than quadruples in 25 years. If all the nickel in the stainless steels produced in one year were to be recycled after 25 years, the recycling of 100% of that material would only represent 25% of the nickel being used to make stainless steel. Therefore, in this case, 100% recycling would translate into a feed ratio of only 25% recycled material if all scrap were sourced only from used consumer and industrial goods (i.e., "old" scrap). Thus, one can conclude that recycling rates are higher than the ratio of recycled feed to total feed; calculating the true recycling rate is difficult because of the varying product lives that contain nickel.

## PRICES AND INVENTORIES

[Figure 4](#) shows prices in 2002 and for the period 1986-2002. Inventories on the LME rose from 19 600 t<sup>9</sup> at the

start of 2002 to 24 500 t by late January, declined to 16 600 t by mid-April, rose sharply to 29 100 t in June, and then drifted down to recover to nearly 22 000 t by year-end.

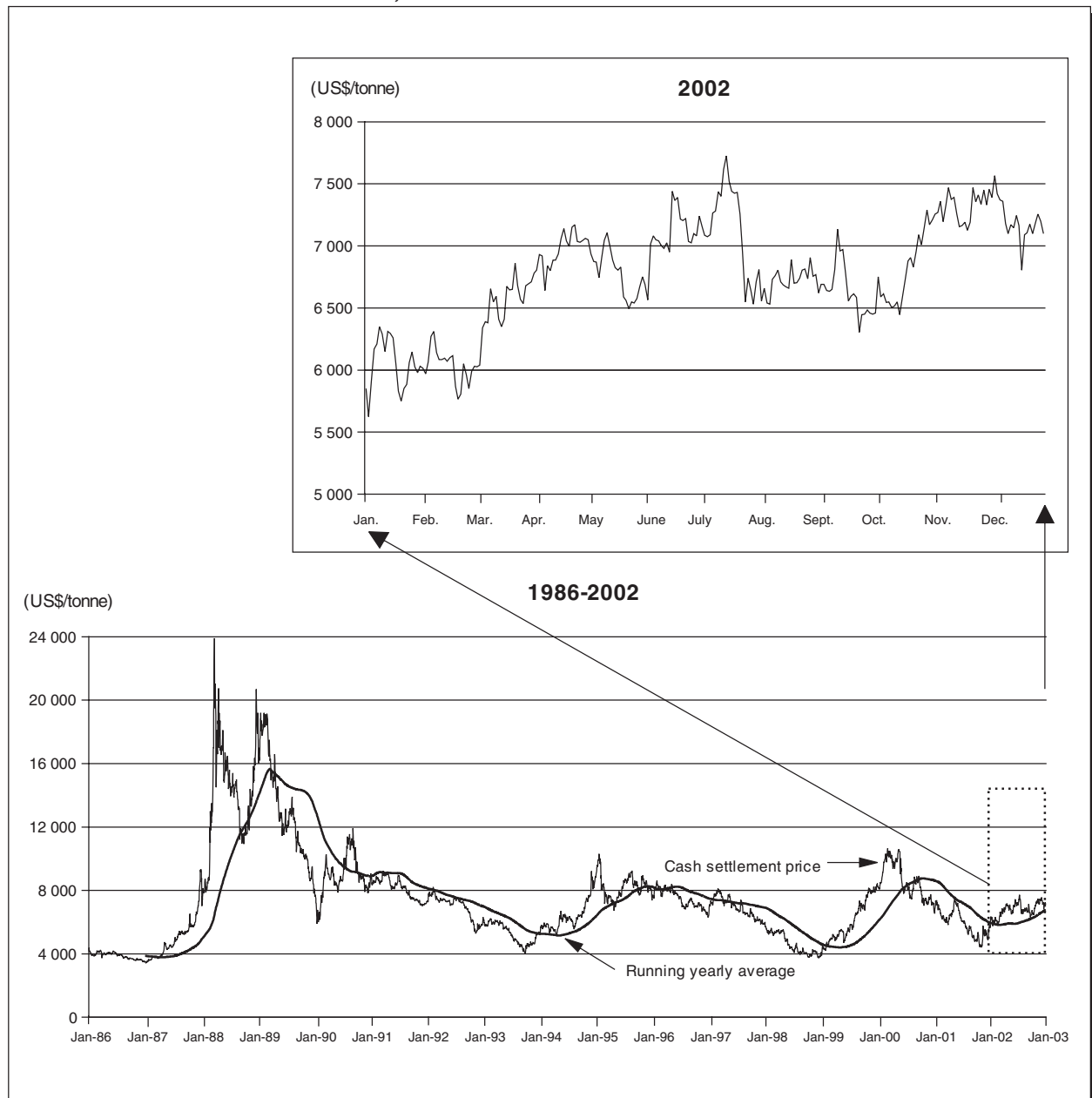
Current and historical nickel prices and inventories are available on the LME's Internet site at [www.lme.co.uk](http://www.lme.co.uk). Other sites for nickel prices and inventories include

[www.metalalloys.com](http://www.metalalloys.com), [www.metalbulletin.com](http://www.metalbulletin.com) and [www.inco.com/products/marketwatch/default.asp](http://www.inco.com/products/marketwatch/default.asp).

### Cobalt

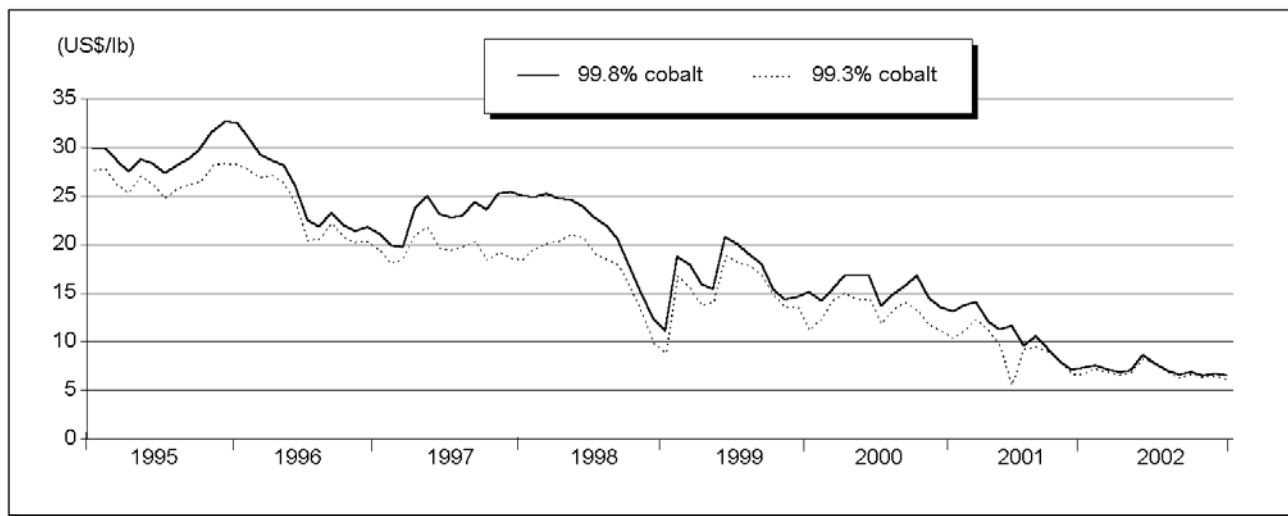
Monthly cobalt prices are shown in [Figure 5](#). No terminal markets such as the LME exist for cobalt, although WMC

**Figure 4**  
**LME Cash Settlement Nickel Prices, 1986-2002**



Sources: International Nickel Study Group; Reuters; World Bureau of Metal Statistics.  
Conversions: \$2.50/lb = \$5512/t; \$3.00/lb = \$6614/t; \$3.50/lb = \$7716/t; \$4.00/lb = \$8818/t.

**Figure 5**  
**Cobalt Prices, Average of Metal Bulletin Monthly Average High and Low Prices, 1995-2002**



Source: *Metal Bulletin*.

Limited reports trading on its Internet site at [www.wmc-cobalt.com/sales.asp](http://www.wmc-cobalt.com/sales.asp). OMG's web site at [www.omgcobalt.com](http://www.omgcobalt.com) does not show trades after September 30, 2002.

## OUTLOOK

### Delays

A number of projects continued to await financing or were delayed. In December, Inco announced that its Goro project was being put on hold while the company carried out a complete review. This followed Inco's news release of a possible 30-45% increase in the \$1.45 billion capital cost estimate for Goro (i.e., to the range of US\$15.50-\$17.50/lb of annual capacity of nickel production). This followed an earlier announcement in October that the project costs could run 15% over the US\$1.45 billion estimate. Geotechnical issues and process plant and infrastructure costs were each identified as contributing about US\$250 million to the potential cost increases. Inco put the delay at a minimum of six months, which would delay startup until at least the second half of 2005. Inco's target is to obtain a rate of return at least equal to the corporate weighted average cost of capital of between 9 and 10%. Inco reported spending US\$385 million on Goro as of year-end with a further US\$260 million committed.

Other projects that did not advance during the year included:

- Gag Island, Indonesia – Falconbridge Limited announced in January that it had terminated its agreement with BHP Billiton with respect to a potential joint venture to develop the deposit, due in part to unresolved forestry issues.
- Ramu project, Papua New Guinea – Highlands Pacific Limited and Orogen Minerals (Ramu) Limited were still engaged at year-end in lawsuits against each other with respect to Orogen's decision to withdraw from the project partnership. Details about the Ramu project are available on the Internet at [www.highlandspacific.com/projects/ramu/index.shtml](http://www.highlandspacific.com/projects/ramu/index.shtml).
- Ravensthorpe/Yabulu project, Australia – BHP Billiton continued its studies of the front-end leaching plant at the future Ravensthorpe mine and the modifications to the Yabulu hydrometallurgical refinery in Queensland.
- Weda Bay, Indonesia – OM Group terminated its agreement with Weda Bay Minerals, Inc. and ceased funding a bankable feasibility study of a project designed to produce up to 30 000 t/y of Ni and 3000 t/y of Co in intermediate forms.

## Intermediate Trade

Intercorporate trade in nickel intermediates exists, often the result of investment in producing facilities. Example of this include:

- a share of matte from PT International Nickel Indonesia shipped to Sumitomo's refinery in Japan;
- OMG's nickel cobalt hydroxide exports from its Australian plant at Cawse shipped to its refinery in Finland;
- PT International Nickel Indonesia's shipments to Inco TNC in Japan and to Sumitomo Metal Mining Co., Ltd.;
- SLN's shipments of matte from New Caledonia to Eramet's Sandouville operation;
- nickel concentrate imports by Outokumpu's smelter in Finland from the MPI/OMG mine in Australia, which in turn is sent to OMG's refinery beside the smelter;
- future output by Coral Bay Nickel (in which Sumitomo has a share) in the Philippines to be shipped to Sumitomo's refinery in Japan.

Compared to the copper and zinc industries, there is relatively little intermediate nickel sold or tolled between companies that is not the result of investment in projects. In the nickel industry, the "non-investment" transactions include:

- BCL matte from Botswana toll refined in Norway and Zimbabwe;
- concentrates from Cosmos and Emily Ann in Australia imported by Inco for its Canadian operations, although Inco purchased stock in the companies that own both of these concentrate-producing mines;
- WMC Resources' matte sales from Australia to OMG in Finland, to Sumitomo in Japan, and more recently to Jinchuan Nonferrous Metals Corporation in China; and
- OMG's imports of nickel matte into Finland from Rio Tinto's Fortaleza smelter in Brazil.

It appears that there will be more potential for more arm's length trade in intermediate forms of nickel than in the past as companies and their financiers may opt to reduce project risk and costs by avoiding the refining stage. With existing refineries able to reduce unit costs with higher throughputs, combined with projects seeking to reduce project costs and technical risk, the present high price phase of the price cycle may result in a proliferation of intermediate nickel producers and, hence, trading.

Various projects exist that await financing such as Ramu in Papua New Guinea or Weda Bay in Indonesia.

Jinchuan appears eager to import nickel concentrates and matte to boost production at its smelter/refinery in China, having concluded an agreement with Sally Malay in the latter half of 2002 and later with WMC Resources. Rio Narcea concluded a financing agreement in late 2002 for an operation to produce up to 10 000 t/y of nickel in concentrates.

## Overbuilding Stainless Capacity

The expansion programs in the stainless steel industry continued in 2002. After increasing production from an estimated 18.7 Mt in 2001 to 20.3 Mt in 2002, future production is projected at about 23 Mt by 2005. There are indications that the nickel industry will not be able to supply sufficient nickel feed to the stainless industry from perhaps as early as mid-to-late 2004 and for a couple of years thereafter. This overcapacity has the potential to have more serious consequences for the nickel and stainless steel industries than have past expansions.

If the nickel industry overbuilds capacity, that will lead to lower prices and reduced revenue for the nickel industry, which in turn will cause industry hardship and curtailment of operations or cancellation of expansions. However, in this case, the projected stainless capacity exceeds the ability of the nickel industry to supply sufficient nickel. Without nickel, not all austenitic producers will be able to make their products – this means that some stainless producers will not be able to produce and therefore will have no revenue.

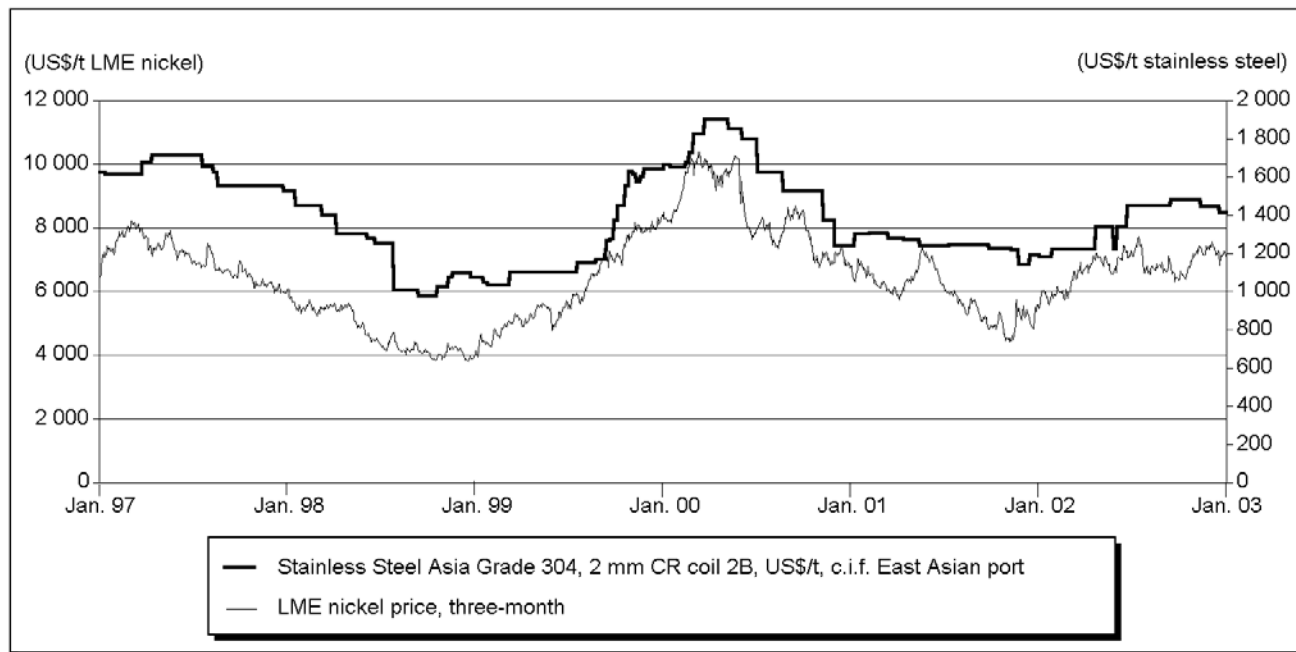
It is expected that stainless producers will first seek to contract for sufficient nickel to keep their operations in business. However, at some point, when the operating throughput of the stainless plants exceeds the nickel supply after the nickel stocks have been exhausted, some stainless plants will be faced with two choices: either to shut down or to produce stainless steel with less or no nickel.

As nickel prices are bid higher and higher as supply declines, changes in some product lines will take place. These include:

- substitution of nickel by other alloying elements;
- substitution of nickel-bearing stainless steel by other materials; and
- a reduction in the amount of nickel used in some stainless applications.

In some markets, stainless usage may be relatively insensitive to increased prices for nickel. But the prospect of years of high stainless prices caused by high nickel prices due to insufficient supply will sow the seeds of the next market correction for nickel. Stainless steel may acquire

**Figure 6**  
**Nickel and Stainless Steel Prices, 1997-2002**



Source: *Metal Bulletin*.

the reputation of an “expensive” material, moderating future demand growth in the medium term. Concurrently, continued high prices may permit a new wave of laterite investments. This could be exacerbated by a rush to be among the “first into production” and benefit from the high prices of nickel. (One recalls the race to beat Voisey’s Bay into production in the late 1990s and its consequences.)

The outlook for nickel demand is a function of the industrial activity of the major countries in the world. The largest user of nickel, both primary and recycled, is the stainless steel industry, whose use is strongly correlated with indices of industrial production (see the Nickel chapter of the 1999 *Canadian Minerals Yearbook*, Figure 5, for a graph illustrating the relationship).

The demand for primary nickel is expected to grow at an average trend rate of 3%/y or less during the next decade. The actual demand in any year will vary about the trend due primarily to changes in world industrial activity, which cause changes in stainless steel demand. It is suggested that high growth rates for austenitic<sup>10</sup> stainless steel would increase nickel prices; a sustained period of prices in the US\$8500/t range (or US\$9500/t, allowing for a weakened U.S. currency) would decrease the competitiveness of a significant portion of austenitic stainless steel production.<sup>11</sup> Unless new lower-cost production came on stream, the higher nickel prices would lead to decreased

demand growth for nickel. It appears that prices will remain at historically high levels in the short term because new projects have been delayed and because the stainless steel industry continues its massive capacity increase.

The December 1998–November 2001 price cycle that peaked in March 2000 at US\$10 660/t did not result in new nickel production capacity building following this peak, as had occurred when prices improved in earlier price cycles. Part of the reason for the lack of enthusiasm by potential new entrants to the nickel industry in times of high prices was due to the legacy of the laterite debts. Lenders and bond holders for two Australian projects, Cawse and Bulong, were disappointed at the inability of these projects to service debt. At the end of 2001, Anaconda Nickel Limited, operator of the third Australian project, reported a loss of A\$458 million, largely due to writeoffs.

In general, the amount of new production capacity scheduled to come on stream in the next five years is regarded as insufficient to meet the expected growth rate in stainless steel production. This implies that the growth in stainless steel production will not be as high as expected with higher nickel prices retarding stainless steel demand.

It seems increasingly likely that the U.S. currency value will decline relative to other major currencies, so the nominal prices in U.S. dollars may increase more than the

prices in Euros, as an example. If the Canadian dollar appreciates relative to the U.S. dollar, this will pose a challenge to Canadian producers who have many of their costs denominated in Canadian currency. Nickel prices are not expected to vary with the rates of inflation expected; technological advances are expected to more than overcome inflationary pressures.

## Cobalt

Cobalt prices (Figure 5) continued their downward trend, due less to increasing nickel production from nickel-cobalt deposits in 2001 than to the downturn in aerospace demand following the terrorist attack in the United States. The expectation is that decisions to proceed with a number of new hydrometallurgical nickel-cobalt laterite plants would further depress cobalt prices in the medium term. However, a lower price would allow cobalt to be used economically in other applications for which it is presently too expensive. The high prices of the mid-1990s would be very difficult to sustain in the future, given present conditions and expectations.

## ADDITIONAL SOURCES OF INFORMATION

Readers may access various additional sources of information on the Internet to obtain more details about nickel in general. A search engine, such as Google ([www.google.com/advanced\\_search](http://www.google.com/advanced_search)) is a good way to start. A few sites for additional information include:

### Natural Resources Canada

Canadian Minerals Yearbook:

[www.nrcan.gc.ca/mmms/cmty/pref\\_e.htm](http://www.nrcan.gc.ca/mmms/cmty/pref_e.htm)

Metal and mineral statistics:

[http://mmsd1.mms.nrcan.gc.ca/mmsd/minstatistics\\_e.asp](http://mmsd1.mms.nrcan.gc.ca/mmsd/minstatistics_e.asp)

Nickel production by month:

[http://mmsd1.mms.nrcan.gc.ca/mmsd/data/default\\_e.asp](http://mmsd1.mms.nrcan.gc.ca/mmsd/data/default_e.asp)

Production by province and territory:

[http://mmsd1.mms.nrcan.gc.ca/mmsd/production/production\\_e.asp](http://mmsd1.mms.nrcan.gc.ca/mmsd/production/production_e.asp)

### Physical/Chemical Properties of Nickel

[www.webelements.com/webelements/elements/text/Ni/key.html](http://www.webelements.com/webelements/elements/text/Ni/key.html)

### Physical/Chemical Properties of Cobalt

[www.webelements.com/webelements/elements/text/Co/key.html](http://www.webelements.com/webelements/elements/text/Co/key.html)

### WMC Market News and Commentary

[www.wmc-nickel.com/news.asp](http://www.wmc-nickel.com/news.asp)

The site provides market information and industry developments (hundreds of items of market information for 1999 onward); however, entries of information seem to terminate in late June 2002.

### International Nickel Study Group

[www.insg.org](http://www.insg.org)

### U.S. Geological Survey

Comprehensive commodity reviews:

<http://minerals.usgs.gov/minerals/pubs/commodity>

### Yahoo Search of Mining News

<http://s6.news.dcn.yahoo.com/search/news>

(Put the word "nickel" into "Your Search.")

## ENDNOTES

<sup>1</sup> The preliminary mine production number for 2001 was reported last year as 193 361 t.

<sup>2</sup> Data for 2002 are shown in the sentences; numbers in parentheses indicate data for 2001.

<sup>3</sup> As defined by the INSG, Class I nickel contains 99% or more nickel; Class II nickel refers to products with a content of less than 99% nickel and can include nickel in ferronickel, nickel oxide sinter, utility nickel, etc.

<sup>4</sup> Clydach output in 2002 taken as INSG reported production of refined nickel in the United Kingdom of 33 800 t.

<sup>5</sup> Falconbridge smelter operations were affected by a labour strike for part of 2001.

<sup>6</sup> The reader should refer to the web reference for the actual wording of the agreement in its entirety, including the definitions of specific terms for purposes of the agreement; the information listed above is not all inclusive and does not necessarily use the language and terms of the agreement. It is intended only to provide general information.

<sup>7</sup> ISSF web site is at [www.worldstainless.org/ix.php](http://www.worldstainless.org/ix.php).

<sup>8</sup> The average of the weekly high and weekly low price as reported by *Metal Bulletin*.

<sup>9</sup> Inventories rounded to nearest 100 t.

<sup>10</sup> Austenitic stainless steels contain nickel whereas ferritic stainless steels do not.

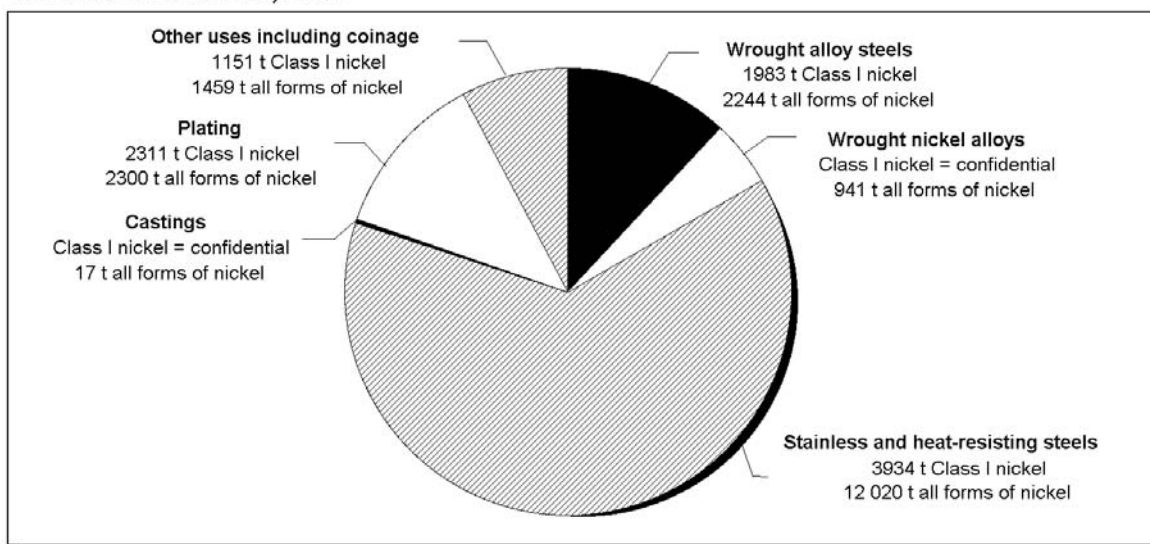
<sup>11</sup> Not all uses of austenitic stainless steels are equally at risk of substitution; some applications are thought to be quite insensitive to substitution.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 64. (2) Information in this review was current as of June 30, 2003. (3) 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. (4) This and other reviews, including previous editions, are available on the Internet at [www.nrcan.gc.ca/mms/cmy/com\\_e.html](http://www.nrcan.gc.ca/mms/cmy/com_e.html).

**NOTE TO READERS**

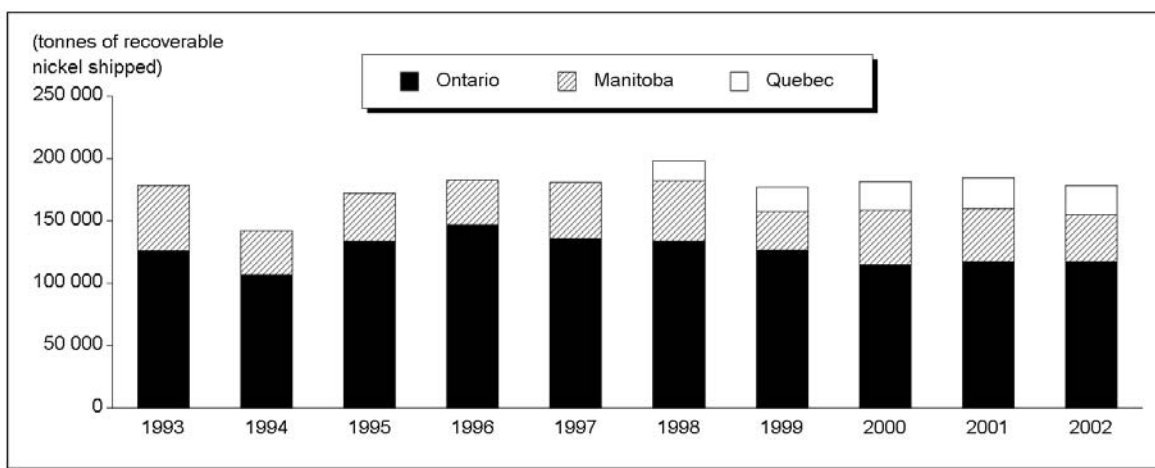
The intent of this document is to provide general information and to elicit discussion. It is not intended as a reference, guide or suggestion to be used in trading, investment, or other commercial activities. The author and Natural Resources Canada make no warranty of any kind with respect to the content and accept no liability, either incidental, consequential, financial or otherwise, arising from the use of this document.

**Figure 7**  
**Canadian Nickel Use, 2002**



Source: Natural Resources Canada.  
Note: Chart reflects total nickel use, including nickel in scrap.

**Figure 8**  
**Canadian Nickel Shipments, 1993-2002**



Source: Natural Resources Canada.

**TARIFFS**

Item No.	Description	Canada			United Canada	EU MFN	Japan (1) WTO	Brazil MFN	India MFN	Taiwan MFN	Korea (2) MFN
		MFN	GPT	USA							
2604.00	Nickel ores and concentrates	Free	Free	Free	Free	Free	Free	3.5%	5%	Free	1%
2825.40	Nickel oxides and hydroxides	Free	Free	Free	Free	Free	4.8%	3.5-11.5%	30%	2.5%	8%
7202.60	Ferro-nickel	6.5%	Free	Free	Free	Free	3.3%	7.5%	25%	Free	3%
7501.10	Nickel mattes	Free	Free	Free	Free	Free	Free	7.5%	15%	Free	1%
7501.20	Nickel oxide sinters and other intermediate products of nickel metallurgy	Free	Free	Free	Free	Free	Free- 44 yen/kg (3)	7.5%	15%	Free	1-2%
7502.10	Unwrought nickel, not alloyed	Free	Free	Free	Free	Free	44 yen/kg	7.5%	15%	1.00%	3%
7502.20	Unwrought nickel alloys	Free	Free	Free	Free	Free	Free-3% (4)	7.5%	15%	1.00%	3%
7503.00	Nickel waste and scrap	Free	Free	Free	Free	Free	Free	3.5%	15%	Free	1%
7504.00	Nickel powders and flakes	Free	Free	Free	Free	Free	Free- 41 yen/kg-3%	7.5%	15%	Free	5%
7505.11	Bars, rods and profiles of nickel, not alloyed	Free	Free	Free	Free	Free	3%	13.5%	15%	2.5%	5%
7505.12	Bars, rods and profiles of nickel alloys	Free	Free	Free	Free	2.90%	3%	13.5%	15%	2.5%	5%
7505.21	Nickel wire, not alloyed	Free	Free	Free	Free	Free	3%	13.5%	15%	1%	5%
7505.22	Wire of nickel alloys	Free	Free	Free	Free	2.90%	3%	13.5%	15%	1%	5%
7506.00	Nickel plates, sheets, strip and foil	Free	Free	Free	Free	Free-3.3%	Free-3%	13.5%	15%	2%	5%
7507.00	Nickel tubes, pipes, and tube or pipe fittings	Free	Free	Free	Free	Free-2.5%	Free-3%	15.5%	15%	2%	8%
7508.00	Other articles of nickel	Free-3%	Free	Free	Free	Free	3%	17.5%	15%	1-4.3%	8%

Sources: Canadian *Customs Tariff*, effective January 2003, Canada Customs and Revenue Agency; *Harmonized Tariff Schedule of the United States*, 2003; *Worldtariff Guidebook on Customs Tariff Schedules of Import Duties for European Union* (42nd Annual Edition: 2002); *Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of Brazil* (9th Annual Edition: 2002); *Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of India* (9th Annual Edition: 2002); *Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of Korea* (9th Annual Edition: 2002); *Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of Taiwan* (7th Annual Edition: 2002); *Worldtariff Guidebook on Customs Tariff Schedules of Import Duties for Japan* (36th Annual Edition: 2002).

(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 44 yen/kg, and nickel oxide containing by weight not more than 1.5% copper, for which the tariff rate is 3%. (4) The tariff rate of 3% applies to nickel alloys other than those containing by weight less than 50% nickel and not less than 10% cobalt.



**TARIFFS**

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2605.00	Cobalt ores and concentrates	Free	Free	Free	Free
2822.00	Cobalt oxides and hydroxides, commercial cobalt oxides	Free	Free	Free	Free
2827.34	Cobalt chloride	4%	3%	Free	Free
2833.29.00.40	Cobalt sulphate	Free	Free	Free	Free
2836.99.10.30	Cobalt carbonates for use in the manufacture of animal or poultry feeds, glues or adhesives, optical fibres or optical fibre bundles or cables, typewriter or similar ribbons, polymers in primary forms or profile shapes or sheets of plastics; cobalt carbonates to be employed as drilling mud or additives therefor in drilling for minerals, natural gas, oil or water	Free	Free	Free	Free
2836.99.90.20	Other cobalt carbonates	3.5%	3%	Free	Free
2915.23.10	Cobalt acetates for use as petroleum refining catalysts, or for use in the manufacture of animal or poultry feeds, glues or adhesives, optical fibres or optical fibre bundles or cables, typewriter or similar ribbons, polymers in primary forms or profile shapes or sheets of plastics	Free	Free	Free	Free
2915.23.90	Other cobalt acetates	6.5%	3%	Free	Free
8105	Cobalt mattes and other intermediate products of cobalt metallurgy; cobalt and articles thereof, including waste and scrap; unwrought cobalt; powders				
8105.20.10	Powders; unwrought cobalt, not alloyed	Free	Free	Free	Free
8105.20.90	Other	3%	Free	Free	Free
8105.90.10	Cobalt bars and rods, not alloyed	3%	Free	Free	Free
8105.90.90	Cobalt and articles thereof, n.e.s.	3%	Free	Free	Free

Sources: Canadian *Customs Tariff*, effective January 2003, Canada Customs and Revenue Agency; *Harmonized Tariff Schedule of the United States*, 2003.

n.e.s. Not elsewhere specified.

TABLE 1a. CANADA, NICKEL PRODUCTION AND TRADE, 2001 AND 2002

Item No.		2001		2002 (p)	
		(tonnes)	(\$000)	(tonnes)	(\$000)
<b>MINE OUTPUT</b>	Nickel content of concentrates produced	194 058	..	187 791	..
<b>SHIPMENTS</b>	Recoverable content of nickel in concentrates shipped from Canadian mines				
	Quebec	24 417	235 480	23 280	245 837
	Ontario	117 140	1 129 694	117 406	1 239 812
	Manitoba	42 743	412 215	37 652	397 602
	Total Canada	184 300	1 777 389	178 338	1 883 250
	Finished nickel output = refined nickel in various shapes in Class 1, plus Class II nickel (as defined by the International Nickel Study Group), which includes nickel oxide sinter	140 591	..	144 476	..
<b>EXPORTS</b>					
2604.00.40	Nickel ores and concentrates (nickel content)				
	United States	6	39	..	4
2825.40	Nickel oxides and hydroxides (weight of material, not nickel content)				
	Hong Kong	409	4 573	234	2 193
	China	91	969	126	1 203
	United States	120	1 134	164	1 052
	Singapore	60	615	64	587
	Japan	11	128	62	250
	Sweden	149	527	64	228
	Brazil	2	43	4	90
	Malaysia	8	77	8	80
	Saint Lucia	-	-	19	29
	Norway	-	-	2	22
	France	1	10	-	-
	Germany	2	25	-	-
	Total	853	8 101	747	5 734
2827.35	Nickel chlorides (weight of material, not nickel content)	-	-	-	-
2833.24	Nickel sulphates (weight of material, not nickel content)				
	United Kingdom	284	1 839	356	8 203
3815.11	Catalysts and other reaction initiators, reaction accelerators and catalytic preparations with nickel or nickel compounds as the substance (weight of material, not nickel content)				
	United States	138	62	1 514	607
	Belgium	19	100	-	-
	Total	157	162	1 514	607
7202.60	Ferronickel	-	-	-	-
7204.21	Stainless steel waste and scrap (weight of material, not nickel content)				
	United States	27 398	24 107	55 964	53 067
	China	1 372	1 400	4 870	3 626
	Taiwan	294	141	942	900
	India	858	827	523	635
	Japan	392	404	202	314
	Germany	-	-	51	130
	Netherlands	-	-	314	77
	South Korea	159	153	40	56
	Hungary	-	-	14	12
	Sweden	-	-	20	11
	Hong Kong	25	31	-	-
	United Kingdom	39	229	-	-
	Total	30 537	27 292	62 940	58 828
7501.10	Nickel mattes (nickel content)				
	Norway	48 381	663 611	49 781	571 056
7501.20	Nickel oxide sinters and other intermediate products of nickel metallurgy (weight of material, not nickel content)				
	United Kingdom	38 061	284 775	37 492	382 630
	South Korea	2 649	17 325	8 761	85 511
	Taiwan	1 292	8 447	2 145	24 001
	United States	1 621	15 556	1 547	12 323
	Belgium	500	3 757	689	8 172
	Total	44 123	329 860	50 634	512 637

TABLE 1a (cont'd)

Item No.		2001		2002 (p)	
		(tonnes)	(\$000)	(tonnes)	(\$000)
<b>EXPORTS (cont'd)</b>					
7502.10	Nickel unwrought, not alloyed				
	United States	50 740	528 980	48 193	507 010
	Belgium	10 482	99 989	8 711	91 318
	Hong Kong	8 410	89 666	8 168	88 010
	Netherlands	7 954	72 285	5 627	59 850
	Taiwan	5 806	57 032	4 882	54 922
	United Kingdom	3 909	36 581	3 877	41 604
	Italy	5 038	49 049	2 836	30 866
	Japan	2 158	21 057	2 827	29 491
	Singapore	3 816	33 125	2 646	28 081
	China	1 614	14 714	1 836	20 599
	South Korea	844	7 552	1 750	18 848
	Spain	120	998	1 628	17 608
	Thailand	1 231	11 183	797	8 775
	India	—	—	558	6 380
	Australia	750	7 661	401	3 999
	France	1 104	9 928	291	3 157
	Luxembourg	24	195	240	2 480
	Philippines	72	800	98	1 133
	Indonesia	150	1 649	99	1 099
	Sweden	—	—	96	1 022
	Switzerland	145	1 412	36	387
	Vietnam	—	—	30	310
	Venezuela	10	126	10	117
	Germany	...	25	5	51
	Chile	72	830	—	—
	Turkey	36	409	—	—
	Brazil	23	240	—	—
	Total	104 508	1 045 486	95 642	1 017 117
7502.20	Nickel unwrought, alloyed (weight of material, not nickel content)				
	China	747	7 834	2 918	33 928
	Hong Kong	3 692	38 075	1 867	19 751
	South Korea	807	8 561	1 040	11 664
	India	—	—	201	2 139
	Belgium	1 332	13 163	92	778
	United States	39	460	54	452
	Italy	—	—	26	393
	United Kingdom	4	28	—	—
	Total	6 621	68 121	6 198	69 105
7503.00	Nickel waste and scrap (weight of material, not nickel content)				
	United States	2 573	10 783	1 888	5 919
	Netherlands	120	130	103	234
	Japan	19	62	20	204
	United Kingdom	69	277	19	134
	India	—	—	53	108
	Italy	—	—	4	100
	Germany	...	2	—	—
	Total	2 781	11 254	2 087	6 699
7504.00	Nickel powders and flakes, alloyed and unalloyed (weight of material, not nickel content)				
	United States	4 516	75 130	4 416	70 633
	Japan	786	9 803	2 186	25 172
	South Korea	148	1 509	357	3 902
	Luxembourg	264	2 326	273	2 892
	United Kingdom	23	3 214	25	2 436
	Taiwan	126	1 238	207	2 118
	Belgium	18	252	234	2 025
	Netherlands	60	551	149	1 640
	Germany	46	810	107	1 325
	Australia	—	—	102	986
	China	20	161	42	448
	France	12	138	9	206
	Brazil	3	58	9	134
	Ireland	1	19	8	133
	Thailand	7	149	4	68
	Chile	—	—	3	54
	Sweden	42	467	7	54
	Philippines	—	—	4	49

TABLE 1a (cont'd)

Item No.	2001		2002		
	(tonnes)	(\$000)	(tonnes)	(\$000)	
<b>EXPORTS (cont'd)</b>					
	Argentina	...	3	3	45
	Indonesia	4	43	2	34
	Hong Kong	...	34	...	24
	New Zealand	—	—	...	20
	South Africa	2	64	1	10
	Ecuador	—	—	...	5
	Mexico	11	73	...	5
	Switzerland	2	26	—	—
	Czech Republic	1	11	—	—
	Turkey	2	26	—	—
	Austria	10	101	—	—
	India	...	9	—	—
	<b>Total</b>	<b>6 104</b>	<b>96 215</b>	<b>8 148</b>	<b>114 418</b>
7505.11	Bars, rods and profiles of nickel, not alloyed (nickel content)				
	United States	11	181	—	—
7505.12	Bars, rods and profiles of nickel alloy (weight of material, not nickel content)				
	United States	1	44	3	106
	France	—	—	...	6
	China	...	1	—	—
	Poland	1	6	—	—
	Brazil	17	105	—	—
	<b>Total</b>	<b>19</b>	<b>156</b>	<b>3</b>	<b>112</b>
7505.21	Nickel wire, not alloyed (weight of nickel wire plus coating if any, not nickel content)				
	United States	8	207	—	—
7505.22	Wire, nickel alloy (weight of alloy plus coating if any, not nickel content)				
	United States	22	493	5	168
	France	—	—	...	7
	Sweden	19	137	—	—
	<b>Total</b>	<b>41</b>	<b>630</b>	<b>5</b>	<b>175</b>
7506.00 (a)	Nickel plates, sheets, strip and foil (weight of material, not nickel content)				
	United States	16	676	...	621
	Sweden	—	—	20	185
	Poland	12	147	3	46
	Romania	—	—	1	10
	Libyan Arab Jamahiriya	—	—	1	4
	China	1	15	—	—
	South Korea	...	3	—	—
	<b>Total</b>	<b>29</b>	<b>841</b>	<b>25</b>	<b>866</b>
7507.00 (b)	Tubes, pipes and tube or pipe fittings alloyed and unalloyed (weight of material, not nickel content)				
	United States	..	2 864	..	1 779
	Venezuela	—	—	..	512
	Germany	..	7	..	331
	South Korea	—	—	..	75
	Singapore	..	91	..	69
	Algeria	—	—	..	56
	India	—	—	..	28
	United Arab Emirates	..	344	..	16
	France	—	—	..	11
	Australia	..	18	..	4
	Japan	..	267	—	—
	Brazil	..	647	—	—
	Malaysia	..	43	—	—
	New Zealand	..	3	—	—
	<b>Total</b>	<b>..</b>	<b>4 284</b>	<b>..</b>	<b>2 881</b>
7508.00	Other articles of nickel (weight of material, not nickel content)				
	United States	..	11 933	..	14 026
	Germany	..	104	..	312
	France	..	62	..	194
	Sweden	..	6	..	174

TABLE 1a (cont'd)

Item No.	2001		2002 (p)		
	(tonnes)	(\$000)	(tonnes)	(\$000)	
<b>EXPORTS (cont'd)</b>					
Cuba	..	7	..	139	
China	..	147	..	134	
Dominican Republic	–	–	..	100	
Poland	..	179	..	77	
Saudi Arabia	–	–	..	56	
Norway	–	–	..	56	
Australia	..	22	..	33	
United Kingdom	..	152	..	33	
Italy	..	38	..	15	
South Africa	–	–	..	8	
Netherlands	..	5	..	8	
Singapore	..	32	..	8	
Spain	–	–	..	7	
Hong Kong	..	14	..	3	
Switzerland	..	2	..	2	
French Polynesia	–	–	..	2	
South Korea	..	9	–	–	
New Zealand	..	60	–	–	
Total	..	12 772	..	15 387	
Total exports	..	2 271 051	..	2 383 829	
<b>IMPORTS</b>					
2604.00.00.20	Nickel ores and concentrates (nickel content)				
	<a href="#">Australia (1)</a>	1 003	9 216	73 365	109 487
	Germany	–	–	6 179	12 177
	United States	938	5 929	10 774	6 281
	France	–	–	19	56
	Ivory Coast	–	–	2	15
	Total	1 941	15 145	90 339	128 016
<b>(NOTE: Trade data for 2604.00.00.20 imports for 2001 and 2002 are believed to be incorrect. Reader should refer to footnote (1) of Table 1a and to page 3 of the text.)</b>					
2620.90	Ash and residues (material believed to contain nickel and cobalt)				
	<a href="#">Cuba (2)</a>	–	303 997	–	333 314
2825.40	Nickel oxides and hydroxides (weight of material, not nickel content)				
	Finland	498	7 036	177	2 046
	United States	3 126	1 254	1 713	899
	Belgium	–	–	1	7
	Total	3 624	8 290	1 891	2 952
2827.35	Nickel chlorides (weight of material, not nickel content)				
	France	63	350	102	680
	United States	77	502	70	441
	Germany	–	–	..	2
	China	–	–	..	1
	Total	140	852	172	1 124
2833.24	Nickel sulphates (weight of material, not nickel content)				
	United States	1 610	5 228	2 381	5 284
	Finland	204	555	303	787
	Belgium	102	294	172	579
	Austria	6	18	20	60
	Germany	–	–	20	58
	Australia	2	6	–	–
	France	3	9	–	–
	South Africa	..	1	–	–
	Total	1 927	6 111	2 896	6 768

TABLE 1a (cont'd)

Item No.		2001		2002 (p)	
		(tonnes)	(\$000)	(tonnes)	(\$000)
<b>IMPORTS (cont'd)</b>					
3815.11	Catalysts and other reaction initiators, reaction accelerators and catalytic preparations with nickel or nickel compounds as the substance (weight of material, not nickel content)				
	Luxembourg	–	–	136	6 073
	United States	489	5 519	337	4 458
	Germany	237	2 799	176	2 068
	Denmark	61	1 878	61	1 801
	United Kingdom	191	2 562	61	947
	South Africa	–	–	30	667
	India	14	116	38	371
	Netherlands	6	90	1	24
	Japan	–	–	1	18
	Belgium	8	186	2	15
	France	...	7	...	1
	<b>Total</b>	<b>1 006</b>	<b>13 157</b>	<b>843</b>	<b>16 443</b>
7202.60	Ferronickel (weight of material, not nickel content)				
	United States	65	339	14	74
	France	–	–	1	3
	<b>Total</b>	<b>65</b>	<b>339</b>	<b>15</b>	<b>77</b>
7204.21	Stainless steel scrap (weight of material, not nickel content)				
	United States	35 720	29 407	34 450	32 596
	China	238	259	291	312
	Canada	1	1	54	46
	Zimbabwe	–	–	19	13
	United Kingdom	–	–	1	...
	<b>Total</b>	<b>35 959</b>	<b>29 667</b>	<b>34 815</b>	<b>32 967</b>
7501.00 (c)	Nickel mattes (nickel content), nickel oxide sinters and other intermediate products of nickel metallurgy (weight of material, not nickel content)				
	Australia	4 634	26 187	513	2 537
	Belgium	353	453	–	–
	Chile	32	79	–	–
	Germany	982	1 041	–	–
	Japan	1	7	–	–
	New Caledonia	...	...	–	–
	Russia	34	40	–	–
	South Africa	1 564	5 997	375	2 206
	Taiwan	...	1	–	–
	United Kingdom	2	16	–	–
	United States	2 297	6 112	842	2 673
	<b>Total</b>	<b>9 899</b>	<b>39 933</b>	<b>1 730</b>	<b>7 416</b>
7502.10	Nickel unwrought, not alloyed (nickel content)				
	Norway	1 029	9 846	934	9 601
	Finland	171	1 913	261	2 442
	United States	56	657	195	1 955
	United Kingdom	45	266	94	1 131
	Canada	22	220	41	487
	Russia	65	612	39	430
	Nauru	–	–	37	408
	Zimbabwe	1	5	3	29
	France	11	123	1	13
	South Africa	4	32	1	5
	China	25	271	–	–
	Germany	...	4	–	–
	<b>Total</b>	<b>1 429</b>	<b>13 949</b>	<b>1 606</b>	<b>16 501</b>
7502.20	Nickel unwrought, alloyed (weight of material, not nickel content)				
	Russia	900	5 235	665	3 915
	United States	171	1 701	251	2 171
	United Kingdom	25	340	12	248
	Netherlands	–	–	20	92
	Germany	331	1 375	4	52
	France	–	–	...	3
	South Korea	–	–	...	3

TABLE 1a (cont'd)

Item No.	2001		2002 (p)		
	(tonnes)	(\$000)	(tonnes)	(\$000)	
<b>IMPORTS (cont'd)</b>					
	Belgium	...	5	...	2
	Norway	—	—	...	1
	Italy	...	...	...	1
	Austria	—	—	...	1
	Malaysia	104	198	—	—
	Total	1 531	8 860	952	6 489
7503.00	Nickel waste and scrap (weight of material, not nickel content)				
	United States	21 246	46 487	20 982	48 327
	United Kingdom	626	4 605	307	2 119
	Norway	38	374	70	457
	France	—	—	57	345
	Netherlands	—	—	37	166
	Latvia	—	—	41	137
	Germany	110	224	30	104
	Switzerland	—	—	21	76
	Japan	—	—	7	53
	Canada	25	70	3	6
	Argentina	14	60	—	—
	Russia	89	502	—	—
	South Africa	60	495	—	—
	Total	22 208	52 817	21 555	51 790
7504.00	Nickel powders and flakes, alloyed and unalloyed (weight of material, not nickel content)				
	Australia	1 323	12 831	673	6 478
	United States	261	4 203	360	4 350
	Germany	227	2 787	211	2 853
	United Kingdom	20	291	69	774
	Ireland	18	394	37	770
	Russia	11	125	27	366
	Belgium	104	1 222	4	61
	South Africa	—	—	3	43
	Finland	—	—	2	37
	Canada	2	57	2	30
	Sweden	...	12	...	14
	Israel	—	—	1	10
	Japan	3	75	1	7
	Austria	1	9	...	6
	Italy	...	1	...	5
	South Korea	7	75	...	1
	Switzerland	8	184	—	—
	Denmark	1	6	—	—
	Total	1 986	22 272	1 390	15 805
7505.11	Bars, rods and profiles of nickel, not alloyed (nickel content)				
	United States	11	194	15	294
	Germany	...	8	...	9
	United Kingdom	...	1	—	—
	Canada	...	1	—	—
	Total	11	204	15	303
7505.12	Bars, rods and profiles of nickel alloy (weight of material, not nickel content)				
	United States	937	19 987	629	14 557
	Germany	22	402	52	886
	Italy	17	377	16	442
	France	...	9	12	172
	United Kingdom	6	110	6	130
	Sweden	—	—	4	76
	Japan	7	157	2	63
	Canada	3	46	1	29
	Taiwan	...	1	...	6
	Spain	—	—	...	6
	Brazil	—	—	...	5
	China	—	—	...	2
	Mexico	—	—	...	1
	Romania	—	—	...	1
	Russia	—	—	...	1

TABLE 1a (cont'd)

Item No.	2001		2002(p)		
	(tonnes)	(\$000)	(tonnes)	(\$000)	
<b>IMPORTS (cont'd)</b>					
	Argentina	1	6	-	-
	Austria	...	1	-	-
	Netherlands	...	6	-	-
	Cayman Islands	1	29	-	-
	Total	994	21 131	722	16 377
7505.21	Nickel wire, not alloyed (weight of nickel wire plus coating if any, not nickel content)				
	United States	41	483	43	521
	Japan	11	93	12	133
	Germany	10	178	1	10
	Sweden	4	48	...	1
	Switzerland	...	5	-	-
	Canada	...	3	-	-
	China	...	4	-	-
	Total	66	814	56	665
7505.22	Wire, nickel alloy (weight of alloy plus coating if any, not nickel content)				
	United States	314	6 709	285	5 455
	Sweden	32	623	87	1 609
	United Kingdom	70	525	88	1 345
	Germany	70	1 195	75	1 246
	France	36	495	39	562
	Australia	4	52	12	199
	Italy	3	50	9	179
	Austria	26	373	6	108
	Canada	-	-	1	4
	Japan	-	-	...	3
	China	-	-	...	1
	Mexico	...	4	...	1
	Taiwan	...	1	...	1
	New Zealand	-	-	...	1
	South Korea	4	26	-	-
	Belgium	15	211	-	-
	Swaziland	...	2	-	-
	Total	574	10 265	602	10 714
7506.00	Nickel plates, sheets, strip and foil (weight of material, not nickel content)				
	United States	440	10 552	591	12 621
	Germany	150	2 632	259	5 080
	Japan	8	160	18	360
	Netherlands	-	-	2	178
	Sweden	1	21	4	73
	United Kingdom	4	88	2	50
	Italy	...	14	4	33
	Spain	-	-	1	18
	France	1	42	1	15
	India	-	-	1	14
	Switzerland	-	-	...	9
	Bulgaria	-	-	...	4
	South Korea	-	-	...	2
	Poland	-	-	...	2
	Canada	...	1	-	-
	Finland	...	3	-	-
	Belgium	...	7	-	-
	Israel	...	4	-	-
	Total	604	13 524	883	18 459
7507.00	Tubes, pipes and tube or pipe fittings alloyed and unalloyed (weight of material, not nickel content)				
	Japan	782	37 548	514	17 805
	United States	770	15 941	551	12 963
	Norway	121	1 123	444	5 440
	France	53	1 996	63	2 105
	Germany	57	1 349	91	1 188
	United Kingdom	56	1 119	31	1 133
	Sweden	3	55	15	242
	Italy	8	214	22	206
	Spain	1	22	3	67
	Canada	...	3	1	14



TABLE 1a (cont'd)

Item No.	2001		2002 (p)	
	(tonnes)	(\$000)	(tonnes)	(\$000)
<b>IMPORTS (cont'd)</b>				
Brazil	17	293	1	6
India	–	–	1	4
Argentina	–	–	...	3
Indonesia	–	–	...	2
South Korea	–	–	...	2
Australia	–	–	...	1
Austria	...	4	...	1
Hong Kong	...	4	...	1
Taiwan	1	11	...	1
China	2	10	–	–
Mexico	9	85	–	–
Russia	38	300	–	–
Total	1 918	60 077	1 737	41 184
7508.00	Other articles of nickel (weight of material, not nickel content)			
United States	737	12 872	711	11 457
China	65	484	77	742
Switzerland	39	254	100	667
Canada	32	311	34	589
United Kingdom	37	703	31	573
Taiwan	32	385	37	460
France	353	1 372	33	458
Germany	4	45	15	400
Israel	9	196	3	92
Italy	7	130	5	71
India	2	41	4	66
Thailand	...	2	10	59
South Korea	2	14	3	47
Netherlands	1	9	1	22
Australia	1	10	1	17
Indonesia	3	6	1	11
Austria	1	3	1	8
Hong Kong	2	21	2	7
Poland	1	10	1	7
Japan	4	23	1	6
Czech Republic	–	–	...	6
Malaysia	...	6	...	3
Spain	–	–	...	2
Sweden	–	–	...	2
Greece	...	4	...	1
South Africa	–	–	...	1
Mexico	...	5	...	1
Norway	2	19	–	–
Total	1 334	16 925	1 071	15 775
Total imports		638 330		723 139
Total exports	..	2 271 051	..	2 383 829
Net exports of nickel		1 632 721		1 660 690

Sources: Natural Resources Canada; Statistics Canada.

– Nil; .. Not available or not applicable; ... Amount too small to be expressed; (p) Preliminary.

(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) While no imports from Australia were recorded in 2000, Jubilee Mines NL recorded at least two shipments of nickel in concentrates to Canada in 2000; an investigation into these shipments has not been completed. In 2001, data shown by Statistics Canada are suspect as reported Australian shipments of nickel in concentrates to Canada were 11 675 t. In addition, the United States has no domestic producers of nickel in concentrate, so country of origin is wrong or classification is in error. In 2002, the data reported seriously overestimate the amount of nickel in concentrates imported from Australia and may be the tonnage of concentrates imported. Australian data show exports of 15 612 t of nickel in concentrates to Canada for 2002. Germany and the United States do not produce nickel concentrates so reported imports may come from other countries or be misclassified. (2) Nickel and cobalt are in an artificial nickel-cobalt sulphide made at an acid leach plant in Cuba using nickel-cobalt oxides as feed. The values reflect both the nickel and the cobalt contents.

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

**TABLE 1b. CANADA, NICKEL PRODUCTION AND USE, 1970, 1975, 1980 AND 1985-2002**

	Production (1) (Mine Output)	Use (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	(a) 13 322
1992	186 384	15 528
1993	188 080	(a) 17 384
1994	149 886	20 746
1995	181 820	20 973
1996	192 649	24 504
1997	(r) 190 502	19 447
1998	(r) 208 301	19 787
1999	(r) 186 236	22 527
2000	190 793	24 976
2001	194 058	17 735
2002 (p)	187 791	18 955

Source: Natural Resources Canada.

(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 1987-2002 are nickel contained in concentrates produced.

(2) Use 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 users on the Natural Resources Canada survey "Nickel Used."

Note: Metals are used in industrial and consumer applications; unlike fuel oil or agricultural commodities, metals are not "used up" or "consumed"; instead, they are recycled. Discussions taking place in international fora indicate that the term "consumption" should be changed to more appropriately reflect actual practice. For this reason, the word "use" has replaced "consumption" in this chapter, where appropriate.

**TABLE 1c. CUPRONICKEL, NICKEL-SILVER, STAINLESS STEELS, AND NICKEL-CADMIUM AND NICKEL-IRON BATTERIES, 2001 AND 2002**

	2001		2002	
	(tonnes)	(\$000)	(tonnes)	(\$000)
<b>STAINLESS STEEL SEMI-FABRICATED ITEMS</b> (excludes scrap)				
<b>Exports – Total For Each HS Class</b>				
7204.29	104 207	20 582	117 663	28 377
7210.90	4 988	7 392	12 112	11 973
7220.20	3 871	12 694	5 739	19 349
7222.11	6 686	15 595	2 902	6 341
7222.19	238	1 032	285	1 328
7222.20	11 502	57 483	5 767	30 415
7222.30	1 568	6 844	3 706	18 310
Total exports	133 060	121 622	148 174	28 464
<b>Imports – Total For Each HS Class</b>				
7204.29	163 183	51 916	155 277	50 197
7210.90	5 080	11 408	9 238	21 181
7212.50.90.13	3 336	8 038	3 508	9 356
7222.11	2 475	10 082	2 229	9 264
7222.19	3 004	14 668	3 831	15 648
7222.20.10	158	925	94	577
7222.20.90	9 187	36 856	9 750	36 387
7222.30.00.11	203	1 341	58	274
7222.30.00.19	5	22	2	10
Total imports	186 631	135 256	183 987	142 894
Net exports of stainless steels	-53 571	-13 634	-35 813	-114 430
<b>CUPRO-NICKEL AND NICKEL-SILVER SEMI-FABRICATED GOODS</b> (nickel-silver is a copper-nickel-zinc alloy)				
<b>Exports – Total For Each HS Class</b>				
7403.23	95	330	–	–
7407.22	150	1 067	239	1 563
7408.22	22	341	65	747
7409.40	1 899	9 823	615	2 569
7411.22	4 805	37 911	5 602	44 905
Total exports	6 971	49 472	6 521	49 784
<b>Imports – Total For Each HS Class</b>				
7403.23.00.10 to 7403.23.00.40	84	300	49	189
7407.22.11 to 7407.22.29.10	89	426	147	689
7408.22.10 to 7408.22.90.30	344	935	262	787
7409.40.00.11 to 7409.40.00.40	108	522	112	578
7411.22.00.10 to 7411.22.00.30	416	2 726	403	2 833
Total imports	1 041	4 909	973	5 076
Net exports of cupro-nickel and nickel-silver	5 930	44 563	5 548	44 708
<b>ELECTRIC ACCUMULATORS</b> (nickel-cadmium and nickel-iron batteries)				
<b>Exports – Total For Each HS Class</b>				
8507.30 Ni-Cd batteries	..	7 916	..	3 463
8507.40 Ni-Fe batteries	..	158	..	67
Total exports	..	8 074	..	3 530
<b>Imports – Total For Each HS Class</b>				
8507.30 Ni-Cd batteries	..	43 861	..	44 896
8507.40 Ni-Fe batteries	..	840	..	1 360
Total imports	..	44 701	..	46 256
Net exports of Ni-Cd and Ni-Fe batteries	..	-36 627	..	-42 726

Source: Natural Resources Canada.

– Nil; .. Not available.

**TABLE 2a. CANADA, COBALT PRODUCTION AND TRADE, 2001 AND 2002, AND USE, 2000-02**

Item No.		2001		2002 (p)	
		(kilograms)	(\$000)	(kilograms)	(\$000)
<b>MINE OUTPUT</b>	Cobalt content of concentrates produced	5 325 593		5 092 795	
<b>SHIPMENTS</b>	Recoverable content of cobalt in concentrates				
	Quebec	321 152	12 313	315 636	7 634
	Ontario	1 401 627	53 737	1 373 674	33 224
	Manitoba	389 636	14 938	338 153	8 179
	Total	2 112 415	80 988	2 027 463	49 036
	<u>Refined (1)</u>	4 062 613		4 303 055	
<b>EXPORTS</b>					
2605.00	Cobalt ores and concentrates (cobalt content)	—	—	—	—
2822.00	Cobalt oxides and hydroxides; commercial cobalt oxides (weight of material, not cobalt content)				
	United Kingdom	355 512	10 305	287 374	7 232
2915.23	Cobalt acetates (weight of material, not cobalt content)	—	—	—	—
8105.10	Cobalt, mattes and other intermediate products of cobalt metallurgy; unwrought cobalt; waste, scrap and powders (cobalt content of unwrought and mattes, and powders; weight of material for intermediates, alloys and waste and scrap)				
	Argentina	500	14	—	—
	Australia	73 000	2 275	—	—
	Belgium	410 038	20 104	—	—
	China	20 000	643	—	—
	France	—	—	—	—
	Hong Kong	85 174	2 219	—	—
	India	857	47	—	—
	Indonesia	—	—	—	—
	Japan	1 003 191	31 922	—	—
	South Korea	21 950	1 137	—	—
	Mexico	—	—	—	—
	Netherlands	584 800	20 510	—	—
	Norway	1 546 190	51 805	—	—
	Singapore	302 400	8 973	—	—
	United Kingdom	95 562	3 880	—	—
	United States	830 747	34 220	—	—
	Germany	1 724	185	—	—
	Portugal	500	22	—	—
	Switzerland	32	2	—	—
	Taiwan	250	12	—	—
	Total	4 976 915	177 970	—	—
8105.20	Cobalt mattes and other intermediate products; powders				
	Japan	—	—	1 704 195	41 804
	Norway	—	—	1 584 011	35 355
	United States	—	—	889 704	25 061
	Netherlands	—	—	620 200	14 723
	Singapore	—	—	533 550	12 644
	Belgium	—	—	382 771	11 943
	Taiwan	—	—	190 470	4 725
	Hong Kong	—	—	150 000	3 464
	United Kingdom	—	—	80 000	2 038
	China	—	—	19 173	994
	South Korea	—	—	20 949	855
	Indonesia	—	—	5 000	118
	Argentina	—	—	2 000	49
	Total			6 182 023	153 773
8105.30	Cobalt waste and scrap				
	United States	—	—	41 800	311

TABLE 2a (cont'd)

Item No.		2001		2002 (p)	
		(kilograms)	(\$000)	(kilograms)	(\$000)
<b>EXPORTS (cont'd)</b>					
8105.90	Cobalt and articles thereof, n.e.s.				
	United States	17 671	4 454	19 922	5 355
	Germany	11 184	3 092	8 584	1 536
	Switzerland	—	—	2 952	143
	Japan	—	—	10 041	120
	Brazil	106	21	264	51
	Ireland	—	—	734	47
	Sweden	396	87	138	41
	United Kingdom	1 116	227	138	32
	Mexico	188	56	94	26
	Panama	—	—	62	12
	South Korea	1	...	2	...
	Argentina	—	—	—	—
	Australia	—	—	—	—
	Austria	856	223	—	—
	France	—	—	—	—
	Netherlands	—	—	—	—
	China	73	19	—	—
	Dominican Republic	8	2	—	—
	Total	31 599	8 181	42 931	7 363
	Total exports	5 008 514	196 456	6 266 754	14 595
<b>IMPORTS (2)</b>					
2805.00	Cobalt ores and concentrates (cobalt content)				
	United States	18 724	626	18 892	309
	Finland	39 453	1 316	12 788	306
	Germany	60 541	589	8 915	90
	Belgium	2 970	115	—	—
	Poland	—	—	—	—
	Switzerland	—	—	—	—
	Total	121 688	2 646	40 595	705
2822.00.00.10	Cobalt hydroxides (weight of material, not cobalt content)				
	United States	31 367	1 270	5 697	336
	Finland	2 553	168	680	30
	United Kingdom	20	1	162	9
	Netherlands	—	—	—	—
	Belgium	32	2	—	—
	Total	33 972	1 441	6 539	375
2822.00.00.20	Cobalt oxides (weight of material, not cobalt content)				
	Japan	10 005	661	15 023	852
	United States	2 774	140	1 458	69
	Belgium	55 804	1 968	409	12
	Finland	75	5	45	3
	South Korea	—	—	—	—
	Australia	324	27	—	—
	Total	68 982	2 801	16 935	936
2822.00.00.30	Commercial cobalt oxides (weight of material, not cobalt content)				
	United Kingdom	492	9	491	9
	United States	364	8	304	6
	Italy	—	—	13	...
	Belgium	—	—	—	—
	South Korea	22 002	704	—	—
	Total	22 858	721	808	15
2827.34	Cobalt chlorides (weight of material, not cobalt content)				
	United States	45 409	703	20 605	318
	Japan	—	—	400	5
	United Kingdom	23	...	20	...
	Germany	50	1	8	...
	Total	45 482	704	21 033	323

TABLE 2a (cont'd)

Item No.		2001		2002 (p)	
		(kilograms)	(\$000)	(kilograms)	(\$000)
<b>IMPORTS (cont'd)</b>					
2833.29.00.40	Cobalt sulphate (weight of material, not cobalt content)				
	United States	24 371	399	41 443	609
	Philippines	1 814	25	12 426	164
	Finland	5 946	67	13 490	129
	China	—	—	500	4
	Russia	100	1	25	...
	Germany	—	—	3	...
	France	1 000	5	—	—
	United Kingdom	—	—	—	—
	Brazil	1 816	25	—	—
	Total	35 047	522	67 887	906
2836.99.10.30	Cobalt carbonates (weight of material, not cobalt content)				
	Philippines	..	28	..	170
	United States	..	89	..	46
	Belgium	..	37	—	—
	Finland	..	9	—	—
	Brazil	..	33	—	—
	Total	..	196	..	216
2836.99.90.20	Other cobalt carbonates (weight of material, not cobalt content)				
	United States	12 473	324	5 528	124
	Finland	16 783	367	5 196	106
	China	—	—	500	9
	New Caledonia	—	—	1	...
	Total	29 256	691	11 225	239
2915.23	Cobalt acetates (weight of material, not cobalt content)				
	United States	26 645	301	13 516	153
	Canada	—	—	—	—
	United Kingdom	—	—	—	—
	Japan	13	...	—	—
	Total	26 658	301	13 516	153
8105.10.10.10	Cobalt waste and scrap fit only for remelting and recovery of the metal content (weight of material, not cobalt content)				
	Canada	—	—	—	—
	Germany	481 787	471	—	—
	Trinidad and Tobago	87	5	—	—
	United States	24 610	570	—	—
	Congo	199 616	1 109	—	—
	Japan	30 329	71	—	—
	Netherlands	37 106	151	—	—
	United Kingdom	105	5	—	—
	Total	773 640	2 382	—	—
8105.10.10.20	Cobalt powders (cobalt content)				
	Australia	367 580	9 224	—	—
	Belgium	90 202	2 935	—	—
	France	1 469	151	—	—
	Germany	422	32	—	—
	Hong Kong	—	—	—	—
	Japan	5 010	57	—	—
	Netherlands	—	—	—	—
	South Africa	55 502	1 963	—	—
	Sweden	136	7	—	—
	United Kingdom	5 709	324	—	—
	United States	77 744	3 355	—	—
	Finland	59 403	2 144	—	—
	Ireland	6 000	205	—	—
	Russia	82	6	—	—
	Switzerland	13 008	383	—	—
	Total	682 267	20 786	—	—

TABLE 2a (cont'd)

Item No.		2001		2002 (p)	
		(kilograms)	(\$000)	(kilograms)	(\$000)
<b>IMPORTS (cont'd)</b>					
8105.10.10.30	Unwrought cobalt, not alloyed (cobalt content)				
	Bahamas	-	-	-	-
	Congo	27 907	881	-	-
	Japan	-	-	-	-
	Russia	-	-	-	-
	Switzerland	-	-	-	-
	United States	1 502	81	-	-
	Belgium	15	1	-	-
	Ireland	83	3	-	-
	Zambia	4 000	122	-	-
	Total	33 507	1 087	-	-
8105.10.90	Unwrought cobalt, alloyed, mattes and other intermediate products of cobalt metallurgy (cobalt content of unwrought and mattes; weight of material for intermediates and alloys)				
	Switzerland	-	-	-	-
	United States	14 706	473	-	-
	Japan	284	4	-	-
	Total	14 990	477	-	-
8105.20.10.10	Cobalt powders				
	Australia	-	-	441 328	8 023
	United States	-	-	50 289	2 403
	Germany	-	-	13 382	364
	United Kingdom	-	-	7 556	341
	Finland	-	-	11 700	282
	South Africa	-	-	6 000	163
	France	-	-	1 717	136
	Belgium	-	-	1 309	70
	Canada	-	-	792	17
	China	-	-	250	7
	Sweden	-	-	140	3
	Norway	-	-	15	...
	Total	-	-	534 478	11 809
8105.20.10.20	Unwrought cobalt, not alloyed				
	Congo	-	-	20 107	457
	United States	-	-	7 874	380
	South Africa	-	-	10 538	247
	Brazil	-	-	6 000	124
	Russia	-	-	4 094	106
	Belgium	-	-	1 136	29
	Norway	-	-	250	7
	Germany	-	-	73	5
	France	-	-	40	3
	United Kingdom	-	-	9	1
	Japan	-	-	1	...
	Total	-	-	50 122	1 359
8105.20.90	Other				
	United States	-	-	2 797	125
8105.30	Cobalt waste and scrap				
	United States	-	-	190 784	784
	Germany	-	-	590 595	663
	Japan	-	-	15 017	19
	Zimbabwe	-	-	123	6
	Hong Kong	-	-	400	2
	Total	-	-	796 919	1 474
8105.90.00.10	Cobalt bars and rods, not alloyed (cobalt content)				
	United States	4 550	422	8 363	654
	Canada	97	6	152	10
	Japan	55	3	49	3
	United Kingdom	-	-	-	-
	Switzerland	26	2	-	-
	Total	4 728	433	8 564	667

**TABLE 2a (cont'd)**

Item No.	2001		2002 (p)		
	(kilograms)	(\$000)	(kilograms)	(\$000)	
<b>IMPORTS (cont'd)</b>					
8105.90.00.90	Cobalt and articles thereof, n.e.s. (cobalt content)				
	United States	51 051	6 558	33 766	4 064
	Norway	–	–	20 167	1 061
	United Kingdom	459	25	619	34
	Canada	999	75	445	29
	Japan	10	1	558	18
	Germany	1	..	111	12
	France	–	–	138	8
	Belgium	997	69	29	2
	South Africa	–	–	1	..
	China	8	1	–	–
	Mexico	–	–	–	–
	Switzerland	–	–	–	–
	Total	53 525	6 729	55 834	5 228
	Total imports		41 917		24 530
	Total exports		196 456		14 595
	Net exports		154 539		-9 935
<b>USE (3)</b>					
		<b>2000</b>	<b>2001</b>	<b>2002</b>	
		(kilograms)			
Cobalt contained in:					
	Cobalt metal and metallic compounds	46 698	x	54 532	
	Cobalt pigments, feed and ground coat frit	8 487	x	x	
	Cobalt salts and driers and other uses (4)	71 530	52 657	x	
	Total	126 715	94 270	91 962	

Sources: Natural Resources Canada; Statistics Canada.

– Nil; .. Not available or not applicable; ... Amount too small to be expressed; (p) Preliminary; x Confidential.

(1) This total includes cobalt refined production sourced from both domestic and imported feed materials, including mixed nickel-cobalt sulphides from Cuba.

(2) Nickel-cobalt sulphides as reported by the International Nickel Study Group (imported into Canada under classification HS 2620.90 Ash and Residue). This material shown in Table 1a includes both the weight and value of imported nickel and cobalt from Cuba and is not included in this table. (3) Available data as reported by users. (4) Other uses include glass and chemicals.

Notes: Numbers may not add to totals due to rounding. The absence of a tonnage and value for the cobalt being imported from Cuba (total value shown in nickel Table 1a, entry 2620.90) in the mixed nickel-cobalt sulphides from Cuba means that the total imports shown are less than the actual imports.



**TABLE 2b. CANADA, COBALT PRODUCTION, TRADE AND USE, 1975 AND 1980-2002**

	Concentrate Shipments (1)	Processed Cobalt Exports (2)	Cobalt Oxide and Hydroxide Exports	Cobalt Ore and Concentrate Exports (3)	Cobalt Oxide and Hydroxide Imports (4)	Use (5)
(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	371	22	33	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	204	–	81	193
1995	2 016	4 227	–	–	41	148
1996	2 150	(r) 4 488	632	–	33	147
1997	2 168	5 829	526	–	39	136
1998	2 262	6 592	457	–	45	146
1999	2 014	6 307	224	10	114	130
2000	2 022	4 987	335	–	103	127
2001	2 112	5 008	355	–	126	94
2002 (p)	2 027	6 225	287	–	24	92

Sources: Natural Resources Canada; Statistics Canada.

– Nil; .. Not available; (p) Preliminary; (r) Revised.

(1) Production includes recoverable cobalt in concentrates shipped. Beginning in 1988, exports and imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. (2) Processed cobalt includes all forms classified in HS code 8105.10 (intermediate forms such as cobalt in matte, unwrought cobalt, alloyed cobalt, waste or scrap of cobalt, cobalt powders) plus all forms classified in HS code 8105.90 (cobalt and articles thereof, not elsewhere specified). (3) Cobalt content. From 1975 to 1988, cobalt recovered in Canada from domestic concentrate plus exports of payable cobalt in concentrate. Starting in 1989 to date, recoverable cobalt in concentrates shipped. (4) Gross weight. Producers' domestic shipments of refined cobalt plus imports of refined shapes. (5) Use of cobalt in metal, oxides and salts; available data as reported by user.

**TABLE 3. CANADIAN NICKEL PRODUCERS - SOURCES FOR MORE CORPORATE INFORMATION ON THE INTERNET**

Full Corporate Name	Web Site	SEDAR Site
Canmine Resources Corporation	not available	<a href="http://www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&amp;issuerNo=00012293&amp;lang=EN">www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&amp;issuerNo=00012293&amp;lang=EN</a>
Falconbridge Limited	<a href="http://www.falconbridge.com">www.falconbridge.com</a>	<a href="http://www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&amp;issuerNo=00000376&amp;lang=EN">www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&amp;issuerNo=00000376&amp;lang=EN</a>
Inco Limited	<a href="http://www.inco.com">www.inco.com</a>	<a href="http://www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&amp;issuerNo=00001084&amp;lang=EN">www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&amp;issuerNo=00001084&amp;lang=EN</a>
Voisey's Bay Nickel Corporation	<a href="http://www.vbnc.com">www.vbnc.com</a>	<a href="http://www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&amp;issuerNo=00001084&amp;lang=EN">www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&amp;issuerNo=00001084&amp;lang=EN</a>
North American Palladium Ltd.	<a href="http://www.napalladium.com">www.napalladium.com</a>	<a href="http://www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&amp;issuerNo=00003026&amp;lang=EN">www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&amp;issuerNo=00003026&amp;lang=EN</a>
Sherritt International Corporation	<a href="http://www.sherritt.com">www.sherritt.com</a>	<a href="http://www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&amp;issuerNo=00002460&amp;lang=EN">www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&amp;issuerNo=00002460&amp;lang=EN</a>
Dynatec Corporation	<a href="http://www.dynatec.ca">www.dynatec.ca</a>	<a href="http://www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&amp;issuerNo=00008191&amp;lang=EN">www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&amp;issuerNo=00008191&amp;lang=EN</a>
FNX Mining Company Inc.	<a href="http://www.fnxmining.com">www.fnxmining.com</a>	<a href="http://www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&amp;issuerNo=00008610&amp;lang=EN">www.sedar.com/command_servlet?cmd=DisplayCompanyDocuments&amp;issuerNo=00008610&amp;lang=EN</a>

Source: Natural Resources Canada.

TABLE 4. CANADIAN NICKEL PRODUCERS

Company	Location	Operation	Production Data				Type of Ni Output	Remarks
			Nickel 2001	Nickel 2002	Cobalt 2001	Cobalt 2002		
				(t)				
Canmine Resources Corporation	Cobalt, Ont.	Hydrometallurgical refinery	–	minimal	–	minimal	Ch	Refinery commissioning started in Dec. 2001; scheduled to be completed in late Q1 2002; initial capacity of 300 t/y Co in chemicals plus by-product Ni in chemicals.
Falconbridge Limited	Katinniq, in Nunavik territory, Que.	Raglan mine/mill	24 570	24 636	318	386	S	Mill optimization completed, mill operated at capacity in Q4; forecast production for 2002 of 26 000 t Ni in concentrate (Jan. 2002 forecast); production in 2000 and 2001 affected by labour strike.
Falconbridge Limited (1)	Sudbury, Ont.	<b>Sudbury Operations</b>						
		Craig mine, u/g	17 300	17 300			SO	Ni in ore mined, rounded to nearest 100 t.
		Fraser mine, u/g	7 300	6 900			SO	Ni in ore mined, rounded to nearest 100 t.
		Lindsley mine, u/g	3 600	5 000			SO	Ni in ore mined, rounded to nearest 100 t.
		Lockerby, u/g	3 100	5 400			SO	Ni in ore mined, rounded to nearest 100 t.
		Total	31 300	34 600				
		Strathcona mill	25 226	27 833	680	690	S	10 000-t/d capacity; mill produces bulk concentrate for shipment by truck to company smelter at Falconbridge, Ont.
		Smelter	54 892	57 854	1 788	1 955	M	Processes concentrate from Falconbridge's Sudbury and Raglan operations plus recyclable Ni, Co, Cu; SO <sub>2</sub> is captured to make sulphuric acid; matte is exported to Falconbridge's Nikkelverk refinery in Norway; provincial permission to export up to 45 360 t/y of recoverable Ni in matte until end of 2009; new draft SO <sub>2</sub> regulations issued in September cutting emission limit by 33% by 2007 and ground level concentration to 0.34 ppm by April 2002.
Inco Limited	Sudbury, Ont.	<b>Sudbury Operations (2)</b>						
		Copper Cliff North mine, u/g					SO	Nominal ore production rate = 900 000 t/y; capacity = 2800 t/d.
		Copper Cliff South mine, u/g					SO	Nominal ore production rate = 1 000 000 t/y; capacity = 3000 t/d.
		Creighton mine, u/g					SO	Nominal ore production rate = 1 100 000 t/y; capacity = 4000 t/d; ground stability problems affecting ore pass reduced production in 2002.
		Garson mine, u/g					SO	Nominal ore production rate = 700 000 t/y; capacity = 2000 t/d; Dynatec Corporation won \$27 million contract to sink 1000-m ventilation shaft and complete associated underground development work.
		Lower Coleman mine, u/g					SO	Mine closed in 2001 except for lower portion; previous capacity was 1400 t/d of ore.
		McCreedy East mine, u/g					SO	Nominal ore production rate = 1 200 000 t/y including Lower Coleman production; capacity of McCreedy East = 2800 t/d of ore.

	Stobie mine, u/g				SO	Includes remaining operations at Frood mine; nominal ore production rate = 3 500 000 t/y; capacity = 8300 t/d of ore.
	Clarabelle mill				S	36 000-t/d mill takes output of all Inco's Sudbury area mines; improved recovery of Ni by 3.4% since 1999; head grade of 1.46% Ni and 1.54% Cu in 2002.
	Nickel smelter				M	Twin flash smelters; slow cooling of matte, then milling to separate to Ni and Cu streams; matte is sent to matte plant, refinery in Sudbury basin, or refinery in United Kingdom; capacity 100 000 t/y of Ni in matte.
	Matte processing plant				II	Produces Ni oxide sinter for export to refineries in Korea and Taiwan or for use in stainless steel industry.
	Nickel refinery				I	59 000-t/y carbonyl refinery producing high-purity Ni pellets, powders and foams.
	Finished Ni production from Sudbury facilities	61 200	68 700		I, II	Inco reported production from Ontario plus Clydach operations less INSG reported production from the United Kingdom for 2001 and 2002.
Clydach, United Kingdom	Nickel refinery	33 800	33 800		I	Carbonyl refinery producing high-purity Ni pellets, powders and foams from Sudbury feed; returns residue to Canada for reprocessing; Co oxide produced from feed exported from Thompson, about 20% of Inco's Co production in 2001 was in the form of Co oxide; Ontario government permission to export Ni sulphide matte, Ni sulphate residues, Ni oxide sinter, and PGM concentrates until year-end 2005.
	Finished Ni production from Sudbury and Clydach	95 000	102 500		I	As reported by Inco in briefing to investment community, February 2003.
	Cobalt originating from Sudbury ores		(e) 885	(e) 930	S	63% of Inco's Co production is sourced from Inco's Ontario ores; Cobalt Development Institute reported that Inco produced 1480 t of Co in 2002, implying Ontario provided 930 t of cobalt product in 2002.
Port Colborne, Ont.	Co refinery		(e) 1 200	(e) 1 200	I	Produces refined Co from Ni-Co carbonate feed from Sudbury; Au, Ag and PGMs separated for further treatment at other sites; PGMs are sent to Inco's Acton, U.K., plant for final recovery; capacity of 1360 t/y of refined Co; about 80% of Inco's Co production is metal assumed to be entirely produced at Port Colborne; Inco Co deliveries were 1582 t in 2002 but produced 1480 t of Co in 2002 according to the Cobalt Development Institute. Court rejected certification of legal action as being a class action in suit brought in 2001; appeal expected to be heard in 2003.
Thompson, Man.	<b>Manitoba Operations</b>					
	Thompson mine, u/g				SO	1400 employees; all mines underground. Production 4500 t below target due in part to maturity of Thompson mine where grades are lower and stopes are smaller.
	Thompson mill				S	13 000 t/d mill; head grade in 2002 was 2.40% Ni; Cu concentrate sent to Sudbury for smelting.
	Thompson smelter				M	Electric furnace smelts partially roasted Ni concentrates from Thompson plus imported concentrates from Cosmos and Emily Ann mines in Australia. Inco's total "external" feed in 2002 added 17 000 t of finished nickel to Inco's output of which an estimated 5300 t came from Emily Ann and an estimated 9800 t came from Jubilee; the bulk of this material is believed to have been destined for the Thompson smelter. Smelter experienced problems due to high magnesium oxide level.

TABLE 4 (cont'd)

Company	Location	Operation	Production Data				Type of Ni Output	Remarks
			Nickel 2001	Nickel 2002	Cobalt 2001	Cobalt 2002		
								(t)
		Thompson refinery					I	55 000-t/y electrolytic Ni refinery produces rondelles and cathodes, the majority of which is used for electroplating applications; Co hydrate is sent to Port Colborne for recovery; Co oxide is sent to the U.K. for processing.
		Finished Ni production from Manitoba	49 900	45 400				As reported by Inco, rounded to nearest 1000 t.
The Cobalt Refinery Company Inc.	Fort Saskatchewan, Alta.	Hydrometallurgical nickel and cobalt refinery	29 225	31 694	2 943	3 065	I	Sherritt International Corporation and General Nickel Company S.A. (owned by the Cuban Ministry of Basic Industries) together own a 50:50 joint venture called Metals Enterprise, which owns The Cobalt Refinery Company Inc.; refinery output progressively increased over past years by de-bottlenecking; produces by-product fertilizer. Record quarterly nickel production of 8282 t in Q2 and record quarterly cobalt production in Q4.
North American Palladium Ltd.	85 km from Thunder Bay, Ont.	Open-pit mine and mill	724	1 254			S	Open-pit palladium mine with by-product Ni production; expansion to 15 000 t/d from 2400 t/d in 2001. Equipment problems with new mill and crusher prevented operation from reaching full capacity. New crusher expected to be completed by mid-2003. Concentrates containing PGMs, nickel and copper are sent to Inco and Falconbridge Sudbury smelters.

Sources: Various annual reports, web sites, industry publications and press releases. Some specific sources are noted below:

Falconbridge Annual Report and Annual Information Form for 2001 and 2002;  
*Canadian Mining Journal*, April-May 2002;  
 Refined Ni production of U.K. according to INSG - Clydach is the sole primary Ni refinery in the U.K.;  
 Inco Annual Report and 10K report for 2001 and 2002;  
*Mining and Mineral Processing Operations in Canada*, 2000-2001, Natural Resources Canada;  
 Sherritt International Corporation Annual Report 2001, 2002;  
 North American Palladium Annual Report 2001, 2002.

Ch = Ni in chemicals.

I = Class I Ni (e.g., cathodes, briquettes, pellets, powders, etc., which have a Ni content of 99% ore more).

II = Class II Ni (e.g., products with a Ni content of less than 99% such as FeNi, NiO, UTILITY™ Ni).

M = matte.

S = sulphide concentrates.

SO = sulphide ore mined.

(1) Falconbridge Limited's production in 2000 and 2001 was affected by a labour strike.

(2) Nominal production as reported in the *Canadian Mining Journal*, April/May 2002; capacity as reported in 2000-01 *Mining and Mineral Processing Operations in Canada*, MR 251, Natural Resources Canada; data are for different periods and may not agree. Data are not available for Inco's Gertrude mine.

**TABLE 5. LIST OF WORLD NICKEL PRODUCERS, 2002**

Country	Full Corporate Name or Identifier	Web Site
Albania	Bitincka mine	www.larco.gr
Australia	Anaconda Nickel Limited Goldfields Mine Management Pty Ltd. Jubilee Gold Mines NL LionOre Australia (Nickel) Ltd. Miitel JV OM Group, Inc. (OMG) Outokumpu Mining Australia Pty. Ltd. Preston Resources Limited QNI Ltd. Tectonic Resources NL Titan Resources NL WMC Limited	http://www.minara.com.au/ (unknown) www.jubileemines.com www.lionore.com www.mincor.com.au www.omgi.com www.outokumpu.com www.prestonres.com.au www.qni.com.au; www.bhpbilliton.com www.tectonicres.com.au www.titanresources.com.au www.wmc.com
Austria	Treibacher Industrie AG	www.treibacher.at/en/index.html
Botswana	BCL Limited Tati Nickel Mining Company (Proprietary) Limited	(unknown) www.lionore.com
Brazil	Barro Alto Mineração Limitada project Codemin SA Companhia Niquel Tocantins Mineração Serra da Fortaleza Limitada	www.angloamerican.co.uk www.angloamerican.co.uk http://www.vmetais.com.br/english/index.htm www.riotinto.com
Canada	Canmine Resources Corporation Falconbridge Limited Inco Limited North American Palladium Ltd. Sherritt International Corporation; The Cobalt Refinery Company Inc.; Metals Enterprise	(unknown) www.falconbridge.com www.inco.com www.napalladium.com www.sherritt.com
China	Jilin Nickel Co. Jinchuan Nonferrous Metals Corporation Jinco Nonferrous Metals Co., Ltd. Sichuan Copper-Nickel Co. Simen Metals (Holdings) Ltd. Tonghua Ni Cu mine (corporate name unknown) Huili Ni mine (corporate name unknown) Xinjiang Nonferrous Metals Industry Corporation	www.jlnickel.com.cn/edefault.htm http://www.jnmc.com/default.asp www.inco.com; www.jnmc.com (unknown) (unknown) (unknown) (unknown) (unknown)
Colombia	Cerro Matoso S.A.	www.bhpbilliton.com
Cuba	Moa Nickel S.A. Union del Niquel	www.sherritt.com (unknown)
Dominican Rep.	Falconbridge Dominicana, C. por A.	www.falconbridge.com
Finland	Kokkola Chemicals Oy Mondo Minerals OM Group, Inc. OMG Harjavalta Nickel Oy Outokumpu Oyj	www.omgi.com www.mondominerals.com/ www.omgi.com www.omgi.com www.outokumpu.com
France	Eramet Group, The	www.eramet.fr
Former Yugoslav Republic of Macedonia	Feni-Rudnici i Industrija za Nikel, Celik i Antimon (FENI)	(unknown)
Greece	General Mining and Metallurgical Co. S.A.	www.larco.gr
Indonesia	PT Antam Tbk PT International Nickel Indonesia Tbk	www.antam.com www.inco.com

TABLE 5 (cont'd)

Country	Full Corporate Name or Identifier	Web Site
Japan	Hyuga Smelting Co., Ltd.	www.smm.co.jp
	Inco TNC Limited	www.inco.com
	Nippon Yakin Kogyo Co., Ltd.	www.nyk.co.jp (mostly Japanese, annual reports at: <a href="http://www.nyk.co.jp/main/english/index.html">http://www.nyk.co.jp/main/english/index.html</a> )
	Pacific Metals Co., Ltd. Sumitomo Metal Mining Co., Ltd.	www.pacific-metals.co.jp (Japanese only) www.smm.co.jp
Kazakhstan	Kempirsai Mining Directorate	(unknown)
Korea, Rep. of	Korea Nickel Corporation	www.inco.com
New Caledonia	Goro Nickel S.A.	www.inco.com
	Le Nickel-SLN	www.eramet.fr
	Société Minière du Sud Pacifique S.A., La	(unknown)
	Société Minière Georges Montagnat S.A. Société des Mines de la Tontouta	(unknown) (unknown)
Norway	Falconbridge Nikkelverk Aktieselskap	www.falconbridge.com
	Nikkel og Olivin A/S	www.outokumpu.com
	Titanium A/S	(unknown)
Philippines	Cagdianao Mining Corporation	(unknown)
	Hinatuan Mining Corporation	(unknown)
	Rio Tuba Mining Corporation	(unknown)
	Taganito Mining Corporation	(unknown)
Russia	MMC Norilsk Nickel	www.nornik.ru/index.jsp?lang=E
	Rezh Nickel Plant Joint Stock Company	(unknown)
	Ufaleynikel Joint Stock Co.	(unknown)
	Yuzhuralnikel Kombinat Joint Stock Co.	(unknown)
Serbia	Ferro-Nickel D.D. Glogovac	(unknown)
South Africa	Anglo American Platinum Corporation Limited	www.angloplatinum.com
	Impala Platinum Holdings Limited	www.implats.co.za
	Lonmin plc	www.lonmin.com
	Nkomati JV	www.avmin.co.za
Taiwan, China	Taiwan Nickel Refining Corporation	(unknown)
Ukraine	Nikomel Limited	(unknown)
United Kingdom	Inco Limited	www.inco.com
Venezuela	Minera Loma de Niquel C.A.	www.angloamerican.co.uk
Zimbabwe	Bindura Nickel Corporation Limited	www.angloamerican.co.uk
	Rio Tinto Zimbabwe Limited	www.riotinto.com
	Makwiro Platinum Mines (Private) Limited	www.zimplats.com

Source: Natural Resources Canada.

Note: Some operations may be idled.

**TABLE 6. WORLD NICKEL PRODUCERS, 2002**

Country	Company	Operation	Nickel Output		Cobalt in 2002	Type of Ni output
			2001	2002		
				(t)		
<b>AUSTRALIA</b>	Anaconda Nickel Limited	Murrin Murrin mine, PAL, refinery	24 991	30 010	1 838	I
	Remarks: Production remained below targets; higher-grade ore being mined to maximize production and grade decline termed a "strategic issue"; operation forecast to achieve operating rate of 32 000 to 36 000 t/y Ni only by mid-2004; Mt. Margaret development deferred despite interest by Jinchuan Nonferrous Metals Corporation; Anaconda defaulted on US\$400 million bonds and creditors agreed to restructuring; Glencore to underwrite new share issue in 2003.					
	Goldfields Mine Management Pty Ltd.	Otter Juan and Cornet mines	(e) 2 300	?	?	SO
	Remarks: No data found for 2002.					
	Jubilee Mines NL	Cosmos mine, mill	11 000	11 300	?	S
	Remarks: Pit mining moving to final stages with first production from u/g mine expected by June 2003; tonnage and grade exceed original reserve calculation by 1% and 15%, respectively; total of 70 000 t of concentrate grading 19.5% Ni dispatched for Canada; smelting and refining costs averaged about A\$1.46/payable pound during 2002; about 2.6 km decline developed during year plus raises and horizontal drifting. Jubilee reported quarterly smelting/refining charges of between A\$1.43 and \$1.48/lb in 2002 (equal to US77¢-80¢/lb based upon Bank of Canada exchange rates); Jubilee ships nickel concentrate to Inco Limited in Canada.					
	LionOre Australia (Nickel) Ltd.	Emily Ann mine, mill	110	5 745	?	S
	Remarks: Mine start-up completed in Q2; some concentrate smelted at WMC rather than being shipped to Inco, but majority of concentrate shipped to Inco's smelters in Canada; shipments of payable Ni in 2002 totaled 5301 t (about 91% of contained); LionOre Mining purchased minority shares in LionOre Australia (Nickel) after obtaining exclusive option from QNI Pty Ltd. (which operates the Yabulu refinery in Queensland and in turn is owned by BHP Billiton plc) to acquire QNI's 69% share in the Maggie Hayes high-grade deposit, located 2 km from the Emily Ann mine concentrator; total underground development of 2.4 km including main decline advance of 453 m; production rate of 320 000 t/y targeted during Q4 2003. Project completion attained in Q4 and escrow funds released.					
	Miitel JV	Miitel and Wannaway mines	8 062	13 500	260	SO
	Remarks: North Miitel orebody discovered, 253 000 t indicated + inferred resource @ 3.9% Ni; five detailed feasibility studies ongoing at year-end to mine Redross, Mariners and North Miitel plus two small orebodies; data for 2001 Ni production revised; Co data reflect payable Co, thus contained Co is higher.					
	OM Group, Inc. (OMG)	Cawse mine, PAL, refinery	?	(e) 9 000	(e) 900	T
	Remarks: Company does not reveal data of Ni-Co intermediate shipped to Finland for refining; however, in transcripts of 2002 Fourth Quarter conference call, a reference was made to Cawse output of about 9000 t of nickel. In OMG's 10K, reference was made to production of about 8000 t/y of Ni. Cobalt production is assumed to be 10% of nickel production. Cobalt from Cawse is eventually recovered at OMG's Kokkola facility.					
	MPI Nickel Pty Ltd. (formerly owned by Outokumpu Mining Australia Pty. Ltd.)	Black Swan mine, mill	21 800	14 350	?	S
	Remarks: Mine and mill sold to MPI Nickel (owned 80% by MPI Mines Ltd. and 20% by OM Group, Inc. (OMG) through OMG Kokkola Chemicals Holdings BV); forecast production in 2003 of 9740 t of Ni; Cygnet orebody expected to be mined out in 2002 with Gosling orebody to be mined out in 2003; concentrate sold to Harjavalta smelter in Finland on contract; contract expires in 2004.					

TABLE 6 (cont'd)

Country	Company	Operation	Nickel Output		Cobalt in 2002	Type of Ni output
			2001	2002		
				(t)		
	Preston Resources Limited	Bulong mine, PAL, SX-EW	6 977	(e) 6 000	200	I
	Remarks: Production in first half of 2002 was 3270 t Ni and 220 t Co; data not released for the year 2002 - estimate by author that 2002 production was in order of 6000 t of Ni. Agreement reached in late August whereby Preston Resources gave up 95% ownership in Bulong to Barclays Bank plc and other noteholders in return for Preston being released from financial obligations associated with Bulong. Operation sources sulphuric acid from WMC Resources Ltd.					
	QNI Ltd.	Yabulu refinery; ammonia leach	28 500	30 000	1 863	I
	Remarks: Imported 2 Mt limonitic laterite ore in 2002 from SMSP in New Caledonia; studies of Ravensthorpe mine/leach plant development and expansion of Yabulu to 45 000 t/y Ni plus 1800 t/y Co to process the mixed Ni-co hydroxide not expected to be completed until late 2003; Queensland government to contribute A\$10 million to training and infrastructure costs at Yabulu.					
	Sally Malay Mining Limited	mine/mill project	-	-	-	S
	Remarks: Off-take agreement negotiated with Jinchuan Nonferrous Metals Corporation in July for life of mine production. Bankable feasibility study completed in August showed 41 300 t of nickel and 2000 t of cobalt in concentrate to be produced over 5 1/2-year life. A\$55 million project based upon proven plus probable reserves of 3 417 000 t @ 1.56% Ni, 0.64% Cu and 0.08% Co. First contracts were awarded in Sept; plans call for first production in Q1 2004.					
	Tectonic Resources NL	RAV 8 mine, mill	4 008	2 450	?	S
	Remarks: Orebody life extended (had been expected to be mined out in July 2002); after proving up more ore, mining continued past year-end. Reserves at end of 2002 were 50 000 t, equal to about nine months of the average mining rate in 2002. Ore was trucked to Kambalda mill and sold to WMC Resources.					
	Titan Resources NL	Radio Hill mine, mill	4 755	3 387	211	S
	Remarks: Radio Hill mine reserves exhausted; property including disseminated material sold to Fox Resources Limited in September 2002; BioHeap™ test work continued on Jinchuan, Inco and WMC material; JV being negotiated with Jinchuan targetting 200 000 t trial in 2003 followed by 1 800 000-t trial in 2004/05. No details about Co recovery from property.					
	WMC Resources Limited**	Kambalda mines, mill	18 653	23 225	?	S
	Remarks: Long/Victor mine sold to Independence Gold in Sept. for A\$15 million with ore treatment to occur at WMC's Kambalda mill; independent operators of recently sold mines increased production in 2002 resulting in 25% increase in Ni in concentrate production in 2002 compared to 2001.					
	WMC Resources Limited	Leinster mines, mill	38 008	40 006	?	S
	Remarks: Mill recovery was upgraded in Sept. and WMC expects to increase recovery by 2.3%; Q1 announcement that drilling below 1100-m level confirmed continuity of main disseminated sulphide zone; Harmony pit scheduled to close in 2004.					



	WMC Resouces Limited	Mt. Keith pit, mill	47 930	43 192	?	S
Remarks: Upgraded nickel recovery in Sept., expect to increase recovery by 1.5%; concentrates exported to Harjavalta smelter in Finland; feasibility study to increase pit output by 25% to be finished in early 2003, which would raise mining rate from 11 Mt/y to 14 Mt/y for A\$200 million and a subsequent increase to 16 Mt/y; commissioning could begin after mid-2004; expansion does not depend upon mining of Yakabindie deposit, which company described as being three to five years in future depending upon approval process. WMC purchased Yakabindie deposit with 292 Mt @ 0.52% Ni from Rio Tinto in 2001.						
	WMC Resouces Limited	Kalgoorlie smelter	96 650	91 574	?	M
Remarks: Smelter takes feed from WMC Resources concentrators plus other sources; matte exported to Finland (OM, Group) and to Japan (Sumitomo); cobalt in residues shipped to Falconbridge plant at Nikkelverk for toll refining; Feb. fire in sulphuric acid plant briefly closed plant; output restricted by air quality issues due to reduced precipitator capacity; agreement with Jinchuan to supply 30 000 t Ni in matte over unspecified period starting in 2005. Agreement announced in January to smelt Emily Ann concentrate and ship matte to Canada may have been for very limited amount as Emily Ann shipped 40 000 t of nickel concentrate containing 5265 t of Ni to Inco in 2002.						
	WMC Resouces Limited	Kwinana refinery	61 324	65 055	?	I
Remarks: Record output after recent upgrade; debottlenecking could take capacity to 70 000 t/y; conceptual plans to increase capacity to 80 000 t/y and beyond. Cobalt is toll refined by Falconbridge at Nikkelverk in Norway.						
<b>AUSTRIA</b>	Treibacher Industrie AG	FeNi smelter	1 300	1 500	–	II
Remarks: Ni recovered from scrap and residues including catalysts from food industry.						
<b>BOTSWANA</b>	BCL Limited	Mines, mill and smelter at Selebi Phikwe	(r) 19 000	20 000	270	M
Remarks: LionOre purchased Anglo American plc's ownership in BCL effective September 30 when LionOre acquired Tati Nickel (see below); LionOre owns 85% of operation with Government of Botswana owning remaining 15%. Smelter problems at BCL forced shut-down in the April-June quarter. Cobalt tonnage refers to cobalt in matte, which is exported for refining.						
	Tati Nickel Mining Company (Proprietary) Limited	Selkirk u/g and Phoenix pit, newly commissioned convention flotation mill replacing dry magnetic mill	8 177	9 539	36	S
Remarks: LionOre purchased Anglo American plc's 43.35% ownership in Tati for US\$76 million; Tati 3.6-Mt/y wet concentrator commissioning begun in Q2, construction was completed in 2002, reaching "near to design capacity" for December operation; Selkirk mine shut in Q3 when pillar recovery operations completed; LionOre acquired majority interest in BCL where Tati's output is smelted (shut-down in April 2002 because of equipment failure – see above); US\$10 million feasibility study of Activox® process at Tati Nickel by end of 2003 and trial plant to be constructed in Australia for assembly and commissioning at Tati in early 2004 -- if successful, potential for commercial plant to be in operation by 2007, producing 17 000 t/y Ni metal.						
<b>BRAZIL</b>	Codemin SA	Niquelandia mine, smelter	5 800	6 000	–	II
Remarks: Increased mining (+22%) and ore processed (+8%) feed resulted in increased production (+3%) of 6000 t Ni in FeNi; grade of ore processed dropped to 1.7% Ni from 1.8% in 2001; FeNi grades 27% Ni.						

TABLE 6 (cont'd)

Country	Company	Operation	Nickel Output		Cobalt in 2002	Type of Ni output
			2001	2002		
	Mineração Serra da Fortaleza Limitada	Fortaleza mine, mill, smelter	10 170	6 273	?	M
Remarks: Production reduced due to lower grade and ground problems, which forced closure of u/g mine from June to Sept.						
	Companhia Níquel Tocantins	Tocantins mine, ammonia leach plant at Niquelandia; refinery at Sao Paulo	16 700	17 675	960	I
Remarks: Expansion plan to 21 000 t/y Ni and 1100 t/y Co during 2004 confirmed in May; first stage to take capacity to 18 000 t by 2003; forecast production of 18 000 t in 2003 rising to 21 000 t in 2005. Expansion had been delayed due to electricity rationing but, as of mid-2002, company generated 50% of own power requirements. Production of nickel per INSG report of refined nickel production in Brazil, and cobalt production per Cobalt News 03/2 of the Cobalt Development Institute.						
<b>CANADA</b>	Canmine Resources Corporation	Cobalt hydrometallurgical refinery	–	minimal	minimal	Ch
Remarks: Hydrometallurgical refinery completed commissioning and was in process of optimizing operations when financial difficulties forced shut-down in July. Company placed under protection of Companies Creditors Arrangement Act to allow for opportunity for restructuring. No resolution by year-end; refinery stayed shut through year-end.						
	Falconbridge Limited	Raglan mine, mill	24 570	24 636	386	S
Remarks: Mill capacity increased from 0.8 to 1.0 Mt/y. All output shipped as Ni-Cu-Co concentrate from Deception Bay to Québec City and then railed to Falconbridge's smelter in Sudbury during the mid-June to mid-March shipping season. Reserves at year-end sufficient for about 18 years of production. Project started that will result in 100% recycling of mill water.						
	Falconbridge Limited	Sudbury - 4 u/g mines, mill, smelter	25 226	27 833	690	S
Remarks: Four mines feed a single concentrator; 2.3 Mt milled in 2002. A separate Cu concentrate is produced from high-copper ore and sent to Falconbridge's Kidd operation for processing. The bulk Ni-Cu concentrate is sent to company's smelter in Sudbury, which also processes recyclable Ni and Co. Exploration continued at the Nickel Rim South deposit located at 1600 m depth targetted at an inferred resource of 6.3 Mt @ 1.7% Ni, 3.4% Cu, 6.2 g/t Pd+Pt+Au; decision whether to sink exploration shaft expected in mid-2003. Existing ore reserves at yearend were sufficient for 8 yrs at targetted operating rate.						
	Falconbridge Limited	Montcalm deposit	–	–	–	SO
Remarks: Feasibility study ongoing at year-end; 7.7 Mt @ 1.39% Ni, 0.67% Cu and 0.06% Co could be mined at 750 000 t/y. Ore would be transported to Kidd Metallurgical Division for milling; concentrate would be smelted at company's smelter at Sudbury. Projected production of up to 8000 t/y of Ni. Decision expected in Q2 2003.						
	Inco Limited	Port Colborne refinery and processing facilities	–	–	(e) 1 200	
Remarks: Produces electrolytic cobalt metal, about 80% of Inco's Co production is produced as metal; capacity reported as 1360 t/y Co; upgrades PGMs, Au and Ag. Some nickel products from Sudbury and Thompson "finished" at Port Colborne. Class action suit filed for \$750 million for past emissions being opposed by Inco. The Cobalt Development Institute reported total Inco production as 1480 t for 2002.						

Inco Limited	Sudbury - 7 u/g mines, mill, smelter, matte processing, carbonyl refinery	61 200	68 700	see Port Colborne	I,II
--------------	---------------------------------------------------------------------------	--------	--------	-------------------	------

Remarks: Produces pellets, powder and NiO sinter; cobalt recovered at Port Colborne; PGMs are sent to Inco facility at Acton in U.K.; NiO is sent to Inco's Clydach refinery in U.K. for recovery into pellets. Production data 33 800 t in 2002 produced at Clydach. NiO exported to South Korea and Taiwan for processing at refineries in which Inco has a share of ownership. Data shown here subtract estimated Clydach production ([see below](#)) from Inco's reported Ontario + UK production.

Inco Limited	Thompson - 2 u/g mines, mill, smelter, electro-refinery	49 900	45 400	(e) 160	I
--------------	---------------------------------------------------------	--------	--------	---------	---

Remarks: Cathode, rondelles; 470-t/y capacity to produce Co oxide. Production includes nickel recovered from imported concentrates from Australia.

North American Palladium Ltd.	Lac des Iles - open-pit mine, mill	724	1 254		S
-------------------------------	------------------------------------	-----	-------	--	---

Remarks: Ni and Cu by-products of Pd concentrate. Continuing problems achieving nameplate capacity after mid-2001 expansion from 2400-t/d to 15 000-t/d mill; optimizing work undertaken on SAG mill; damage to new crusher discovered in Sept. resulted in lost production; studies under way to increase Pd recovery by finer grinding.

The Cobalt Refinery Company Inc.	Hydrometallurgical nickel-cobalt refinery, produces about 250 000 t/y of by-product fertilizer	29 225	31 694	3 065	I
----------------------------------	------------------------------------------------------------------------------------------------	--------	--------	-------	---

Remarks: Company owned 50% by Sherritt International Corporation and 50% by General Nickel Company S.A. (the latter a state-owned Cuban company). Operation processes Ni-Co residue from pressure leach operation located at Moa Bay in Cuba ([see entry](#)); high-grade residue containing about 50% Ni shipped to eastern Canada and then railed to Fort Saskatchewan, Alberta, for processing along with small amounts of material from third parties to recover Ni and Co in form of briquettes and powder. Record annual Ni and Co production at refinery. Sherritt is considering an expansion of operations at Moa and Fort Saskatchewan.

<b>CHINA</b>	Cu-Ni mine (company name unknown)	Tonghua Cu-Ni mine	(e) 500	(e) 500	?	S
--------------	-----------------------------------	--------------------	---------	---------	---	---

Remarks: Cu-Ni mine; reported production of about 500 t/y of nickel in concentrates.

	Ni mine (company name unknown)	Huili Nickel mine and smelter	?	?	?	M
--	--------------------------------	-------------------------------	---	---	---	---

Remarks: Reportedly a mine and smelter with capacity of about 1400 t/y Ni.

	Jilin Nickel Co.	3 mines, smelter, refineries	?	?	?	M,I
--	------------------	------------------------------	---	---	---	-----

Remarks: Capacity reported between 9500 t/y Ni in matte and 1000 t/y Ni cathodes plus 3500 t/y Ni hydroxide; recent production data not available; production in 1998 said to be about 5000 t Ni; smelts Ni concentrate from other producers. Company web site reports owning three nickel mines, two smelters, three refineries and two chemical plants amounting to largest installed capacity to produce nickel sulphate.

	Jinchuan Nonferrous Metals Corporation	Mines, mill, smelter, refinery	(e) 50 000	(e) 48 000	(e) 1000	I, Ch
--	----------------------------------------	--------------------------------	------------	------------	----------	-------

Remarks: Jinchuan has ambitious plans to increase production to 100 000 t/y of nickel by 2006 but lacks mine capacity to sustain this level of refined production. Company has held talks with Anaconda, Heron Resources and Weda Bay about possible cooperation/development. Titan Resources continued negotiation of joint venture to test BioHeap leaching at Jinchuan. Jinchuan and Sally Malay reached agreement for off-take contract for new 8000-10 000 t/y Ni in concentrate production. Contract with Cubaniquel for supply of nickel and cobalt in intermediate sulphides since 2001.

TABLE 6 (cont'd)

Country	Company	Operation	Nickel Output		Cobalt in 2002	Type of Ni output
			2001	2002		
	Sichuan Copper-Nickel Co.	Chengdu refinery	?	(t) ?	?	I
Remarks: Refinery; capacity and output unknown.						
	SimSen Metals (Holdings) Ltd.	Mine	?	(e) 500	?	S
Remarks: Started up in 1999; ships concentrate to Jinchuan; forecast from 1999 that production would be 1500 t contained Ni in 2000; estimated production of 500 t of nickel in concentrates in 2002 with 2001 likely less.						
	Xinjiang Nonferrous Metals Industry Corporation	Kalatongke	(e) 1 900	?	?	M,I
Remarks: Ni-Cu mine, smelter, refinery.						
<b>COLOMBIA</b>	Cerro Matoso S.A.	Cerro Matoso mine, FeNi smelter	38 500	44 000	—	II
Remarks: Expansion completed in Jan. 2001 when second processing line started up; mine reserves grade 2.2% Ni; bulk of FeNi output shipped to Europe.						
<b>CUBA</b>	Union del Niquel	Commandante Ernesto Che Guevara Mining and Metallurgical Combine (Punta Gorda) mine and refinery	(e) 32 200	(e) 30 000	(e) 1 000	II,S
Remarks: Program to reduce production costs by converting to domestic high sulphur oil (imported oil costs represented 55% of operating costs); in addition to Ni oxide, plant increasing by-product output of mixed Ni-Co sulphides production; plans to expand operation to range of 50 000 to 55 000 t/y, possibly drawing on some of resources of Las Camariacas; exports Co concentrate (mixed Ni-Co sulphides?) to China.						
	Union del Niquel	Commandante Rene Ramos Latour Mining and Metallurgical Combine (Nicaro) mine and refinery	(e) 11 000	(e) 9 000	—	II
Remarks: Older plant with high energy costs; output limited by depletion of nearby orebodies; 11-km conveyer system to new mining areas scheduled for completion by 2005, which could allow production to rise to 17 000 t Ni in NiO.						
	Moa Nickel S.A.	Pedro Sotto Alba mine, PAL (e)	(e) 29 400	(e) 30 600	(e) 2 750	T
Remarks: Cuban government stated goal of expanding production to range of 50 000-55 000 t/y at Moa; operation output increasing due to mining new orebodies and de-bottlenecking; mixed Ni-Co sulphides exported to Fort Saskatchewan refinery (ratio of Ni:Co output for Fort Saskatchewan refinery used to estimate Ni and Co tonnage, data rounded and approximate).						

**DOMINICAN  
REPUBLIC**

Falconbridge Dominicana, C. por A.	Falcondo mine, FeNi smelter	27 800	23 300	–	II
------------------------------------	-----------------------------	--------	--------	---	----

Remarks: Plant re-opened in Jan. after being shut in Oct. 2001 for economic reasons; new contract signed with workers; power plant maintenance Oct.-Dec. and problems obtaining oil supplies in Dec. due to Venezuelan strikes cut production to 22 500 t compared to forecast of 24 000 t.

**FINLAND**

Mondo Minerals Oy	Lahnaslampi mine, Horsmanaho mine	(e) 200	?	?	S
-------------------	-----------------------------------	---------	---	---	---

Remarks: Talc operations produce flotation concentrate of pyrrhotite and pentlandite. Company has produced at least since 1990. Concentrate grades between 8% and 9% Ni.

Outokumpu Oyj	Hituri mine, mill	2 600	2 500	?	S
---------------	-------------------	-------	-------	---	---

Remarks: Mine produced 600 000 t of ore. Concentrate sent to Harjavalta smelter in Finland. OMG made agreement with Outokumpu in 2001 to maintain operation of mine for feed to OMG's refinery at Harjavalta.

Outokumpu Oyj	Harjavalta smelter	?	?	?	M
---------------	--------------------	---	---	---	---

Remarks: Matte is sent to OMG refinery on site. Concentrate supplied from Black Swan operation in Australia, Hituru mine in Finland, Nikkel og Olivin and Titania in Norway. Trade data (imports reported by Finland and exports reported by Australia) conflict such that calculation of output was not possible.

OMG	Kokkola Chemicals Oy	–	–	8 200	n.a.
-----	----------------------	---	---	-------	------

Remarks: Production cut in fourth quarter by 20% following OMG's re-evaluation of inventory. Company-wide production of cobalt cut in 2002 by 1100 t. Facility located on land owned by Outokumpu Zinc Oy. OMG production in 2002 shown as 8200 t by Cobalt Development Institute. Output is cobalt chemicals and refined cobalt.

OMG Harjavalta Nickel Oy	Harjavalta refinery	(e)(r) 55 300	(e) 55 350	?	I
--------------------------	---------------------	---------------	------------	---	---

Remarks: OMG does not release production data. In addition to feed from the Harjavalta smelter, refinery receives matte feed from Fortaleza in Brazil and WMCR in Australia plus mixed Ni-Co hydroxides from Cawse PAL in Australia. Company revalued inventory in 2002 and began restructuring, which included ending agreement with Weda Bay Minerals, Inc. to fund feasibility study for development of 30 000 t/y Ni + 3000 t/y Co project, which could have supplied intermediate feed to Harjavalta refinery. Company stated that it had agreements in place in late 2002 covering 90% of projected nickel feed requirements for 2003 and 2004. OMG reduced Ni inventory by 5500 t during 2002 and nickel inventories for 2003 to be reduced by 3850 t. Production estimated using INSG data for Class I nickel production in Finland for 2002. 2001 production estimate revised from 54 600 t.

**FRANCE**

The Eramet Group	Sandouville refinery	13 033	11 444	175	I,Ch
------------------	----------------------	--------	--------	-----	------

Remarks: Plant output decreased due to drop in demand for high-purity nickel by aerospace industry. Plant processes matte from Doniambo smelter in New Caledonia to produce nickel and cobalt chemicals and high-purity Ni.

**FORMER YUGOSLAV  
REPUBLIC OF  
MACEDONIA**

Feni-Mak	Feni-Mak mines, FeNi smelter	3 000	5 100	–	II
----------	------------------------------	-------	-------	---	----

Remarks: Production as shown in INSG statistics; plant purchased in 2000 by Feni-Rudnici i Industrija za Nikel, Celik i Antimon (FENI) of France.

TABLE 6 (cont'd)

Country	Company	Operation	Nickel Output		Cobalt in 2002	Type of Ni output
			2001	2002		
				(t)		
<b>GREECE</b>	General Mining and Metallurgical Co. S.A. (LARCO)	Mines, FeNi smelter	19 600	19 200	–	II
Remarks: LARCO produces FeNi from three main domestic mining areas (Agios Ioannis, Evvia and Kastoria). Company has imported material from Albania in past few years, but no recent information whether imports continue. Agreement with European Nickel plc to import about 500,000 t/y of nickel laterite ore from Çaldag deposit in Turkey after 2002 (ore grades about 1.4% Ni). Capacity of LARCO estimated at 22,000 t/y of Ni in FeNi.						
<b>INDONESIA</b>	PT Antam Tbk	Gebe, Pomalaa, Gee, Buli mines	(e) 49 000	(e) 60 000	?	L
Remarks: Total production was 4.4 Mt (wet) vs. 3.6 Mt (wet) in 2001. Production was 1.15 Mt (wet) exported to BHP Billiton plc's Yabulu hydrometallurgical refinery in Queensland, Australia, and 3.25 Mt (wet) of saprolitic ore. Saprolitic ore is sent to company's FeNi smelters as well as being exported to Japanese FeNi smelters. (Ni content of ore mined estimated using reported reserve grades and moisture contents for reserves - note that estimates will vary from actual Ni contained if ore mined was not at average grade and moisture contents.) Cobalt may be recovered from ore sent to Yabulu. Antam began selling new product to Yabulu called low-grade saprolite ore (LGSO) from Pomalaa mine to offset some production of low-grade limonitic ore.						
	PT Antam Tbk	Pomalaa FeNi I and FeNi II plants, smelter lines	10 302	8 804	–	II
Remarks: Production decreased due to labour interruption and two smelter shut-downs for repairs at the FeNi II unit kiln and power plant. Feed grade of ore to FeNi smelter is about 2.4% Ni. Company has toiling agreement with Pacific Metals Co of Japan. Financing for expansion of FeNi capacity to 26,000 t/y Ni in FeNi approved by shareholders in June whereby assets pledged as collateral and German Export Credit Agency to insure US\$ 240 million in loans from banks, US\$ 75 million to be obtained from domestic banks and remainder of US\$ 390 million to come from Antam's equity. Project anticipated to begin in March 2003.						
	PT International Nickel Indonesia Tbk (PT Inco)	Soroako mine, smelter	62 600	59 500	–	M
Remarks: Five-month furnace rebuild brought forward to September when canal leak forced temporary shut-down. Plant demonstrated operation at rated capacity of 68 000 t/y during December quarter. Ore grade increased to 1.77% Ni from 1.69% Ni in 2001 and stripping rate increased to expose more ore. Agreement with PT Antam to develop East Pomalaa orebody as feed source for Antam's FeNi smelters, delivering 1 Mt/y of saprolitic ore for US\$7/wet tonne based upon a mining cost of US\$ 4/wet tonne.						
<b>JAPAN</b>	Hyuga Smelting Co., Ltd.	FeNi smelter at Hyuga, Miyazaki Prefecture	21 800	(e) 19 000	–	II
Remarks: Owned 60% by Sumitomo; intention to expand production to 25 000 t/y Ni in FeNi from current 19 000 t/y announced in 2000, no construction reported in 2002; obtains feed from New Caledonia and Indonesia.						
	Inco TNC Limited	Nickel refinery located at Matsuzuka, Mie Prefecture	(e) 48 000	(e) 49 000	–	II
Remarks: About 20% of total PT Inco Ni matte sent to Sumitomo for refining to metal with remainder going to Inco TNC for conversion to NiO, which is used in stainless steel industry in Japan and as feed to Ni refineries in Korea and Taiwan (in which Inco has interests). Production estimate based upon quantity of finished Ni reported produced from PT International Nickel less deliveries to Sumitomo.						

	Nippon Yakin Kogyo Co., Ltd.	FeNi smelter at Oheyama, Kyoto Prefecture	12 445	12 400	–	II
--	------------------------------	-------------------------------------------	--------	--------	---	----

Remarks: Produces FeNi from imported ore from New Caledonia and Indonesia (PT Antam).

	Pacific Metals Co., Ltd.(Pamco) Prefecture	FeNi smelter at Hachinohe, Aomori	42 000	(e) 40 500	–	II
--	-----------------------------------------------	-----------------------------------	--------	------------	---	----

Remarks: Has toll smelting arrangement with PT Antam. Produces FeNi from ore imported from Indonesia and Philippines. Ore contract was suspended by New Caledonian producer SMSP in early 2001.

	Sumitomo Metal Mining Co., Ltd.	Electrolytic refinery at Niihama, Ehime Prefecture	32 526	32 300	355	I
--	---------------------------------	-------------------------------------------------------	--------	--------	-----	---

Remarks: Plant capacity to be increased from 36 000 t/y Ni to 45 000 t/y Ni by mid-2004 to handle additional feed including material from Coral Bay Nickel project in Philippines. Sumitomo apparently had been ready to purchase a 25% share of the Goro project in New Caledonia, but this was halted due to the anticipated cost-overruns at the project, which resulted in the suspension of Goro pending a re-evaluation. Capacity could be increased to as high as 60 000 t/y Ni and 1100 t/y Co.

<b>KAZHAKSTAN</b>	Kempirsai Mining Directorate	Laterite mines	?	?	–	L
-------------------	------------------------------	----------------	---	---	---	---

Remarks: No information available about production; mines thought to be inactive.

<b>NEW CALEDONIA</b>	Sociète des Mines de la Tontouta (SMT)	Nakety, Moneo and Karenbe mines and Nakety/Bogata project with Argosy/Norilsk	?	?	–	L
----------------------	-------------------------------------------	----------------------------------------------------------------------------------	---	---	---	---

Remarks: Exported 956 000 t of garineritic ore to Sumitomo's FeNi smelter in Japan in 2002. MMC Norilsk Nickel terminated purchase agreement with Argosy Minerals Inc. to buy into the Nakety/Bogota project.

	Le Nickel-SLN	Doniambo FeNi smelter	58 973	59 867	?	II, M
--	---------------	-----------------------	--------	--------	---	-------

Remarks: Expansion plans to take production at Doniambo smelter to 75 000 t of Ni in FeNi. Doniambo is already the world's largest FeNi smelter. Part of output is in form of nickel matte, which is sent to France for refining. Output in 2002 was 11 323 t Ni in matte and 47 799 t Ni in FeNi. Cobalt recovered in France and presumably contained in matte exported.

	Le Nickel-SLN	Kouaoua, Nepoui Kopeto, Tiebaghi, Thio, and Poro mines	?	?	?	L
--	---------------	-----------------------------------------------------------	---	---	---	---

Remarks: Mines produced 2.6 Mt of garnieritic ore. SLN exported 166 000 t of garnieritic ore to Nippon Yakin and Sumitomo FeNi smelters in Japan as well as 475 000 t of limonitic ore to BHP Billiton plc's QNI refinery in Australia.

	La Société Minière du Sud Pacifique S.A.	Various mines on both coasts and Koniambo project with Falconbridgeincluding	(e) 6500 including limonite exports	(e) 6500 including limonite exports	?	L
--	------------------------------------------	---------------------------------------------------------------------------------	----------------------------------------------	----------------------------------------------	---	---

Remarks: Owned by investment agency of the Northern Province. Exports were 440 000 t (wet) of high-grade ore in 2001 and in 2002. Principal customers were Sumitomo (Hyuga plant) and Nippon Yakin in 2002. Company also ships limonitic ore to QNI in Australia. SMSP holds 51% of Koniambo project being studied by Falconbridge (60 000 t/y of Ni in FeNi planned).

TABLE 6 (cont'd)

Country	Company	Operation	Nickel Output 2001	Nickel Output 2002	Cobalt in 2002	Type of Ni output
				(t)		
	Société Minière Georges Montagnat S.A.	Tontouta open pit	(e) 3500 not including limonite expos	(e) 2500 not including limonite expos	—	L
Remarks: Leases Tontouta pit from SLN; exported 169 000 t in 2002 to Japanese FeNi smelters compared to 225 000 t in 2001. Also ships limonitic ore to QNI in Australia.						
<b>NORWAY</b>	Nikkel og Olivin A/S	Mine, mill	2 500	1 700	(e) 80	S
Remarks: Mine ceased operation Oct. 18 due to depletion of ore; total production from 1989 to 2002 was 32 500 t of Ni, 9140 t of Cu and 1530 t of Co in concentrates.						
	Falconbridge Nikkelverk Aktieselskap	Nikkelverk refinery	68 221	68 533	3 994	I
Remarks: Refinery established new production record for Ni and other metals during Q3; forecast production of 72 000 t of Ni in 2003 with increased custom feed (note: based upon doubling of Tati Nickel concentrate production, which is sent to BCL and then to Nikkeverk); plant capacity of 85,000 t/y Ni, 40 000 t/y Cu, and 4500 t/y Co was confirmed during Q3; company could expand operation to 100 000 t/y Ni, 60 000 t/y Cu and 5000 t/y Co if market conditions warrant. Falconbridge approached by Fox Resources Limited about possible plans to produce intermediate feed to be produced from sulphuric acid leach of 50 000-t ore stockpile at former Radio Hill mine. Plant produced 11 t of PGMs in 2002 compared to 7.3 t in 2001. Falconbridge cobalt production includes toll refined material from WMC Resources, secondary feed and any cobalt recovered from BCL matte.						
	Titania A/S	TiO, magnetite mine	400	(e) 400	?	S
Remarks: By-product low-grade Ni concentrate is sent to Outokumpu's smelter at Harjavalta, Finland.						
<b>PHILIPPINES</b>	Cagdianao Mining Corporation	Mine	3 000	?	—	L
Remarks: No public information is available about mine production in 2002. All Ni mines in Philippines together are reported to have produced 24 000 t of Ni in ore in 2002.						
	Coral Bay Nickel Corporation	Mine/HPAL plant	—	—	—	S
Remarks: Project under construction for completion in late 2004. Sumitomo's HPAL process to take stockpiled limonitic ore as feed to produce intermediate sulphides containing about 10,000 t/y of Ni and 700 t/y of Co to be processed at Sumitomo's refinery in Japan. Delays due to environmental concerns. Project owned 54% by Sumitomo, 18% by Mitsui & Co, 18% by Nissho Iwai and 10% by Rio Tuba Nickel Mining Corporation (itself owned 27% by Pacific Metals Corporation, plus 4%-5% by each of Nippon Steel, Nisshin Steel, and Nissho Isai).						
	Hinatuan Mining Corporation	Mine	—	—	—	L
Remarks: Mine believed to remain closed (since 2000). Permission to ship stockpiled ore was denied in 2001. No further information available.						



Rio Tuba Nickel Mining Corporation	Rio Tuba mine	4 350	?	–	L
------------------------------------	---------------	-------	---	---	---

Remarks: Company part owner of Coral Bay Nickel HPAL project ([see entry](#)). No public information about Rio Tuba production in 2002 available. All Ni mines in Philippines together are reported to have produced 24 000 t of Ni in ore in 2002.

Taganito Mining Corporation	Mine located in Suriago del Norte	13 000	?	–	L
-----------------------------	-----------------------------------	--------	---	---	---

Remarks: No public information about mine production in 2002 available. All Ni mines in Philippines together are reported to have produced 24 000 t of Ni in ore in 2002.

<b>RUSSIA</b>	MMC Norilsk Nickel	Taimyr Peninsula - 7 mines, 2 mills, 2 smelter/refineries (see mine names <a href="#">below in notes</a> )	?	?	?	I,M
---------------	--------------------	------------------------------------------------------------------------------------------------------------	---	---	---	-----

Remarks: Mines produced 13 Mt and were source of most of company's nickel, copper, cobalt and all PGMs. Division mined 13 Mt of ore in 2002. Outokumpu involved in ongoing modernization of smelters and refineries. In 2001, Oktaybrsky mine was most important of producing mines, accounting for half the nickel and 53% of PGMs produced by Arctic Division. Author estimates that Arctic Division was source of about 180 000 t of finished Ni produced by the company.

MMC Norilsk Nickel	Pechanganickel in Kola Peninsula - 3 mines, mill, agglomeration plant, smelter ( <a href="#">see mine names below in notes</a> )	?	?	?	M
--------------------	----------------------------------------------------------------------------------------------------------------------------------	---	---	---	---

Remarks: Ni tonnage is estimate of finished nickel production originating in Kola mines. Division produced 7 Mt of ore. Matte from Nikel smelter near mines shipped to Severonickel for refining. Modernization of smelter begun in 2001 after grant of US\$31 million from Norwegian government and US\$30 million credit from Nordic Investment Bank. Severny-Glubkoy mine is focus of investment in division. Author's estimate that Kola supplies about 35 000-40 000 t of finished nickel produced by Norilsk in 2002.

MMC Norilsk Nickel	Severonickel refineries in Kola Peninsula	?	?	?	I
--------------------	-------------------------------------------	---	---	---	---

Remarks: Processes matte from Pechanganickel's Nikel smelter plus matte from Arctic Division, plus domestic and imported scrap and recyclables, including auto catalysts; some carbonyl nickel production.

MMC Norilsk Nickel, all divisions	223 000	218 000	4 200	I
-----------------------------------	---------	---------	-------	---

Remarks: Mine production was 20 Mt @ 1.40% Ni, 2.14% Cu, 5.94 g/t PGMs in 2002. Production forecast is 240 000 t for 2003. Investment plan to 2015 approved in December, allocating US\$125 million per year in Arctic Division, US\$25 million per year in Kola operations (likely mines) plus US\$30 million per year in milling. In addition, US\$80 million per year for smelter improvements over five years. In May, Norilsk obtained permission to sell PGMs directly to customers. Norilsk is the world's largest producer of nickel and palladium. For more details about operations, see company annual report for 2002 at [www.nornik.ru/upload/findocs/2003/MMC\\_2002\\_AR\\_Eng.pdf](http://www.nornik.ru/upload/findocs/2003/MMC_2002_AR_Eng.pdf).

Rezh Nickel Plant Joint Stock Company	Talovsk mine, smelter	4 400	2 823	?	M
---------------------------------------	-----------------------	-------	-------	---	---

Remarks: Plant re-opened in April after five-month shut-down. Reportedly two of four furnaces in operation by July. Trial shipment of 300 t of Ni matte to Jinchuan Nickel in China reported.

Ufaleynikel Joint Stock Co.	Ufaley and Serovskoye mines, refinery	(e) 9 500	6 500	2 100	II, I
-----------------------------	---------------------------------------	-----------	-------	-------	-------

Remarks: Plant closed in Q3 of 2001 due to low nickel prices; nameplate capacity of 17 000 t/y Ni as granules and in FeNi unlikely achievable, and effective capacity estimated at about 7000 t/y of Ni in granules from Rezh matte; tolls Co to produce metal and oxide (possible double counting with respect to Norilsk output); status of Ni laterite mines at Ufalei and Serov unknown.

TABLE 6 (cont'd)

Country	Company	Operation	Nickel Output		Cobalt in 2002	Type of Ni output
			2001	2002		
				(t)		
	Yuzhuralnikel Kombinat Joint Stock Co.	Buruktalskoye mine (Orenburg region) and Sakharinskoye mine (Chelyabinsk region)	(e) 13 600	18 400	?	L
	Remarks: Production 70% Ni and 30% Ni in FeNi. Mechel Steel Group owns 70% of operation. Feb. 2002 report that production for month had risen to 950 t of Ni after repair and restart of another furnace. Company likely supplying Ni for Mechel operations. Production estimate updated for 2001.					
<b>SERBIA-KOSOVO</b>	Ferro-Nickel D.D. Glogovac	Cikotava and Gllavica laterite mines and FeNi smelter near Pristina	–	–	–	II
	Remarks: Plant believed to be inactive during 2002.					
<b>SOUTH AFRICA</b>	Anglo American Platinum Corporation Limited	Underground and open-pit mines, smelters, base-metal and precious-metal refineries	19 500	19 400	–	I
	Remarks: Nickel is a by-product of mining PGMs. Company's expansion program to 2006 will increase company's nickel output to 33 000 t/y at "steady state." New mines under development, UG2 concentrator to be expanded; Polokwane smelter expected to be completed in late 2003. Anglo Converting Process (ACP) to replace Pierce Smith converters with Austmelt technology allowing increased sulphur dioxide capture.					
	Anglovaal Mining Limited, Anglo American plc	Nkomati JV mine/mill	4 400	5 025	60	S
	Remarks: Cobalt data refer to "sold" material and contained Co could be twice this value; environmental permitting for expansion to 16 000 t/y refined Ni output continuing at year-end; company also examining "various alternatives." Expansion project to 16 000 t/y Ni and 900 t/y Co plus copper and PGMs apparently continues to be delayed.					
	Impala Platinum Holdings Limited	Various mines, smelter and base-metals refinery in Bushveld complex	(e) 13 500	(e) 13 900	–	I
	Remarks: Ni is by-product of PGM operations; Impala supplements own feed with tolled and purchased concentrates processed by Impala Refining Services (IRS); FY 2003 nickel production was 8000 t from own mines plus 6700 t from tolled and refined concentrates. Plan to study expansion of Ni refinery to handle 40 000 t/y Ni and 4000 t/y Co in intermediates from potential revival of Nonoc operation on hold. Handles nickel in PGM concentrates from Zimbabwean mines. Calendar year production estimated based on average fiscal year production rates.					
	Lonmin plc	Eastern Platinum Limited, Western Platinum Limited mines, smelter and refinery	?	?	–	Ch
	Remarks: Ongoing US\$500 million expansion; Ni is by-product of PGM operation; INSG put capacity at 3000 t/y Ni as Ni sulphate; production data not released; Lonmin plans expansion of platinum production by about 50% from 2001 levels, implying some increase in Ni by-product production can be expected.					

	Northern Platinum Limited	Mines, mills, smelter, base-metal removal plant	1 400	(e) 1 400	–	Ch
Remarks: Ni is by-product of PGM operation; produces approximately 1400 t/y Ni in concentrate, which is sold in form of Ni sulphate to Anglo American Platinum Corporation Limited.						
<b>SOUTH KOREA</b>	Korea Nickel Corporation	Onsan refinery	28 000	29 000	–	II
Remarks: Produces Class II Ni (UTILITY™ grade at 97%); feed includes NiO feed from Inco Sudbury operation and Inco TNC in South Korea as well as Australia and Russia. Imports of NiO during 2002 were 40 000 t gross weight equal to about 31 500 t of contained Ni.						
<b>SPAIN</b>	Rio Narcea Gold Mines, Ltd	Aguablanca project	–	–	–	S
Remarks: Company completed bankable feasibility study for nickel sulphide mine/mill to produce up to 10 000 t/y of nickel in concentrate. Financing for US\$64 million project secured in Dec.						
<b>TAIWAN</b>	Taiwan Nickel Refining Corporation	Transforms NiO to make UTILITY™ Ni (97% Ni) at Kaohsiung Hsien	(e) 10 000	(e) 13 400	–	II
Remarks: Transforms NiO UTILITY™ Ni; plant output estimated assuming 76% Ni in feed and 99% recovery in process with no changes in inventory; data are not released.						
<b>TURKEY</b>	European Nickel plc and As Krom through Bosphorus Nickel	Çaldag mine	–	–	–	L
Remarks: Mine purchased by European Nickel plc in late 2002; contract with LARCO for 500 000 t/y of laterite ore planned to start after Nov. 2002 (resource grade is 1.4% Ni with approximately 0.05% Co). European Nickel plans heap leaching tests using 5000 t of ore and technology similar to that developed by Titan Resources. Target is to produce 20 000 t/y of Ni-Co sulphides annually.						
<b>UKRAINE</b>	Nikomel Limited	Pobuzhsky Ferronickel Works	1 500	–	–	II
Remarks: Plant was planning to receive 0.5 Mt laterite ore from SMSP but no details of trade found. Plant reported under rehabilitation in mid-2003 indicating that it probably did not operate in 2002. Test shipment of 90 000 t ore in 2001 could have allowed production test of about 1500 t in 2001.						
<b>UNITED KINGDOM</b>	Inco Limited	Clydach carbonyl refinery	33 800	33 300	–	I
Remarks: Takes NiO from Sudbury to produce Ni pellets, foams and powders; residue from refining is returned to Sudbury for reprocessing; data shown are INSG production reported for U.K. These data are counted by Inco in Ontario division production totals.						
<b>UNITED STATES</b>	Stillwater Mining Company	Mines, mill, pgm smelter/refinery	358	639	–	Ch
Remarks: Palladium operation producing by-product nickel sulphate, which is shipped to Canada for recovery. Norilsk Nickel made offer to purchase 51% ownership in Stillwater in November for US\$100 million cash and US\$240 million in palladium inventory.						
<b>VENEZUELA</b>	Minera Loma de Niquel, C.A.	Loma de Niquel mine, FeNi smelter	9 700	15 500	–	II
Remarks: Mining increased to 1.3 Mt with 1.1 Mt @ 1.7% being processed to yield 15,500 t Ni in FeNi (FeNi grade is 27% Ni).						

TABLE 6 (cont'd)

Country	Company	Operation	Nickel Output		Cobalt in 2002	Type of Ni output
			2001	2002		
				(t)		
<b>ZIMBABWE</b>	Bindura Nickel Corporation Limited	Trojan and Shangani mines, smelter, refinery	7 400	7 750	?	I
	Rio Tinto Zimbabwe Limited	Empress refinery	6 635	6 412	?	I
	Mimosa Mining Company (Pvt) Limited	Mine/mill	(e) 200	413	–	S
	Makwiro Platinum Mines (Private) Limited (owned by Zimbabwe Platinum Mines Limited)	Ngezi mine and Selous metallurgical complex mill and smelter	–	929	–	M

Remarks: As Bindura operates the only nickel mines in the country, INSG data for country mine production used as estimate of company's mine production. Company tolls matte plus recovers undetermined tonnage of nickel from chemicals from South Africa. In December Bindura warned that company would close unless currency controls were modified (2001 data updated to reflect INSG mine production data for Zimbabwe).

Remarks: Toll refines matte from BCL by leaching and electrowinning.

Remarks: PGM operation producing by-product nickel. Output sent to Impala for refining. Expansion to increase PGM production by 400% to be completed in late 2003. Impala and Aquarius Platinum Limited each own 50% of Mimosa's parent company, ZCE Platinum Limited. Production for 2002 and estimate for 2001 are for financial years ending in mid-2003 and mid-2002, respectively.

Remarks: PGM operation producing by-product nickel and copper. Nickel in ore grades in order of 0.1% Ni. 1.6 Mt open pit ore hauled to Selous flotation concentrator (at former Hartley mine, now closed). Concentrate smelted and matte sent to Impala for recovery in South African refinery. Nickel sales reported and production estimated to be higher than sales in 2002.

Sources: Various web sites and press releases as well as commercial publications.

(e) Author estimate; n.a. Not applicable.

Ch = Ni content in Ni chemicals; Co = cobalt; FeNi = ferronickel; I = Class I Ni (e.g., cathodes, briquettes, pellets, powders, etc., which have a Ni content of 99% or more); II = Class II Ni (e.g., products with a Ni content of less than 99% such as FeNi, NiO, UTILITY™ Ni); L = laterite ore; M = matte; NiO = nickel oxide; S = sulphide concentrates; SO = sulphide ore mined; T = Ni intermediates such as Ni carbonates, Ni sulphides or Ni hydroxides.

\*\* In December, WMC Limited was split into two entities: Alumina Limited and WMC Resources Ltd. The latter contains the metals assets of the former WMC Limited.

Notes: Cobalt Development Institute data for cobalt production used when producer data not available or are listed as sales or deliveries.

Norilsk mines nickel in two divisions: the **Arctic division** in the Taimyr Peninsula and the Kola Peninsula. The deposits and mines in the Arctic division are: Oktabrynsky deposit -- mined by Otkaybrsky mine and Taimyrsky mine, both underground operations; Talknak deposit -- mined by Komsomolsky, Mayak and Skalistaya mines, all underground mines; the Skalistaya mine is under construction and may be delivering only development ore to the mills; Norilsk 1 deposit -- mined by Zapolyarny underground mine and Medvezhy Ruchey open-pit mine. The deposits mined in the **Kola peninsula** are: Zhdanovskoye deposit - mined by Tsentralny open pit and the Severny Glubokiy underground mine, the latter under development. Zapolyarnoe deposit -- mined by Severny mine and Kaul-Kotseivaara underground mines.

**TABLE 7. CANADIAN NICKEL PROCESSING CAPACITY, 2002**

	Smelter	Refinery
	(t/y of contained nickel)	
Falconbridge Limited Sudbury, Ontario	70 000	n.a.
Inco Limited Sudbury, Ontario	100 000	59 000
Sudbury, Ontario (1)	18 000	n.a.
Thompson, Manitoba (2)	n.a.	55 000
The Cobalt Refinery Company Inc. Fort Saskatchewan, Alberta	n.a.	32 000
Canmine Resources Corporation (3) Cobalt, Ontario	n.a.	300

Source: Natural Resources Canada.

n.a. Not applicable.

(1) Produces nickel oxides sinter. (2) Thompson smelter capacity listed at 63 000 t/y in 2001. (3) Plant shut by financial problems before capacity could be established; production to have been by-product nickel in salts.

**TABLE 8. WORLD MINE PRODUCTION OF NICKEL,<sup>(1)</sup> 1998-2002**

	1998	1999	2000	2001	2002
	(000 tonnes)				
Russia	235	235	235	235	237
Australia	144	119	(r) 166	205	189
Canada	208	186	191	194	188
New Caledonia	125	(r) 110	118	118	100
Indonesia	74	89	98	102	122
Cuba	68	67	(r) 71	77	77
Colombia	29	39	59	53	58
China	48	50	51	52	55
Brazil	33	33	(r) 36	34	36
South Africa	36	36	37	36	39
Other (14 countries)	117	93	112	119	130
Total	1 117	(r) 1 058	(r) 1 174	1 224	1 229

Source: INSG *World Nickel Statistics* (October 2003).

(r) Revised.

(1) Ni content of sulphide concentrates or Ni content of lateritic ore mined.

Notes: Totals may not add due to independent rounding.

**TABLE 9. WORLD PRODUCTION OF PRIMARY NICKEL, 1998-2002**

	1998	1999	2000	2001	2002
	(000 tonnes)				
Russia	227	228	(r) 221	252	239
Japan	127	134	161	154	158
Canada	147	124	134	141	145
Australia	80	79	111	128	132
Norway	70	74	59	68	69
China	40	45	51	50	54
New Caledonia	45	45	44	46	49
Cuba	39	39	40	41	41
United Kingdom	36	36	(r) 37	33	39
South Africa	39	38	38	34	34
Dominican Republic	21	23	23	23	24
Other (13 countries)	165	158	165	191	198
<b>Total</b>	<b>1 035</b>	<b>1 024</b>	<b>1 083</b>	<b>1 160</b>	<b>1 179</b>

Source: INSG *World Nickel Statistics* (October 2003).

(r) Revised.

**TABLE 10. WORLD USE<sup>(1)</sup> OF PRIMARY NICKEL, 1998-2002**

	1998	1999	2000	2001	2002
	(000 tonnes)				
Japan	169	183	200	162	191
United States	150	152	150	129	115
Germany	97	101	104	110	110
Taiwan	42	47	62	83	92
South Korea	70	89	(r) 90	81	91
China	68	81	78	75	83
Italy	53	55	(r) 53	57	67
France	55	52	(r) 50	51	53
Spain	31	38	38	44	47
Finland	37	41	43	39	41
Other (more than 25 other countries)	274	244	256	273	282
<b>Total</b>	<b>1 009</b>	<b>1 082</b>	<b>1 123</b>	<b>1 104</b>	<b>1 171</b>

Source: INSG *World Nickel Statistics* (October 2003).

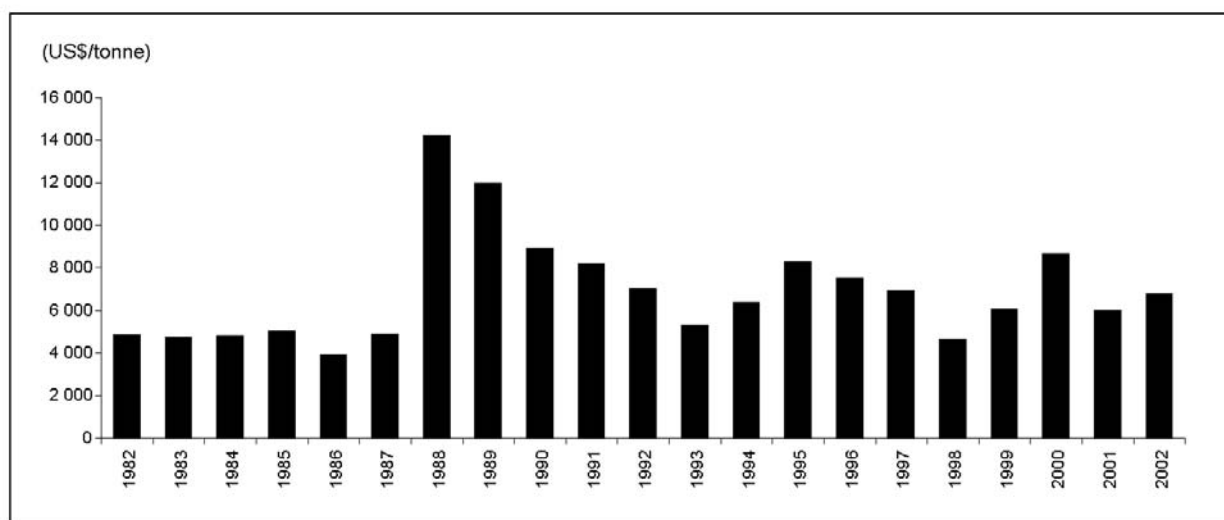
(r) Revised.

(1) The term "use" replaces "consumption" to reflect the fact that nickel is not being "used up" in its applications; over 500 000 t/y of nickel is recycled yearly, which is not included in the above data.

**TABLE 11. AVERAGE ANNUAL  
NICKEL PRICES, 1981-2002**

	Settlement Price	
	(US\$/t)	(converted to 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
1999	6 015	2.73
2000	8 641	3.92
2001	5 948	2.70
2002	6 772	3.07

Sources: INSG *World Nickel Statistics* (various issues); London Metal Exchange; *Metal Bulletin*.

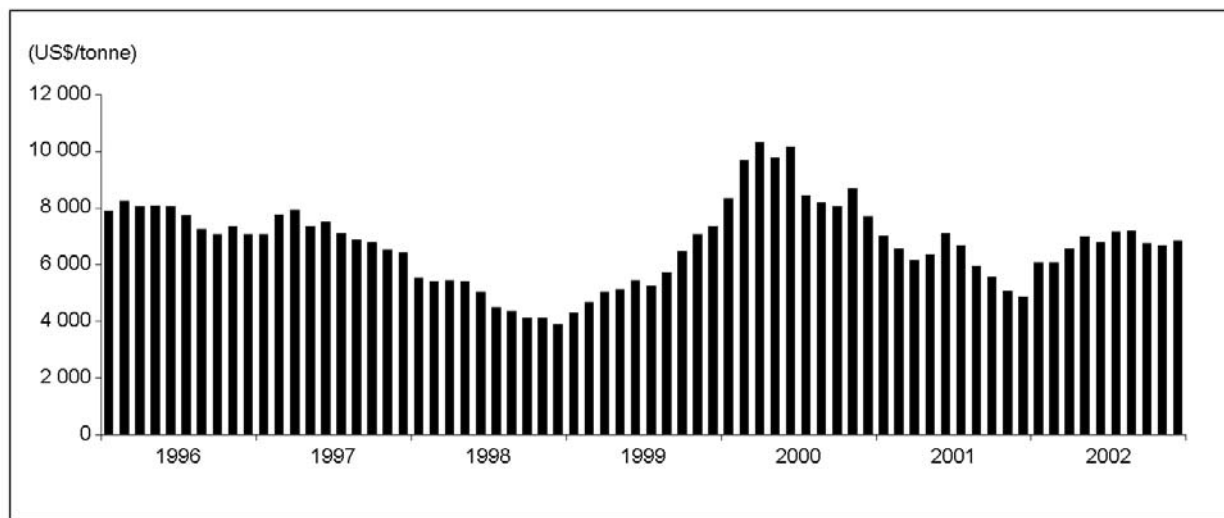
**LME Settlement Nickel Price, Annual Average, 1982-2002**

Sources: *Metal Bulletin*; Metalprices.com; London Metal Exchange; International Nickel Study Group.

**TABLE 12. AVERAGE MONTHLY NICKEL PRICES, SETTLEMENT PRICE, 1996-2002**

	1996	1997	1998	1999	2000	2001	2002
	(US \$/t)						
January	7866	7047	5495	4272	8314	6999	6047
February	8219	7737	5390	4630	9658	6528	6033
March	8024	7899	5399	5015	10284	6138	6541
April	8047	7318	5397	5106	9731	6334	6962
May	8030	7485	5023	5403	10134	7064	6764
June	7712	7065	4479	5198	8415	6645	7123
July	7207	6838	4329	5704	8168	5940	7146
August	7057	6763	4084	6452	8010	5525	6720
September	7321	6507	4106	7031	8642	5030	6644
October	7034	6383	3875	7325	7683	4828	6808
November	6946	6142	4135	7953	7344	5082	7317
December	6584	5949	3881	8087	7319	5268	7197
	(converted to US\$/lb)						
January	3.57	3.20	2.49	1.94	3.77	3.17	2.74
February	3.73	3.51	2.44	2.10	4.38	2.96	2.74
March	3.64	3.58	2.45	2.27	4.66	2.78	2.97
April	3.65	3.32	2.45	2.32	4.41	2.87	3.16
May	3.64	3.40	2.28	2.45	4.60	3.20	3.07
June	3.50	3.20	2.03	2.36	3.82	3.01	3.23
July	3.27	3.10	1.96	2.59	3.70	2.69	3.24
August	3.20	3.07	1.85	2.93	3.63	2.51	3.05
September	3.32	2.95	1.86	3.19	3.92	2.28	3.01
October	3.19	2.90	1.76	3.32	3.48	2.19	3.09
November	3.15	2.79	1.88	3.61	3.33	2.31	3.32
December	2.99	2.70	1.76	3.67	3.32	2.39	3.26

Source: INSG, various issues of *World Nickel Statistics* to April 2002.

**Monthly Average LME Settlement Price of Nickel, 1996-2002**

Sources: *Metal Bulletin*; Metalprices.com; London Metal Exchange; International Nickel Study Group.



**TABLE 13. REFINED COBALT PRODUCTION, 1997-2002**

Company	1997	1998	1999	2000	2001	2002
(tonnes)						
<b>PRODUCTION OF COMPANIES BELONGING TO THE COBALT DEVELOPMENT INSTITUTE</b>						
OMG	5 000	5 250	6 200	7 700	8 100	8 200
Zambia (a)	3 949	5 011	3 946	(c) 2 316	(c) 2 789	4 344
Russia	3 800	3 700	4 000	4 100	4 600	4 200
Falconbridge	3 417	3 851	4 009	3 433	3 314	3 993
ICCI	2 250	2 640	2 770	2 855	2 943	3 065
Gécamines	2 808	4 490	(b) 5 180	4 320	3 199	2 149
QNI	617	1 395	1 539	1 520	1 818	1 863
China	1 200	1 200	1 200	1 200	1 470	1 842
Murrin Murrin			83	925	1 452	1 838
Mopani Copper				1 026	1 876	1 800
Inco	1 500	1 740	1 420	1 470	1 450	1 480
Umicore (1)	1 200	1 200	950	1 110	1 090	1 135
CTT	220	241	470	1 200	1 200	1 100
Brazil	266	364	630	792	889	960
Kasese			77	420	634	450
Sumitomo	263	329	221	311	350	354
India	110	120	120	206	250	270
South Africa	294	320	320	320	252	250
Bulong			79	192	203	200
Eramet	159	172	180	204	199	176
Subtotal	27 053	32 023	33 394	35 621	38 078	39 669
<b>STOCKPILE DELIVERIES</b>						
DLA	1 621	2 310	1 679	3 083	1 893	1 284
<b>TOTAL COBALT AVAILABILITY</b>						
Grand total	28 674	34 333	35 073	38 704	39 971	40 953

Source: *Cobalt News*, 02/2, April 2002, The Cobalt Development Institute. Table re-arranged in order of descending production for 2002; data reproduced with permission of The Cobalt Development Institute.

"Refined cobalt" includes:

All cobalt units whether in metal or chemicals that are derived from feed requiring further refining.

The following materials are NOT counted as feed: DLA or other stockpile releases, Russian output, production from Likasi, and lower-grade production from Moroccan mines.

(a) Zambian production includes ZCCM, RAMZ, and Avmin.

(b) Revised to include Central Mining Group.

(c) Chambishi Metals plc production only.

(e) Estimate.

(1) Union Minière SA changed its name to Umicore.

ICCI = International Cobalt Company Inc. (marketed by Sherritt International Corporation)

OMG = OM Group, Inc.

CTT = Cie. de Tifnout-Tiranimine

DLA = Defense Logistics Agency

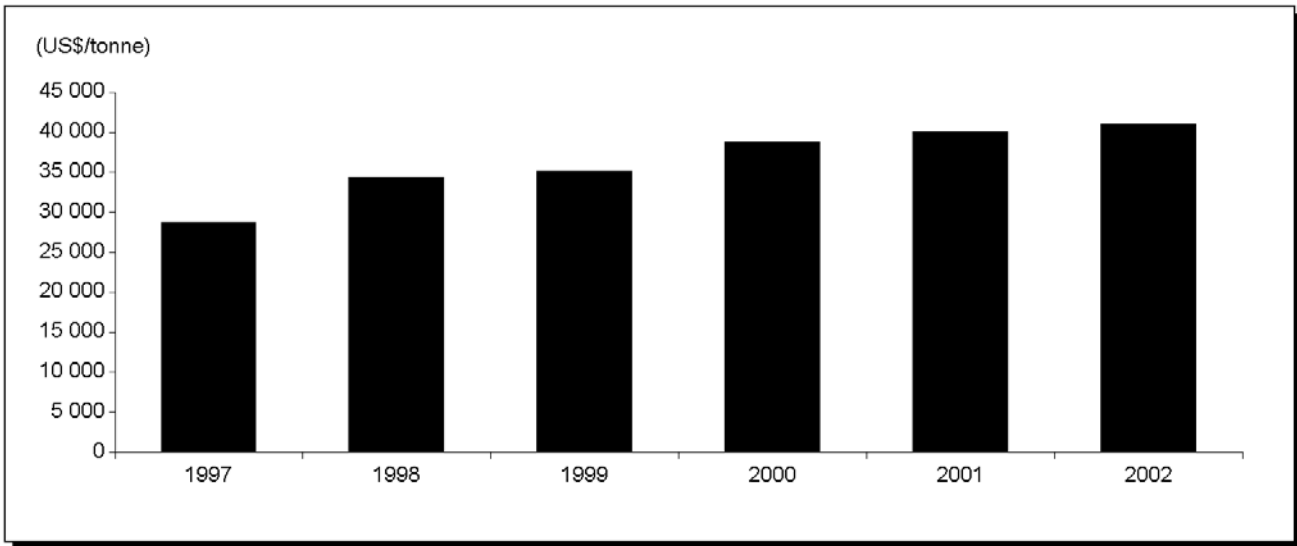
ZCCM = Zambia Consolidated Copper Limited

RAMZ = Roan Antelope Mining Corporation

Gécamines = La Générale des Carrières et des Mines

Mopani Copper = Mopani Copper Mines plc (a JV comprising the Mufilira mine/smelter/refinery plus the Nkana mine and cobalt plant)

### Cobalt Availability, 1997-2002



Source: Cobalt Development Institute data, *Cobalt News* 03/2.  
Note: Availability = company production plus DLA deliveries.

---